The Peanut Collaborative Research Support Program (CRSP)

2005 External Evaluation Report

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The Peanut Collaborative Research Support Program

External Evaluation Panel

2005 Report

Acronyms

AARP	American Association of Retired Persons
ANAPO	*La Asociación Nacional de Productores de Oleaginosas y Triga* (of Bolivia**)**
BIFAD	Board for International Food and Agriculture Development
CDC	Centers for Disease Control and Prevention (of the U.S.A.)
CGIAR	Consultative Group for International Agricultural Research
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement* or Centre for International Cooperation for Agricultural Research for Development (of France)
CRSP	Collaborative Research Support Program
EEP	External Evaluation Panel
ENEA	*l'Ecole Nationale d'Economie Appliquee* (of Senegal)
EU	European Union
FDA	Food and Drug Administration (of the United States.)
H.B.C.U	Historically Black Colleges and Universities
H.C.	Host Country
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome;
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IPM	Integrated Pest Management
MDG	Millennium Development Goal
ME	Management Entity (of the Peanut CRSP)
M.S.	Master of Science degree
NARS	National Agricultural Research Centers
NGO	No-Governmental Organization
Ph.D.	Doctor of Philosophy degree
PIIM	Peanut Industry Incubator Model
P.I.	Principal Investigator
SCR	Southern Corn Rootworm
TSWV	Two spotted wilt virus
U.S.A./U.S.	United States of America
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WHO	World Health Organization

The Peanut Collaborative Research Support Program External Review Panel Report 2001-2005

The Mission:

Economic and social advancement through development of sustainable, environment- and health-protecting peanut-based industries in developing countries and the U.S.A.

Executive Summary

The External Evaluation Panel (EEP) of the Peanut Collaborative Research Support Program (CRSP) has reviewed the program's achievements and impact, focusing on the last five years. Based on documented results and field visits the EEP concludes that the Peanut CRSP has:

- been a highly effective and innovative program;
- made a difference in the lives of many beneficiaries and increased the institutional and human capacity of its partner research institutions (particularly in Africa where economic advancement has been elusive);
- through open competition involved many US Universities including two Historically Black Colleges and Universities (HBCU);
- produced advanced technologies that are likely to provide realizable and affordable health benefits to developing countries by reducing impaired nutrition and infectious diseases;
- developed an industry incubator model for trade and enterprise development and facilitated partnership with the private sector;
- developed successful production technologies which have been adapted and transferred to improve incomes of farmers especially in Africa and Latin America; and
- helped realize the mission of the United States Agency for International Development (USAID) and the Millennium Development Goals (MDGs) of reduced poverty, greater gender equity, improved environment, and increased access to trade and partnerships.

1 Introduction

The current Peanut CRSP Grant began in 1996 with program adjustments made in 2001 based on the 2000 EEP Review. The Peanut CRSP uses a value-chain approach developed around five thematic or cluster areas: (1) Food Safety and Nutrition; (2) Production Efficiency; (3) Socio-economics 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.A.) would be achieved. Plans were developed to resolve major constraints to the host countries and U.S.A. peanut sector and to ensure that social and gender issues were addressed.

This 2004-2005 review concluded that the Peanut CRSP had been highly effective in developing technologies through research in the five thematic/cluster areas, and the technologies transferred to farmers, entrepreneurs, and key stakeholders have resulted in significant impacts in the host countries and the U.S.A. The Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degree training, short-term training of host country scientists, and training of peanut farmers, entrepreneurs, and other stakeholders was important to technology transfer and is a major impact of the program. Institutional capacity has been developed. Information was made available worldwide through various media. Web-based program and fiscal management has been efficient and cost-effective.

Impacts, achievements and mechanisms for technology transfer within the five thematic cluster areas were identified and evaluated for their importance in the host countries and the U.S.A., and for the benefits to women who are most often peanut farmers and village level or small-scale peanut-food processors. These impacts and achievements are summarized as follows.

2 Food Safety and Nutrition Research

Specialized clay (NovaSil™) that is highly adsorptive of aflatoxins in the digestive tract of the animal was found in earlier Peanut CRSP research. NovaSil as a feed additive (0.25% of the feed) binds aflatoxin and prevents adsorption, metabolism, and subsequent aflatoxicosis in animals. Research to transfer this to human application was added in this phase[1]. A study showed that lifetime exposure to NovaSil was harmless to rats. Based on these results, a human study was conducted in the U.S.A. that showed no adverse nutritional effects from consuming the clay. The program has started to collect data on human safety and to test the efficacy of NovaSil in people in Ghana, who are naturally exposed to high levels of aflatoxin. Necessary Ghanaian Governmental clearances have been obtained.

Levels of aflatoxin biomarkers in the blood, rates of both hepatitis B and C infections, and immunity indicators were measured for people in the Ashanti Region of Ghana. This study established a baseline of aflatoxin exposure, and is the first study in the world that measured by flow-cytometry cellular immune status in relation to aflatoxin levels. Data on the

[1] Estimates of human exposure are that 4.5 billion people experience uncontrolled exposure to aflatoxin in developing countries. While widely recognized as a trade barrier and cause of cancer this toxin also suppresses immunity and impairs nutrition and through these mechanisms can be logically connected to 44% of the burden of disease in these countries (Williams et al. 2004. Am J Clin Nutr 80:1106-22).

proportions of leukocytes and the deficiencies in subsets of lymphocytes and monocytes, and in monocyte function are the first evidence of the association of high aflatoxin exposure levels with these types of immune impairment in humans.

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Peanut CRSP research on dietary intervention to remove aflatoxin through chemisorption is now being considered by the World Health Organization (WHO). This method has significant potential impact on many major health risks (i.e., diseases caused by suppressed immune systems, impaired nutrition, and cancer) in developing countries. An estimated 4.5 billion people are chronically exposed to aflatoxin from dietary sources and this cluster of Peanut CRSP projects offers a practical and low cost solution to this problem.

Gender studies in Uganda show that women farmers and housewives have no knowledge of aflatoxin, showing the need for extensive outreach and education. The socio-economics project in Ghana has trained professionals (900 in three workshops) to increase awareness of the aflatoxin problems. Producers, consumers, and processors (male and female) will be familiar with the prevalence and health effects of aflatoxins, and available interventions to manage contamination.

Nutrition research showed that peanut consumption is associated with improved lipid profiles (reduced cardiovascular disease risk) and has provided critical evidence that peanuts have a satiety factor that offsets the high-energy content making the food neutral for obesity. The initial Peanut CRSP research inspired other research and the pool of information contributed to the Food and Drug Administration (FDA) awarding a health claim for peanuts. Peanut CRSP research contributed to the reversal of an 18% reduction in peanut consumption in the U.S.A. during the 1990's, and current sales of peanut products are increasing more than 10% annually.

3 Production Efficiency Research

Significant impacts were achieved in peanut variety development. In Uganda and Malawi, the National Agricultural Research Programs released rosette-resistant, short-season cultivars bred by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and tested by Peanut CRSP participating scientists. In Uganda, it was estimated that the new varieties, when fully adopted by farmers, could contribute about US$47 million annually to the economy. A higher yielding, disease-resistant variety was released in Bolivia. New cultivars with disease resistance, seed dormancy, and oil quality that increase shelf life are near release in Senegal and Burkina Faso.

Contrasting rosette disease resistant and susceptible peanut lines.

A new variety was released in Texas with properties that reduce rancidity, which is benefiting processors by extending the shelf life of peanut products. A nematode-resistant variety was released in Texas and benefits producers in nematode-prone areas. Impact studies in North Carolina show continued benefit from CBR disease resistant varieties developed earlier with Peanut CRSP support. Cultivars introduced from Bulgaria yield 5-20% more than the local Valencia types in New Mexico. In Florida, genetic marker research is identifying genes for drought tolerance and other traits that have potential to decrease the time and costs for developing new varieties.

Improved crop production practices have doubled yields and caused five to six-fold increases in peanut areas in Bolivia and Guyana. In Ghana, farmers (50% are women) that adopted environmentally-friendly integrated pest management (IPM) practices have increased yields two-fold. IPM technology has been transferred through farmer field schools, television, radio, and other extension means. In Ghana and Benin, crop models have identified major constraints to production and showed that yield increases and reduced costs of production are attainable.

Farmers and scientists at a field day in Ghana.

In North Carolina, farmers who adopted the Tomato Spotted Wilt Virus (TSWV) Index reduced virus incidence by 50% in a single year. Since its adoption, there has only been one year of significant virus incidence. Also, the farmers and extension agents' adoption of the Southern Corn Rootworm (SCR) Advisory Index has reduced pest damage by 50% per year. The SCR treatment of preventive applications of insecticides has been reduced to only "high risk" areas. These environmentally-friendly advisory programs utilized Peanut CRSP research outputs.

4 Socio-economic, Gender and Policy Research

Significant socioeconomic impacts have been achieved in addition to those cited in the Food Safety and Nutrition Research section (gender concerns and aflatoxin awareness). Economic impact studies have documented the impacts of variety adoption and IPM practices in North Carolina, Thailand, Malawi, Uganda, Senegal and the Philippines. Peanut CRSP also documented the economic and health benefits of vitamin A-fortified peanut butter and aflatoxin-free peanut sauces in the Philippines.


Market issues being discussed with a peanut buyer in Guyana.

In Senegal, impact studies have shown a 25% yield increase when farmers adopted new varieties developed earlier by the Peanut CRSP. Socio-economic data in Senegal resulted in an increased number of publications on the impact of new varieties, pricing and marketing of peanuts, optimizing farm planning to reduce poverty, and peanut production and processing. The capacity of the host country institution was greatly increased in socio-economic research and the in the desire to publish information.

Policy research in West African countries, including Senegal, contributes to policy decisions soon to be made whether to join an economic partnership with the European Union or to enter into a Generalized System of Preferences; the latter is better for the peanut sector. Poverty could be reduced by 1.3%

through the full adoption of the rosette resistant varieties released in Uganda.

5 Post-harvest and Utilization Research

Peanut butter in a Philippines market stall.

In the Philippines, impact studies showed a 37% increase in peanut butter production in the Metro Manila area with the co-development of vitamin A-fortified peanut butter by the food industry. Children who are most at risk of vitamin A deficiency are the highest consumers. Adoption of hand sorting technology by a company to assure aflatoxin-free peanuts for production of a peanut sauce ("*Kare-kare*"), led to the company entering the U.S.A. market, with significant economic returns from increasing export volumes. Transfer of the technology to women's cooperatives in central Philippines improved the quality and packaging of a peanut product and significant increase in their income. Similar results were obtained in Thailand among village level peanut processors. Villages generally concentrate on processing of one product for market.

In the U.S.A., a patent is pending for 2005 for peanut enhanced resveratrol. Peanut processors, globally, will benefit from the introduction of resveratrol-enhanced peanuts for use in many products. Consumers will benefit from the nutraceutical peanuts with their anti-cancer and anti-cardiovascular disease properties.

Production of new high-protein food products and other nutraceuticals from peanut processing by-products resulting from Peanut CRSP research has potential to add value to the peanut industry worldwide. It could also meet the fast growing demand for meat substitutes in vegetarian diets. The meat analog industry in the U.S.A. is growing rapidly providing an opportunity to increase peanut market demand. Peanut-derived nutraceuticals will also tap into the large and growing nutraceuticals and functional food market, currently estimated at US$17 billion per year.

6 Information, Training, and Technology Transfer

A Peanut CRSP developed Web-based World Geography of Peanut is a significant repository for worldwide peanut publications and information. It includes data on the status of the peanut production and industry in many countries, with potential use in policy making.

A technology transfer project in Thailand continues the partnership with this USAID "graduate country" in regional training efforts, resulting in Thailand being a center of excellence for training of trainers. Frequent workshops, largely attended by women, focus on product development and food safety practices. The program is also reaching many villages in Thailand and assisting women entrepreneurs in improving the production and marketing of peanut food products. Most villages follow the "one village one product" scheme of the processing, fostered by the Thai Princess' development program for poor villages, utilizing Peanut CRSP-developed technologies.

A significant achievement in the Philippines has been the development of strong partnership with the private food industry. The partnership was described as the Peanut Industry Incubator Model (PIIM) and identifies and solves problems, and transfers relevant Peanut CRSP technologies to the user. This model requires that the research institution and private food industry partners agree on the projects to be developed early through intensive interactions, and allows the food industry to access public research capacity and technologies while cost-sharing where resources allow. The model could be applied in other developing countries with some modification to consider country-specific situations.

The experience in Bolivia shows that for peanut production technologies to be adopted by farmers, research has to be complemented by a strong technology transfer effort and a seed production program. Participation of technology transfer/extension institutions and farmers' associations has facilitated the access of farmers to new peanut varieties, management practices, and information. It also generated the interest of the Bolivian government that increased the priority of peanut in its agricultural development plans.

7 EEP Recommendations

1. Based on the significant achievements, impacts, and benefits of the present program and the constraints still confronting the peanut sector in the host countries and the U.S.A., the EEP strongly recommends that the Peanut CRSP be continued into a third ten-year phase.

2. The Peanut CRSP is addressing the whole value chain of an important food and cash crop and this should continue in the future. The holistic approach contributed to the success of the program relative to the resources provided by USAID and it facilitated the leveraging of funds by U.S.A. and host country participating institutions.

3. Food safety/health and nutrition research should be of high priority due to its high potential for global impacts on health and well-being of people, but is more costly than traditional agriculture programs. Hence, higher funding level is needed for this important research area that is pioneered by Peanut CRSP, and that bridges health and agriculture concerns.

4. The future program should include the full range of production, post-harvest, utilization, and market development projects in each host country or region to insure that product value-addition is addressed early and that the producers also benefit through better market elasticity.

5. Socio-economic projects should cut across all projects to ensure inclusion of research to provide baseline information for later impact analyses, economic viability of technologies, policy interventions, market information, and risk management for improved decision-making. It is recommended that to continue the progress towards achieving the goal of better gender equity, adequate resources to plan, monitor, and evaluate social and gender concerns within and across projects..

6. Information exchange and networking mechanisms, collaboration with other research stakeholders, and training should continue as core functions of the program. Management should continue to promote collaboration and efficient use of resources within the program.

7. Continue the development of partnerships to facilitate transfer of technologies to beneficiaries and other stakeholders. Strong collaboration between the components of a project cluster and across countries in a geographic region should be fostered in the future.

A peanut butter mill installed at a women's cooperative in the Rupununi (Guyana) to utilize local peanuts for school feeding and adding value to local consumers.

A recently released variety in Senegal resulting from CRSP activity. Production increases have been achieved by farmers using CRSP technologies in Ghana, Uganda, Malawi, Guyana and Bolivia.

On farm trials of ANAPO/CRSP varieties in the Mairana valley of Bolivia (left), and discussion at the Saavedra Research Station (below).

Peanut butter produced in a village factory spread on cassava bread. This snack is being evaluated for acceptance by scholars. The Ministry of Education is interested in exploiting locally produced peanuts and cassava as the basis for a sustainable school feeding program. If utilized for the school feeding program this will help consume the excess peanut production that has developed over the past year and generate employment in these remote areas.

Technology adoption is needed across the full value chain for peanuts.

The Peanut Collaborative Research Support Program
External Review Panel Report
2001-2005

Main Report

The Mission:
Economic and social advancement through development of sustainable, environment- and health-protecting peanut-based industries in developing countries and the U.S.A.

I. Introduction

The current Peanut Collaborative Research Support Program (CRSP) Grant began in 1996 with program adjustments made in 2001 based on the 2000 External Evaluation Panel (EEP) Review. The Peanut CRSP uses a value-chain approach developed around five thematic/cluster areas:

(1) Food Safety and Nutrition;
(2) Production Efficiency;
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Program content assured that the Title XII expectations of impact in the host (developing) countries with benefits to the United States (U.S.A.) would be achieved. Plans were developed to resolve major constraints to the host countries and U.S.A. peanut sector and to ensure that social and gender issues were addressed.

1.1 Achievement of Peanut CRSP Goals

The EEP determined that these goals, which continued from Phase 1 of the program, have been achieved in a satisfactory manner. The goals of the Peanut CRSP in Phase 2 (2001-2005) are: (1) to enhance the peanut research capabilities of developing countries and the United States (U.S.A.), and (2) to focus this increased capability on development of technology that will help remove constraints limiting sustainable production and utilization.

The Peanut CRSP goals and projects remain relevant to the United States Agency for International Development's (USAID) agricultural strategy and its four development goals, and are contributing to their attainment in a positive way. The Peanut CRSP goals were directly relevant to three of the four themes of the USAID's 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 smallholder participation in markets, which are also existing priorities for the Peanut CRSP.

The main goals are: (i) to expand trade opportunities and improve the trade capacity of producers and rural industries, (ii) to improve the social, economic, and environmental sustainability of agriculture, (iii) to mobilize science and technology and foster capacity for innovation, and (iv) to strengthen agricultural training and education, outreach, and adaptive research. For the future, the Peanut CRSP is well positioned to continue addressing these development goals, and the broader global Millennium Development Goals (MDGs) of poverty reduction, gender equity, environmental conservation, and building partnerships.

1.2 Program Focus, Budget, and Projects

Peanut CRSP implemented five themes based on research opportunities related to the global constraints identified in peanut production and utilization worldwide at the beginning of Phase 2. The projects built on the past achievements of the program and the accumulated experience and expertise of participating scientists in the U.S.A. and the host countries. In 2001-2005, 29 projects were implemented in five thematic areas: (i) food safety and nutrition (6 projects); (ii) production efficiency (8 projects); (iii) socio-economics and policy (5 projects); (iv) post-harvest and utilization (4 projects); and (v) training, information (3 projects), and program management (3 projects). Eight projects were not active by 2005 during the external evaluation. The distribution of projects by themes/clusters is shown in **Annex Table 1**.

USAID funds the Peanut CRSP and eight other CRSP's. In 2001, the Peanut CRSP proposed a total of US$15 million budget to implement the program and projects. The total expenditure from 2001-2005 was US$8.99 million (**Annex Table 2**), with US$2.55 million provided in 2005/06 providing a total of US$11.54 million of the approved $15 million. The EEP is pleased to note that USAID has maintained the funding for the program even under budgetary constraints in past years, an indication of its commitment to peanut research in the U.S.A. and the host countries.

1.3 Geographic Focus

Peanut CRSP is carrying out research in seven of the top 20 peanut producing countries worldwide and complements well the peanut program of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) located in eight of these countries (**Annex Table 3**). As recommended in 1996, the focus of the Peanut CRSP was shifted to Africa with 10 countries implementing 24 projects (some are multi-country). The number of host countries and projects is less in other geographic regions. The Peanut CRSP is implemented in nine of the 18 poorest countries in the world (Benin, Bolivia, Burkina Faso, Ghana, Guyana, Mali, Mozambique, Senegal, and Tanzania), hence it is expected to contribute to poverty reduction.

For 2001-2006, the Peanut CRSP has implemented 24 research projects (10 are multi-country and across regions) in five regions, with seven global projects (**Table Annex 4**). The geographic locations are: (i) Western Africa (13 projects), (ii) Southern Africa (3 projects), (iii) Asia (3 projects), (iv) Latin America and Caribbean (2 projects), and (v) Eastern Europe (2 projects). There are 20 host countries participating in the Peanut CRSP implementation for 2001-2005 (Phase 2). These locations were determined in 2001 by: (1) research opportunities to solve major constraints in production and utilization, (2) complementarity with the peanut projects of ICRISAT, its main research partner (a center under the Consultative Group for International Agricultural Research or CGIAR); and (3) USAID priorities and specific research opportunities.

Eight of the top nine peanut producing states [2] in the U.S.A. participate in Peanut CRSP implementation (**Annex Table 5**). Hence, the program is well distributed geographically and is expected to benefit many U.S. peanut producers. In 2005 there are 11 U.S. states and 14 U.S. universities participating in the program including two historically black colleges and universities (**Annex Table 6**). Georgia implements 6 research projects, Florida 4 projects, and North Carolina 3 projects, while the remaining projects are implemented in ed inAlabama (2), Connecticut (1), Indiana (1), New Mexico (1), Oklahoma (1), Texas (2), Virginia (2), and Wisconsin (1). Universities in Connecticut, Indiana, and Wisconsin, not located in peanut growing areas, have been competitively selected for their complementary scientific expertise. Georgia also implements 3 training and communication and 3 management projects.

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[2] Georgia (44%), Texas (20%), Alabama (12%), Florida and North Carolina (8%), Oklahoma and Virginia (2%) South Carolina and New Mexico (1%)

1.4 External Evaluation Process and Panel

External Evaluation Process. An external review process is an integrated and mandated part of all Collaborative Research Support Programs (CRSPs). An External Evaluation Panel (EEP) is important in Peanut 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-March 2005); and (4) prepare thematic summaries and consolidated EEP Report (April-May 2005). **Annex Table 7** shows the evaluations and project site visits carried out by the EEP members. A final draft of the EEP Report is due for discussion and comments by the Peanut CRSP Board of Directors in June 2005, and submission to USAID by the end of June. This report will be the basis for decisions on the Peanut CRSP for the future.

External Evaluation Panel Members. The EEP consists of seven members, as follows with their areas of expertise and country: (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, Socio-economics (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 U.K., assisted the EEP. The list of EEP members and brief bio-data are shown in **Annex Table 8.**

II Key Outputs, Findings, and Observations

2.1 Food Safety and Nutrition Research

Although only eight of the 24 research projects in the Peanut CRSP were in this cluster of projects, it was apparent that there is a wide portfolio of projects, some of which are very ambitious, but with potential to have large impact. Clearly spreading the available funds widely means that the Peanut CRSP is only 'pump-priming' in some areas and achievement of a critical mass for a specific project is highly dependant on leveraging of funding from other sources.

A number of the Principal Investigators made the point that involvement with the Peanut CRSP was prestigious and it stimulated working with developing countries (which they might otherwise not do). But funding was, in some cases, very limited that without funding from other sources, it could achieve very little alone. Whilst with an exciting array of projects offering relevant and attractive opportunities for peanut research, it is tempting to fund a wide portfolio of projects; the question nevertheless arises whether a more focused approach, funding a smaller number of projects, might not be advisable for the next funding period.

The prevention, detection, and amelioration of the adverse health effects of aflatoxins in peanuts feature large in the food safety cluster of projects.

2.1.1 Prevention and Detection of Aflatoxin Contamination. The prevention aspect goes back to basics, as far as understanding the mechanisms of fungal attack on peanut plants at a molecular level (UW149) and trying to understand the triggering of secondary metabolism. This work is very fundamental and while academically exciting, is many years away from exploitation in practical terms. Linking with a host country has been difficult due to the need to find a country with scientific sophistication to match the University of Wisconsin, although a recent link with South Africa has been achieved.

Evaluation of different agronomic practices in terms of the influence on aflatoxin levels has been carried out in AUB30. Using two experimental plots for peanut production in Ghana, different post-harvest techniques have been assessed and a number of different samples taken for analysis. Also treatments such as use of clove-based products as anti-fungal agents during storage have been tested. This work has been primarily observational assessing economic impact rather than technology-driven in terms of developing innovative practices.

Improved storage of peanuts has been covered by UWI49 at University of Georgia. Conducting research in Botswana, an approach using silica-based materials to incorporate with stored peanuts is practical, low-cost and has been shown to be effective. These sharp-edged materials work through penetrating the shell of hard-bodied insects, effectively killing them and preventing damage, and minimizing subsequent fungal infection.

Two projects address the need for low-cost analytical methods for screening and analyzing mycotoxins. In UWI49 at the University of Georgia, a low-cost aluminum-based column has been developed made from locally available materials. Using bromination of the extract and analysis by fluorimetry, between 300 and 400 samples a day can be screened at a limit of 5 ppb. This test system is very practical and sufficient work has been undertaken for a validation to be pursued. This simple output needs to be exploited through inter-laboratory validation and involvement in a wider community in developing countries. A similar approach has been proposed in TAM50 using NovaSil clays for analytical clean up. However, in TAM50 this is peripheral to the main thrust of the funded work, and has not progressed as far as the work at the University of Georgia with which it effectively competes.

2.1.2 Amelioration of the Adverse Health Effects of Aflatoxin. The main cluster of food safety projects demonstrate the effectiveness of using clay in the human diet to reduce bio-availability of aflatoxins and thus leading to health improvements through reduced exposure. Monitoring biomarkers of human exposure to aflatoxins, such as aflatoxin M_1 in urine and other clinical parameters of disease and nutritional status, are being used for initial benchmarking (UAB56). The intention of TAM50 is to use an intervention strategy with inclusion of NovaSil clay in the diet to adsorb aflatoxins.

Preliminary work in terms of demonstrating no adverse effects of NovaSil clay in both a rat study and a human study (i.e., no absorption of nutritional components) has been completed in the U.SA. Planning is well advanced for an intervention study in Ghana using Novasil in capsule form for a population group, which has already been identified as being highly exposed to aflatoxin through peanuts and other dietary components such as corn. Prior to the intervention, during the intervention and after ceasing to take the clay capsules, the University of Alabama-Birmingham will undertake monitoring of clinical parameters (including immune status) looking for changes indicating the effectiveness of the clay in making aflatoxin unavailable.

It was recognized from an early stage in this cluster of projects that if the intervention study using capsules proved effective, it would be necessary to introduce clay into the diet in a less obtrusive form. Again working with Ghana (OKS55), a number of 'traditional' peanut products have been reformulated to incorporate NovaSil clay (at 0.5-1.0%). This food/consumer science project has looked not only at practical considerations (i.e., grittiness), but also storage parameters and ways of making these traditional products more attractive and acceptable to consumers in Ghana.

There are some notable features regarding this cluster of projects. First, that establishment of partnership and collaboration in Ghana is outstanding. This has partly been achieved through early work on AUB30, where work on the ground in Ghana on consumer awareness of aflatoxins established rapport with local people. This building of confidence in the host country was re-enforced by the health studies (including workshops for health officials) carried out as part of UAB56. Second, the coordination and collaboration between projects TAM50, UAB56, OKS55, and AUB30 is highly commendable, especially bearing in mind the interdisciplinary nature of the work involving chemists, toxicologists, health workers, economists, and food scientists. Third, the high potential for impact in health terms must be emphasized. Notwithstanding the controversial debate as to the relevance of aflatoxins with regard to HIV/AIDS, the reduction of dietary exposure to aflatoxins in the developing world will unquestionably have a significant health impact. Finally, the fact that Peanut CRSP funding alone would have achieved only a fraction of what has been achieved so far must be acknowledged since considerable ingenuity in terms of getting samples analyzed and success in leverage of funding from elsewhere has been critical in the successes so far.

2.1.3 Other Health Aspects of Peanut Consumption. A mixture of food chemistry and food processing has been carried out in UGA01, again working with Ghana as the host country. Work carried out has had a food safety thrust, in terms of examining whether decontamination can be achieved through chemical treatments (various nucleophiles) and through extrusion cooking. This work has also recently attempted to link into the project cluster (above) through looking at incorporation of clays in extrusion cooked peanut products. The weakness of extrusion cooking based project is that it is a technology of developed countries and while it 'adds value' through processing, one wonders if the time is right for technology transfer to developing countries or whether it is premature. The most interesting feature and probably more novel has been the attempt to produce hypoallergenic peanut butter, this has involved making peanut butter from extruded peanut flour and peanut oil, but while allergenicity was reduced, there was an adverse effect on sensory quality.

Work has been undertaken in PUR10 studying the health effects of peanut consumption. Work to date has indicated that peanut oil does not hold stronger satiety properties than oil rich in monounsaturated or polyunsaturated fatty acids. While significant dietary compensation from peanuts was observed, daily energy and fat intake were significantly increased with addition of oils to the diet. No differences were observed in responses between countries (U.S.A., Ghana, and Brazil). On energy balance there were no significant differences in resting energy expenditure, thermogenic effect of feeding or physical activity among participants ingesting peanut oil, olive oil, safflower oil or supplemental oil. Body weight increased significantly in all intervention groups but not the no-oil control group. Findings on the effects of peanut oil on plasma lipids are still being evaluated.

Taken overall, it is concluded that the strong effects of whole peanuts on appetite, energy levels and lipid levels are not replicated through ingestion of oil alone. This suggests that other fractions in the nuts are responsible and these need to be identified. This project is novel, could have a significant impact for the peanut industry in terms of health benefits and has a good link with Brazil and Ghana as the host countries.

2.1.4 Conclusions. Overall, it can be concluded that a wide and exciting portfolio of projects have been funded with all showing some success and in some instances potential for having a high impact. For the future, the EEP recommends more focus of resources through either funding a smaller portfolio of projects or terminating some projects (not because they have been performing badly but simply based on a prioritizing) to achieve critical mass elsewhere.

2.2 Production Efficiency Research

2.2.1 The Projects. Six of the eight projects evaluated in this area by the 2000 EEP review were continued into the 2001-2006 period. One project on utilization of wild *Arachis* species was discontinued, although some aspects were transferred to a similar, existing project. In addition, two projects were added to the Production Efficiency portfolio bringing the total to eight.

Three projects involve biotechnology, including the development of molecular markers, and transformation of germplasm for disease resistance using pathogen-derived resistance. Four projects are using conventional means for genetic enhancement, and have concentrated on the deployment of technologies such as improved varieties, production practices, harvesting, and post-harvest operations. Two projects have concentrated on the development of integrated pest management (IPM) practices, characterization of production constraints, development of models for risk management, and the transfer of these technologies to research and extension agencies, and to farmers.

2.2.2 Outputs and Achievements. In most cases, projects have led to the development of improved technologies and interventions. Improved production practices, including site and seed selection, agronomic practices, pest and disease control, and harvest practices have led to yield increases in most host countries. Improved varieties and useful germplasm have been developed or identified in a number of projects:

(1) Bolivian germplasm collected and evaluated (UFL16) has led to the identification of useful resistances to TSWV, leaf spots, rust, white mold and invasion by *Aspergillus flavus*. These have been used in crosses and two derivatives have been included in UPPT (pre-release) tests in the U.S.A. One could be released in the U.S.A. in 2006, and a release from these crosses can soon be expected in Bolivia as well. In Bolivia a line introduced from the USA has been released.

(2) Sources of resistance sources have been identified and used use for *Sclerotinia*, TSWV, seed dormancy, improved quality (high Oleic), and to abiotic (water and heat) stresses (TAM17). Nematode resistance in the variety NemaTAM was introgressed from wild species, and the release of a second wild species derivative is pending.

(3) The CRSP (project NCS19) has facilitated screening trials for thrips, potato leafhopper, Southern corn rootworm and TSWV resistance, and a number of germplasm lines showed some levels of resistance in North Carolina.

(4) In the U.S.A., UGA28 has been using biotechnology to develop virus resistant peanuts, while in Malawi and Uganda varieties developed by ICRISAT were released and are having a significant impact on production by farmers.

(5) NCS19 and UFL13 have successfully demonstrated yield increases possible with integrated management. UFL13 has used growth simulation to characterize yield gaps, and NCS19 has shown the benefits of integrated pest management. Both are developing the predictive capabilities of modeling and Geographic Information System (GIS) procedures for pest, disease, and aflatoxin risk management. Models developed could have application in other countries such as Bolivia and Guyana.

(6) Cultivars introduce from Bulgaria yield 5-20% more than the local Valencia types in New Mexico.

2.2.3 Training and Capacity Development. The TAM17, UFL13, FAM51 and NCS19 projects have trained a total of six scientists. One student completed a Ph.D. degree and five completed M.S. degrees.

Institutions and scientists in the U.S.A. and host countries have benefited from training in new procedures and techniques. Expertise in data collection, software development and modeling has been gained in UFL13 and NCS19. UGA28 has contributed to improved transformation techniques resulting in greater recovery of transgenic plants with better fertility.

TAM17 has refined the introgression of useful traits from wild species, the identification of markers for useful traits, fatty acid and oil quality assay capabilities, and molecular biological techniques. FAM51 has characterized biochemical responses to drought and has identified drought-resistant genotypes. Screening techniques have been improved, and markers for identification of drought tolerant genotypes have been identified. Proteins are being evaluated for their anti-microbial activity against *Aspergillus flavus.*

Items of equipment have been made available to some host countries and include vehicles, computers, digital cameras, and Global Positioning Systems (UFL13 and NCS19). In addition, labor saving devices for planting, harvesting, and shelling peanuts have been supplied to collaborators in Senegal, Ghana, Guyana, and Bolivia.

2.2.4 Technology Transfer. A significant improvement in technology transfer has been apparent during this second phase of the program. Notable achievements are the adoption of improved production practices extended through field days, workshops and farmer training activities in countries such as Ghana (UFL13 and NCS19), and Bolivia (UFL16) where yields have been increased two-fold. In Guyana (UFL52) the CRSP presence has resulted in a dramatic increase in area planted and production (five fold).

The use of farmers as trainers is a very positive development, notably in Ghana (UFL13 and NCS19), Bolivia (UFL16) and in Guyana (UFL52) following farmer field school methodology.

Improved varieties have been identified in a number of countries, often through farmer participatory evaluation, and these are currently undergoing multiplication and deployment: Two short-duration, rosette-resistant varieties have been released in Uganda and one is scheduled for release in Malawi in 2005; improved varieties have been identified in Guyana; a rosette-resistant variety has been released in Ghana; and leaf spot-resistant varieties are scheduled for release in Senegal and Burkina Faso. The adoption of rosette-resistant varieties in Uganda and Malawi are expected to result in benefits amounting to more than US$47 million.

Improved harvest and post-harvest practices have been demonstrated in a number of countries, and yield losses, and labor requirement, have been reduced in Ghana. Food safety awareness is becoming more apparent, but is one area that requires increased effort.

2.2.5 Developing Partnerships. Recommendations made by the 2000 EEP for the strengthening of inter-project and other partnerships have paid off and a notable improvement has been recorded. Collaboration on modeling between UFL13 and NCS19 has improved with the additional effort on the development of an aflatoxin sub-model, and the extension of their findings to other projects (UFL16, TAM17 and UFL52) will be beneficial.

In-country partnerships between projects, state agencies, non-government organizations (NGOs), traders, and processors (i.e., in Guyana, Bolivia, Ghana, Malawi, and Uganda) have also improved and should be encouraged. The wide range of partners, including universities and international institutes participating in FAM51 is particularly encouraging.

The holding of host country Principal Investigators' meetings to improve coordination and collaboration across all production efficiency projects, and to encourage the development and use of lead centers to foster technology transfer could strengthen these partnerships.

2.3 Socio-economics, Gender and Policy Research

Socio-economics and policy research (five projects, two are also discussed in the Food Safety/Nutrition cluster) supported the technical research carried out by the Peanut CRSP. The specific approaches followed by projects in the socioeconomic thrust were variable and included: assessing the socioeconomic impacts of vitamin A fortification of peanut butter; assessing the socioeconomic changes following adoption of new cultivars and integrated pest management; assessing the impacts of peanut related food processing, science innovations on processing, village level farmer surveys and marketability of peanuts.

2.3.1 The Projects. Some of the achievements of the socio-economic projects are described below:

Impact assessments: Project NCS07, focused on impact assessment and through surveys in Philippines, Thailand and North Carolina, established that: (1) hundreds of Filipinos began consuming the new vitamin A-fortified peanut butter, expecting reduced vitamin A deficiency; (2) the collaborating company learned that by selling this improved product its brand developed the second largest in market share; (3) another company targeting aflatoxin elimination by hand sorting of peanuts saw its export of "*kare-kare*" sauce with peanut to the U.S.A. increase from 9.9% to 49% in three years. (4) weather-based advisory for IPM adoption was preferred (at rates of 43-52% in 1999-2000) over other Peanut CRSP developed IPM practices, according to the farmer survey; and (5) of the Peanut CRSP-developed varieties, farmers preferred NCV11 and NC12C, which showed consistently high adoption rates of over 40% in 1999-2003; The Perry variety reached this level in 2002-2003.

Aflatoxin issues: The understanding of local knowledge and control of aflatoxin through the food chain was investigated. Farm level and market surveys in Uganda (VT54) showed low levels of aflatoxin contamination immediately after harvest and drying. However, processed nuts 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 European Union (E.U.) standards, an indication that aflatoxin contamination occurs during post-harvest handling and processing stages. In Ghana similar data on the extent of knowledge about aflatoxin and its control were obtained (AUB30).

Industry prospects. In Bulgaria analysis of the economics of peanut production (AUB30) was undertaken to determine the prospects for this crop in the post-centrally planned economy. Knowledge of researchers on the methods of economic analysis was enhanced by new software and interactive exchange visits to Alabama and Bulgaria. The Principal Investigators realized that the analytical tools necessary for this project would need to be modified to suit Bulgaria.

Economic analysis (NC) methodologies tested and used in the project (VT09), especially the poverty index analysis and experimental economic analysis of environmental benefits, are 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 (including West Africa).

2.3.2 Training and Capacity Development. Three Ph.D. students from West Africa were trained (two at the University of Connecticut and one at North Carolina State University) in sophisticated economic and policy analysis methods and two others are in training at Virginia Tech. Nine M.S. students (five at Virginia Tech) completed their degrees with research on trade policies, economic impacts, post-harvest practices, and Partnership Agreements.

Training outcomes included: four female agricultural extension students at Makerere University; one female M.S. student (ethnographical methodologies, qualitative analysis, thesis writing); one host country Principal Investigator on administrative and accounting skills; three male agricultural extension workers on how to train farmers; two male health supervisors, and eight health workers were trained on health education methodologies and gender issues.

Workshops included: two workshops on education methodologies, gender, and aflatoxin contamination; one workshop at Makerere University on health education methodologies and gender issues; workshops in the Philippines and Thailand to train non-social scientists and graduate students in social science research methods; a workshop, sponsored by the Peanut CRSP (through the University of Connecticut and ENEA) and the Soil Management CRSP (J Antel - Montana State University) to introduce the Tradeoffs Model.

Publications included: impact assessment of the vitamin A fortification of peanut butter of an industry innovator, socio-economic impacts on families, eliminating aflatoxin in peanut-based products, and socioeconomic impacts of the transfer of new sorting technology to a Philippine company. Many technical papers were also generated.

2.3.3 Beneficiaries and Benefits. Beneficiaries of this project include policy-makers and top-level government decision-makers in all countries (in agriculture, health, trade, research, extension, and rural development), who utilize the results of the impact study and case studies to enhance transfer of healthy and safe (aflatoxin-free) peanut-based food products and improved processes to the private food industry. These include micro- and small-scale rural enterprises, consumers who benefited from increased vitamin A nutrition through a safe and convenient medium, and industry learned that they could expand market shares with enhanced products.

Principal Investigators and collaborating institutions in other countries benefit from the use of impact assessment and case study methodologies, including developed survey instruments and questionnaires used in the Philippines, Thailand and other locations. The U.S.A. benefited from increased and more accessible information on the impacts on farmers who used Peanut CRSP developed varieties and IPM practices. Graduate students in U.S.A. and developing countries have been trained.

Collaborating institutions, like ENEA in Senegal and Makerere University in Uganda, have benefited from degree and non-degree training of faculty and students.

Producers, scientists, consumers, and processors (male and female) will have increased knowledge of the prevalence and health impact of aflatoxin and interventions to reduce aflatoxin along the custody chain in the host country environments.

2.3.4 Partnerships were key Peanut CRSP developments in all locations. The main collaborating institutions in the Philippines were: the Food Development Center/National Food Authority, the University of the Philippines at Diliman, and the Principal Investigators, with inputs from North Carolina State University. Collaborators in Thailand were Kasetsart University and the North Carolina State University Principal Investigators. The main institutional partner of Peanut CRSP in Senegal is ISRA. In Uganda the partner is the National Agricultural Research Organization, and in Malawi it is Chitedze Agricultural Research Station, and ICRISAT. The first domain of partnerships developed is between ENEA (Senegal) and the University of Connecticut. This partnership has had many positive benefits for both institutions. The partnerships developed with other Peanut CRSP projects (i.e., Virginia Tech and Auburn University) and with the Soil Management CRSP are also significant. These collaborations have facilitated several activities including organizing workshops and joint research activities.

Virginia Tech collaborated with the Centre for International Cooperation in Agricultural Research for Development (CIRAD), the

ICRISAT-Mali Office, the University of Georgia on breeding using genetic manipulation, the University of Connecticut on household surveys, the International Food Policy Research Institute (IFPRI) on the use of IFPRI's Uganda and Malawi data sets, and Integrated Pest Management (IPM) CRSP to share research sites and information in Uganda.

2.3.5 General Observations. The last EEP recommended that efforts should be made to encourage intra-Peanut CRSP collaboration to facilitate the transfer of information and strategies especially lessons learned from Asia to West Africa and other regions. The project (NC07) remained focused in Asia (specifically Philippines and Thailand), but impact analysis and assessment was increased in Africa through involvement of VT09, UCN36, and in Bulgaria through AUB30. The work on economic assessment and policy analysis is critical and commendable. The senior economists are world-experts with extensive experience in the region. The EEP noted that some Principal Investigators spend limited time (i.e., 15% fulltime equivalent) in project activities, which may be sufficient to advise graduate students, but would not allow them to discuss with top-level government officials the important global trade, economic, and policy issues in specific countries to ensure buy-ins by policy makers early in the process.

2.3.6 Recommendations. Peanut CRSP Management Entity has to develop a strategy to ensure that relevant socio-economic and impact assessment activities and case studies are considered in the planning and design stage of each project to ensure that key performance indicators are agreed and benchmark data are documented by the U.S. Principal Investigators and collected by host country collaborating institutions as a regular activity.

Gender concepts must be viewed in all Peanut CRSP projects as constraints/opportunities met by both men and women, and the research in the Socio-economic cluster must help understand how to redefine research to ensure that solutions are relevant to their specific needs.

Organize existing expertise into a center of excellence for peanut research and education in Ghana. Given the level of advanced research and the multi-level commitment to the Peanut CRSP work, Ghana would be an excellent choice. Technology and innovation would spread from Ghana.

Conduct economic analyses of the under-appreciated and strategic link between production and the value chain, in several if not all countries supported by the Peanut CRSP. A guiding principle will be to design models that can be used to connect with analyses that might be done beyond the farm-gate, particularly those focusing on value-added activities.

2.4 Post-harvest and Utilization Research

2.4.1 Relevance and Research Approaches. The Peanut CRSP has adopted the approach of addressing the full value chain for peanut. This cluster of projects focuses on post-harvest preservation and addition of value to the commodity/ingredient and to the consumer. The projects are aimed at expanding the market for peanut and thus helping to maintain value for producers, processors, and consumers. As a commodity the crop provides farmers with between 15% and 30% of the potential value of the crop to the consumer, and research/development to realize a greater share of that potential is a great opportunity for economic development and poverty alleviation. The Principal Investigators involved are pragmatic and have deployed a judicious mix of technology transfer and research to achieve the development of peanut based food industries.

Many of these projects are also closely connected with and work on the issues of managing aflatoxin levels through food processing. The cluster has projects in Bulgaria (UGA11), Philippines (UGA04), Thailand (regional UGA37), Senegal (NCA32), and relevant projects in the area of Food Safety and Nutrition (PUR10, OKS55, and UGA01). The projects involved have all addressed capacity development through the research undertaken and training and facilities have been strong features of these projects.

2.4.2 Outputs and Achievements. In this cluster of projects, the conceptualization and development of a model for food industry development was a significant achievement that has wide application to future activities of this program and other commodity-focused CRSPs. In previous phases of the Peanut CRSP, many products have been developed with potential application in various markets. In this phase there has been a very significant increase in the transfer of technologies and commercialization of results from this area of research endeavor. The change in results and greater impact has been based on the establishment and use of the Peanut Industry Incubator Model (PIIM).

This mechanism was established in the Philippines where the Principal Investigators called for proposals from industries that processed peanuts to address opportunities and problems faced by that industry. A cost-sharing requirement was established to ensure commitment on the part of industry that benefited from the access to the research capacity of the Peanut CRSP research partnership. The model has been successful in the Philippines and adopted in Thailand and under consideration in Bulgaria, and will be a feature of future activities by the Peanut CRSP in the food sector. A salient feature of the PIIM is that it provides a mechanism by which small industries without the capital resources for research can bring to market products that require optimization through research of production, consumer preferences, and any other aspect of food technology.

2.4.3 Technical Outputs. The Principal Investigators working in this cluster of projects have been highly effective and have developed new products (NCA32, UGA04, UGA11), explored potential neutraceutical applications of peanut, and generated data that has been used to promote new consumption of peanuts in both the U.S.A. and developing countries. This has been a very effective part of the program and has helped expand the world market for peanuts. Two former exporting nations that have benefited from Peanut CRSP food sciences have become importing countries as the consumer demand has increased.

New products developed and commercialized include: vitamin A-fortified peanut butter, high resveratrol peanuts, cracker nuts, and peanut punch (a peanut-based beverage). The control of aflatoxin contamination in products was achieved through the development and transfer to companies of an effective clean-up process. This allowed access to international markets and increased sales of peanuts by the partner enterprise, and resulted in a rapid expansion of production, access to new markets and greater profitability.

In the U.S.A., entrepreneurs have licensed Peanut CRSP technologies, and the benefits of working on the nutritional aspects of peanut have both lead the industry into this research area and has resulted in much greater sales of peanut. These results are being extended to drive peanut sale in other countries, for which all participants in this industry will benefit.

2.4.4 Training and Capacity Development. This thematic cluster has also been very prolific in this area. Students have received M.S. and Ph.D. degrees with support from the Peanut CRSP. Institutional capacity has been expanded in Bulgaria, Philippines, and Senegal. In the case of Bulgaria, the facilities developed by the Peanut CRSP positioned that country to be a regional center for food research in the areas of product development and sensory evaluation. Host country scientists have been able to conduct research in the U.S.A. and transfer that experience to their own research institutions.

A very significant development is the capacity and mechanism provided by the PIIM. The building of relationships between research institutions and food industries/entrepreneurs provided a constituency and resource base for the future.

2.4.5 Technology Transfer. The PIIM originally developed and tested in the Manila area is now being used across the nation, now being deployed in Thailand and considered in Eastern Europe, and being proposed for the South American and African regions. This model has explicit technology transfer functions. The participatory nature of the method is also a factor facilitating transfer of technology and by ensuring the relevance of the research making technology transfer almost 'automatic'.

2.4.6 Partnerships. Strong partnerships have been developed in this cluster of projects. The partnership that has been developed by the Peanut CRSP with peanut processing industries has helped in the success that has occurred in this sector. The U.S.A. peanut industry is a strong supporter of the program. Similar developments are evident in each of the countries where the program is functioning in the food sector.

The PIIM engages the institutional research capacity with the small- and medium-scale food industries to mutual benefit. Examples of functioning partnerships are found in all the projects of this cluster.

2.4.7 General Observations. The program needs to maintain the approach of researching the full value chain for peanuts. This has been successful and has provided great value to the program and the intended beneficiaries.

2.4.8 Recommendation. In any future program it is important that geographical clusters of Peanut CRSP projects contain a post-harvest/value-adding project to help promote consumer demand that producers need for their products.

2.5 Information, Technology Transfer, and Program Management

2.5.1 The Projects. Information, training, technology transfer, and program management activities in the Peanut CRSP are coordinated through six projects (UGA37, UGA38, UGA39, UGA40, UGA41 and UGA05). The Peanut CRSP Management Entity provides leadership for training host country personnel and U.S. graduate students, organizes scientific workshops, manages USAID funds, publishes and distributes the International Arachis Newsletter, coordinates submission of project reports, provides outreach to international and U.S. stakeholders and partners, and supports the Board of Directors and Technical Committee governance activities through four projects (UGA38-41).

The UGA05 project is funded to assemble and make available knowledge regarding peanut food system components related to production, socioeconomic considerations, utilization and food safety through a comprehensive database on the World Wide Web. In addition, UGA05 conducts studies documenting available information about peanut production, processing and utilization in specific countries. UGA37 extends to Thailand and Southeast Asian scientists peanut post-harvest processing and utilization technologies.

2.5.2 Accomplishments. The accomplishments in this cluster of projects have been substantial. The University of Georgia and specifically the Management Entity should be commended for excellent management of the Peanut CRSP. The Management Entity is innovative, fiscally efficient, and supportive of Principal Investigators. The development of web based management tools reduced administrative costs and improved efficiency of the Principal Investigators and the Management Entity. It is recommended that other CRSPs consider adopting the web-based management tools developed by the Peanut CRSP Management Entity.

The Management Entity has provided excellent leadership in terms of programmatic direction by extending the value chain to issues related to human health. Continuous evaluation of programmatic thrusts will be needed to ensure that the Peanut CRSP addresses the most significant issues related to peanut production and utilization in host countries. In the interests of efficient program operation the Management Entity should consider having the University of Georgia transfer project funds to host country organizations rather than devolve this responsibility to the participating universities. Alternatively, U.S. Principal Investigators must be proactive to ensure that their universities transfer research funds to host countries in a timely manner. Continued emphasis on partnerships will be essential for continued success of the Peanut CRSP.

There have been significant accomplishments in the different projects. The Peanut CRSP has developed the "World Geography of the Peanut" website (UGA05). This database is an excellent outreach and educational tool that provides useful information to a wide range of people interested in peanut production and utilization. In addition, Peanut CRSP Principal Investigators may archive their publications in the database. Country studies document peanut production and utilization in specific countries.

The Program introduced new and improved post-harvest and processing technologies to Thai nationals, Southeast Asian individuals (researchers, extension workers, private processors), and small-scale processors through training (UGA37). Approaches used included training courses, internships, "hands on" workshops, extension education programs, web sites and written materials.

The Peanut CRSP has achieved success through post-graduate education of host country and U.S. students that increased the number of scientists having appropriate research skills and knowledge of peanut production and utilization research (UGA38 and the technical projects). The sponsorship of periodic Principal Investigators' conferences and scientific workshops has also been highly useful to Peanut CRSP participants in upgrading research skills and knowledge. UGA39 provides flexibility for funding Peanut CRSP activities that are not identified in individual technical projects and are not a part of UGA41. Notable activities of UGA39 include sponsorship of special publications, organization of special meetings, and External Program Evaluation costs. UGA40 accomplishments include publication and distribution of the CRSP newsletter and other technical materials; sponsorships of seminars, workshops and training programs for host country scientists; and collaborations with other CRSPs, CGIAR centers, National Agricultural Research Systems (NARS), and NGOs on programs of mutual interest.

UGA41 has developed an innovative suite of web-based management tools that minimizes the administrative burden on Principal Investigators, minimizes duplication in reporting accomplishments, and makes reports and transactions transparent to all. The use of electronic databases has lowered administrative costs of the Peanut CRSP (17% of total cost) and allowed a greater proportion of funds to be provided to individual projects. The databases also allow the Peanut CRSP Director to become more involved in technical projects, and to seek supplemental funding for the program rather than be tied up with administrative trivia. The databases simplify project reporting for both scientific accomplishments and financial management.

2.5.3 Areas for Improvement. The following could be considered for improvement in a future program:

(1) UGA05 could be better integrated into other Peanut CRSP activities including greater interaction of the Principal Investigator with the Principal Investigators of other projects. Although project leaders may post their publications on the "World Geography of the Peanut" web site, few Principal Investigators have chosen to do so.

(2) UGA38 has supported graduate education of host country students. However, universities have experienced difficulties in obtaining visas for host country graduate students using the USAID TraiNet system and have resorted to using alternative means of gaining visas. As a result Peanut CRSP funds are not directly supporting host country graduate students.

(3) UGA37 host country scientists report that a lack of time limits their ability to

provide training for extension workers and villagers.

(4) UGA39 has no apparent weaknesses given the limited goals associated with the project.

(5) UGA40 could increase effectiveness with additional workshops, seminars and training programs for host country participants if funds were available. Additional focus on translating Peanut CRSP findings into policy documents useful to host country decision makers would be desirable.

Through UGA41, the Management Entity is effectively managing the Peanut CRSP with minimal staffing. The Management Entity should evaluate if the administrative functions can be sustainable over the long term with the current staffing level. One challenge relates to the finding that some host country scientists and Principal Investigators reported difficulties in transferring funds from the participating U.S.A. universities to the host country organization.

III Research Benefits and Impacts

3.1 Benefits and Impacts in the Host Countries

In 2001-2005, 20 host countries participated in the Peanut CRSP implementation. The main regional focus is Africa, with 10 countries implementing 24 research projects (some are multi-country). The other 10 host countries are in South and Southeast Asia (4), Latin America and the Caribbean (5), and Eastern Europe (1). The program shift to Africa, was in response to the recommendation by the 2000 EEP, and is deemed a good decision by the 2005 EEP.

3.1.1 Human Capital Development in Research. A very important achievement of the Peanut CRSP in Phase 2 with a widespread impact in the host countries, is the development of research capacity of scientists, researchers, and policy makers. Improved research capacity resulted from graduate degree programs, non-degree training (post-doctoral fellowships and internships), and short-term visits to U.S. universities. Thailand has become a center for excellence in training of trainers for the Asian region (UGA37), thereby also benefiting other host country scientists. UGA39 also provides flexible support for additional degree and short-term training by the Management Entity.

In 2001-2005, 31 host country and U.S. scientists and researchers completed M. S. degrees and 7 completed Ph.D. degree (about 29% male and 71% female overall), see **Annex Table 9a** and **9b.** Twenty-four graduates (63%) are from host countries and 14 (37%) are from the U.S.A. (**Annex Table 9b**). There has been a high pay-off for educating graduate students and Peanut CRSP should continue the graduate programs. Graduate students are well satisfied with their educational experience, although there have been problems with English language proficiency (TOEFL requirement), and delays in processing U.S. visas which could be minimized by more training on USAID's TrainNet system.

Non-degree technical training, study visits to the U.S.A., and participation in international and regional conferences, provided opportunities for host country scientists and researchers to learn new research methods and share information. In 2001-2005, about 135 scientists, researchers and policy makers participated in these events (Annex **Table 10a),** with 124 (92%) coming from host countries **(Annex Table 10b**). The skills acquired in training allowed the scientists and researchers to apply these techniques and technologies under their own country-specific situations, to carry out better scientific research, and participate in research networks. Accurate counts are difficult at events such as field days, but records show at least 3,342 men and women farmers, villagers, processors, extension workers, and other stakeholders also benefited from training on various topics (**Annex Table 11a** and **11b**).

3.1.2 Socio-economic and Policy Benefits and Impacts. The beneficiaries of Peanut CRSP technologies in the host countries are varied including researchers, policy makers, extension staff, men and women farmers, the private sector, NGOs, etc. In response to the earlier EEP recommendations, five socio-economic and policy projects were implemented with significant implications to the host countries. These included impact of: peanut products in Philippines and training in Thailand (NCS07), peanut marketing systems in Senegal (UCN36), production efficiency and market development in Haiti, Dominican Republic, Bulgaria and Jamaica (AUB30), aflatoxin reduction in Ghana and Benin (AUB30), and policy analyses in Malawi, Senegal and impact analysis in Uganda (VT09). VT54 is tapping into women's associations to create awareness of villagers on the health effects of aflatoxin. The studies provided data on the impact of Peanut CRSP technologies in the host countries and build socio-economic research capacity that is much needed in the host countries. Similar work should be continued in the future.

3.1.3 Technolological Benefits and Impacts. One of the strengths of the Peanut CRSP is its support to germplasm exchange, breeding, and variety testing in the host countries for location-specific adaptation. Examples are breeding for tolerances to drought in India and Bangladesh (FAM51), resistance to tomato spotted wilt virus (TSWV), leaf spot, and *Aspergillus flavus* in Bolivia (UFL16), resistance to thrips, potato leafhopper, soil insects and rosette virus in Ghana and Benin (NCS19). The current effort on resistance work, including the use of wild species, is commendable as this activity is a critical concern in all host countries.

Release and eventual adoption of new peanut varieties developed by Peanut CRSP supported host country scientists have high potential impact. Some examples of varieties are: the disease-resistant Mairana variety in Bolivia (UFL16), two short-duration, rosette-resistant varieties in Uganda (UGA28), a rosette-resistant variety in Malawi (UGA28) and and the near release of leaf spot-resistant varieties in Senegal and Burkina Faso (TAM17). The eventual, wide adoption of rosette-resistant varieties in Uganda is expected to add US$47 million annually to farmers' incomes.

Multi-disciplinary teams of scientists in the U.SA. and host country research institutions have developed crop management technologies that would complement resistant varieties that would require low or minimum input use. These technologies would be appropriate for smallholder and resource-poor farmers in developing countries. There have been some successful cases of increased peanut production and productivity using Peanut CRSP developed technologies. Examples are: Crop modeling using PNUTGRO in Ghana and Benin (UFL13), IPM technologies in Ghana (NCS19) and improvement of CROPGRO and release of a new Windows version (UFL13), with potential application in other countries (i.e., Guyana and Bolivia).

3.1.4 Post-harvest and Utilization Benefits and Impacts. Another area where Peanut CRSP has significant impact in some host countries is the development and utilization of peanut and peanut-based products in partnership with the private sector. The vertical integration of production to post-harvest and utilization requires linkages to food science research institutions (UGA04, UGA11 and NCA32). A key achievement is the industry incubator model developed in the Philippines with the private food industry (UGA04) that has potential application in other countries (Bolivia, Guyana, Bulgaria, Ghana, etc.). Impact of adoption of Peanut CRSP technologies in the Philippines (NCS07) are: (i) Vitamin A-fortified peanut butter was commercialized with 37% increase in production; (ii) aflatoxin-free, better quality peanut products became available in local stores and supermarkets; and (iii) a company has started to export aflatoxin-free peanut sauces to the U.S.A.

A complementary area is the development of micro- and small-scale, village-level peanut processing enterprises in Thailand (UGA37) and the Philippines (UGA04). In Thailand, Kasetsart University trained over 250 villagers (mainly women) on peanut processing and manual sorting technology. Trained villagers initiated village-level enterprises that are producing aflatoxin-free peanut products with better packaging. These enterprises have provided the main cash income of women in these villages. Similar experience occurred in the Philippines involving women peanut processors with support from Leyte State University scientists (UGA04).

3.1.5 Health-related Benefits and Impacts. Aflatoxin has been a program concern since the inception of the Peanut CRSP, but human health-related research was added to the Peanut CRSP agenda in 2001. Ten projects address aflatoxin-related issues: detection (UWI49) and forecasting (UGA22), preventing contamination (UWI49, FAM51), decontamination (UGA01, UGA04, NCA32), preventing exposure (TAM50, OKS55), socio-economics (AUB30, VT54), and human consequences (UAB56).

Results of Peanut CRSP research would have significant impact in the host countries where the problem is pressing but awareness of the effect on human health is quite low. Surveys on farming, post-harvest, and processing practices and aflatoxin levels and awareness in Ghana (AUB30), in Senegal and Uganda (VT54), Bulgaria (UGA11), and the Philippines (UGA04), have been carried out. Data generated by these projects are important in understanding the socio-economic, health, and nutritional effects of aflatoxin in humans, especially for awareness building among policy makers and health workers. Peanut CRSP could continue to play a critical role in bridging agricultural concerns and human health issues, demonstrated in this phase.

A high potential impact area for Peanut CRSP is reducing dietary exposure to aflatoxin with its human health implications. Several projects have demonstrated the effectiveness of using clay in human diet to reduce bioavailability of aflatoxins, done mainly in the U.S.A. (UAB56 and TAM50). A study examining safety in long-term exposure using rats and humans (short term) both found no adverse effects. In Ghana a trial to use NovaSil clay in human diets in capsule form (TAM50); is approved for the final year of this phase. Also in Ghana (OKS55), traditional peanut products were reformulated to incorporate NovaSil clay (at 0.5-1.0%) without adverse effect on consumers' acceptance.

3.1.6 Strengthening Linkages with Extension and Farmers/Entrepreneurs. To facilitate the adoption of Peanut CRSP technologies, many projects have linked with extension institutions and producers/farmers' associations, mainly through host country initiatives. Examples are: (1) the Princess Sirinthorn's development project in poor villages in Thailand with Kasetsart University and extension service providing training and guidance to villagers (mostly women), on Peanut CRSP-developed technologies (UGA37), and (2) the *Asociacion Nacional de Productores de Oleaginosas y Trigo* or ANAPO, a progressive farmers' association, has developed a Peanut Seed Program in Bolivia, and successfully linked research outputs and seed supply with farmers' associations (UFL16).

A significant effort of technology transfer has benefited a large number of men and women farmers and entrepreneurs and other stakeholders. Many projects use farmers' field days, workshops, study tours, and other extension activities. Farmers' training received emphasis in several host countries using farmers as trainers (i.e., farmers' field schools) such as in Ghana (UFL13 and NCS19), in Bolivia (UFL16), and in Guyana (UFL52). A summary of field days, workshops, and farmers' training is shown in **Annex Table 11a and 11b**.

3.1.7 Institutional Development and Sustainability. Some host countries benefited from funding assistance to develop/improve facilities and provision of critical equipment. Examples are: four research and sensory testing laboratories in Bulgaria (UGA11), greenhouse facilities and equipment in Bolivia (UFL16), pilot food laboratory and facilities in the Philippines (UGA04), equipment such as digital camera and GPS in Ghana and Benin (UFL13 and NCS19), and training equipment in Thailand (UGA37). Vehicles were provided in Guyana and Ghana, and maintained in Burkina Faso. Improvement of research facilities and human capital development would ensure sustainability of the research initiatives supported by Peanut CRSP in the host countries.

3.1.8 Leveraging of Funds. There has been considerable leveraging of funding from host country governments and other sources resulting from Peanut CRSP commitment, providing another sustainability factor. Some examples are: the Thai Government has provided the cash equivalent of US$27,500 in 2003-2004 to train Thai nationals, farmers, and villagers (UGA37); USAID GEM project supports farmers' associations in developing Peanut Collection Stations in the Philippines (UGA04); and a technology transfer project of the Inter-American Development Bank (IADB) has contracted ANAPO in Bolivia to provide extension services to farmers (UFL16). Canadian and USAID mission funds have been exploited to train people in post harvest processing and quality assurance in Guyana. In the human health area completion of the analyses of samples was possible with the assistance of partner research institutions in the U.S.A. using leveraged funds (UAB56 and TAM50). Documentation of fund leveraging by national research institutions from the government, private sector partners, and donors needs to be improved in the future.

3.2 Benefits and Impact in the United States

The impact of the Peanut CRSP in the United States has been significant. First, much of the early seed money was in areas that have led the industry into areas that have improved consumption. Second, the funds have stimulated development of new and innovative varieties with disease resistance. Third, the Peanut CRSP has fostered the development of a product that will render aflatoxin less of a health hazard. And finally, the program has encouraged collaboration among scientists from many disciplines around the world to work together in partnerships that would be unthinkable without encouragement from the Peanut CRSP.

The overall impact has been positive and has acted as a catalyst for expanding peanut research into new areas years before other funding entities have committed funds. Much of this technology is being captured in the 'World Geography of Peanut' web site supported by the Peanut CRSP: http://lanra.anthro.uga.edu/peanut/knowledgebase/.

3.2.1 Food Safety Benefits and Impacts. This is an area that the Peanut CRSP has made one of its long-term impacts. The development of aflatoxin absorbing NovaSil that can be ingested with or prior to eating peanuts or peanut butter and thus render the toxin unavailable will improve the safety of peanut products worldwide. It is estimated that the U.S.A. peanut industry spends in excess of US$25 million a year in attempting to reduce/eliminate this toxin in the diet of peanut consumers. The ability to incorporate the consumer into this process will significantly reduce the cost now incurred by the industry. It is hoped that eventually the NovaSil can be incorporated into peanut products so that the clay won't have to be taken separately.

Similar products are already being used on many animal feeds in the U.S.A. This peanut product will allow an increased value for peanut meal also once it passes regulatory approval. Much of the meal is currently sold at a significant discount and has to be blended with other lower aflatoxin containing meals to be used.

The Peanut CRSP is leading the WHO into the realization that aflatoxin is a solvable issue critical to the incidence of infectious diseases. This effort ultimately could save millions of lives and provide important security and diplomatic benefits to the U.S.A. through increased good will.

3.2.2 Nutritional Benefits and Impacts. This is an area of early inventiveness by the Peanut CRSP. The Peanut CRSP was funding peanut nutrition research long before many in the peanut industry thought about heralding the nutrition benefits of peanuts. The peanut consumption suffered double digit decline in the late eighties and early nineties,due to the perception that peanuts were not healthy due to their high content of oil. Early studies funded by the Peanut CRSP developed new information on the nutritional value of peanut. Much of the existing information was over 40 years old and outdated. This new data coupled with studies that showed that peanut did not contribute to people getting fatter when added to the diet has promoted the consumption of peanuts in the last eight years and increased sales rapidly.

Now we know that peanuts are one of the healthier foods we can consume according to American Association of Retired Persons (AARP). Advertising by many of the major food manufacturers in the U.S.A. touts the many health benefits of eating peanuts. Now seen as healthy and part of a low carbohydrate diet, peanut consumption has seen double digit increases in each of the last five years. Additionally with advertising from the National Peanut Board and the State grower organizations, using much of the research data funded by the Peanut CRSP, we are now seeing generic programs adding other dimensions to the health message. One of the peanut economists showed that the largest portion of the consumption increase came from this healthy food message. Another industry leader said, "This Peanut CRSP data was the key element to the overall health and nutrition perception. That's what turned around the consumption of peanuts in the last five years".

Many major manufacturers of peanut products report record sales for the last five years. It has been estimated that the impact of this increased consumption has been as much as US$500 million annually. Peanut consumption in all products has increased on average over 10% in the last five years. Consumption in the current partial year already shows an increase of 9%.

3.2.3 Production Efficiency Benefits and Impacts. The single largest expenditure for a U.S. peanut grower is fungicides. The estimated cost per acre is from US$15-US$30 per acre or over US$50 million dollars a year. The Peanut CRSP has been a leader in funding peanut seed breeders to develop varieties that are resistant to many fungal diseases.

The Peanut CRSP-funded research that has developed a released runner variety that is resistant to nematodes. This variety was developed with the use of molecular markers a developing breeding tool for peanuts. The variety has been planted commercially in Texas and Oklahoma during the last several years and is expected to see a significant increase with the 2005 plantings. This variety is particularly helpful where no nitrogen using crops are available. Additionally the breeders in Texas released a Spanish variety developed with the help of the Peanut CRSP that now represents over 60% of that market. It has multiple disease resistance and increased yield. Work also is continuing in New Mexico on new varieties with increased yields using a Bulgarian Valencia germplasm.

The same effort with Peanut CRSP funding has produced seed varieties in the North Carolina-Virginia area that represent almost 70% of the varieties planted. Many of these new cultivars have resistance to *Cyclindrocladium* black rot, a disease that the growers of this area have no other tool to manage economically.

3.3. Gender Considerations and Impacts

3.3.1 Gender Issues in Peanut Research. Peanut CRSP has considered gender issues in project planning and implementation. Women are, by nature of the peanut sector, major beneficiaries of any peanut technology. The Peanut CRSP has the opportunity to provide leadership in this area through expanded gender studies and socio-economic research. Improving peanut production and value-added products cannot easily be separated from realizing improved gender equity in developing countries since women are often the primary small-scale producers, processors, and traders of peanuts and processed food products. Peanuts provide their main source of income that benefits the family directly. This strong gender equity significance of peanut has been part of the Peanut CRSP perspective since the start of the program, and most projects are addressing technical issues with social and gender perspectives.

3.3.2 Gender-focused Projects. In the past 10-year cycle, the Peanut CRSP has carried out projects designed to explore further the gender concerns associated with peanuts in developing countries. A project in Malawi in 1996-2001 examined household economic issues and the importance of peanut to gender equity. From 2001 a project on aflatoxin in relation to women as primary providers of health and nutrition was carried out in Uganda. The Principal Investigator of the project (VT54) has also served as the Gender Advisor for the Peanut CRSP Technical Committee to ensure that the gender perspective is considered in the Annual Work Plans.

Women make up the majority of peanut farmers and small-scale, village processors in many developing countries. The high percentage of women attending farmers' training events, the training of women processors at the village level, and the high percentage of women in the host countries receiving short-term and advanced degree training affirms that women are benefiting from Peanut CRSP research and development initiatives. Clearly, one of the many impacts and achievements of the Peanut CRSP is that women have derived significant economic and social benefits.

3.3.3 Examples of Benefits to Women during the current five-year phase are as follows:

Women scientists and researchers from the host countries and the U.S.A. significantly benefited from degree training supported by the Peanut CRSP. In 2001-2005, of the 31 M. S. degree and seven Ph.D. degree graduates supported by the Peanut CRSP, 71% overall were women.

The Princess Sirinthorn's development project in poor villages in Thailand is benefiting villagers (mostly women) who were trained on Peanut CRSP-developed technologies by Kasetsart University. In 2003, Kasetsart University in Thailand (UGA37) trained 163 villagers (mainly women) on peanut sorting technology to reduce aflatoxin, and on processing of traditional and new peanut products (i.e., roasted peanuts, honey-roasted peanut butter, and peanut patties). Trained villagers initiated village-level enterprises that are producing aflatoxin-free peanut products with better packaging. These enterprises are the main source of cash income of women.

In the Philippines, Leyte State University scientists have trained villagers and assisted in the development of small-scale peanut processing enterprises, mainly by women (UGA04). Villagers have adopted manual sorting technology and are now producing aflatoxin-free new and traditional peanut products with better packaging with increased shelf life. The scientists continue to optimize and improve traditional products that are preferred by local consumers. Local Government Units have started to support the development of similar agro-processing enterprises in other villages.

In Uganda, where women make up the majority of peanut farmers and do most of the post-harvest and processing activities, the Peanut CRSP has linked with the National Association of Women in Uganda (NAWOU) and their sub-organizations. NAWOU is providing access to local women's organizations to ensure that they participate in project activities implemented by the University of Ghana. Such linkages should be maintained and strengthened. The research program in Uganda is conducted by a female student from Makerere University and explored the awareness of villagers on the health effects and management of aflatoxin. The study is providing baseline data on the impact of Peanut CRSP technologies prior to education programs to change behavior, and also build socio-economic research capacity that is much needed in this host country. Similar work should be continued in the future. One workshop was held at Makerere University on health education methodologies and gender issues.

Ghana has benefited significantly from the introduction of interventions to improve production. The use of farmer field schools has been particularly effective in technology transfer to farmers, and field days (one was televised widely in Ghana) have been well received. Training videos and DVDs have been produced. Interaction with farmers in one village (50% women) was ample evidence of the rapid adoption of improved crop practices. Farmers were very enthusiastic and eager to learn more about improving peanut yields and their incomes. They were equally eager to impart knowledge to other farmers. Farmers in the Ejura region have doubled their yields since participating in this program.

In Guyana, the gender composition of workshop participants has varied depending on the topic offered. When value-adding and post-harvest processing technologies were discussed, about 65% of the participants were women, while attendance at field days focused on production practices were dominated by men. Most of the small-scale processors that provide peanut butter to the lunch program of the local schools are women.

Women, children, and indigenous peoples are usually disadvantaged groups in rural farming areas in most developing countries. Because of the great importance of peanut to these people and the opportunity for this crop to contribute to the realization of the Millennium Development Goals (MDG) on gender equity, the Peanut CRSP could become a flagship program for gender equity efforts. To assure that the highest possible gender equity benefit is achieved, Peanut CRSP projects should include (in their design) strategies to ensure that women, children, and indigenous groups benefit directly from future technological interventions (i.e., disease-resistant peanut varieties, aflatoxin-free peanut products, etc.) by Peanut CRSP.

Additional experience working on gender issues in Peanut CRSP research in a host country like Uganda would enhance gender awareness in research in agriculture and health-related issues that Peanut CRSP could build upon to improve its collaborative work in developing countries.

IV Lessons Learned and Sustainability

4.1 The Whole Value Chain

The decision to carry out research across the whole value chain for peanuts has been a successful approach and should guide the design of any future program. The definition of the value chain ending with the value to consumers and their health has provided a very effective market development opportunity, as demonstrated by the effective use of the data in promoting peanut products in the U.S.A. The benefits to peanut consumption worldwide are important to the strategic goals of USAID's agricultural (expansion of markets), and health goals.

4.2 Market Pull versus Technology Push

In Guyana and Bolivia, the production challenges were relatively simple and rapid advances in production were achieved without the parallel expansion of demand resulting in lower prices. The inelasticity of these markets demonstrates the need to balance production research with post-harvest, utilization research and market development. For the future the program needs to ensure market demand through a balanced portfolio of projects and activities aimed at creating market pull for the adoption of production enhancing technologies. The lessons of production technology treadmills learned in the U.S.A. should be applied to developing countries for poverty reduction, a Millennium Development Goal, to be realized.

4.3 Market Location Opportunities

The conversion of some countries like the Philippines and Thailand from exporters to importers of peanut has been a lesson that many developing countries that produce peanuts should consider. Most countries aspire to sell peanuts on the international market; but ignore the potential value of peanuts in their own food industries. The value adding opportunity in peanuts is a potential that can provide good economic development opportunities and in many cases there is a greater value to peanuts in the local market than internationally. The international market is very competitive and many developing countries cannot realistically be competitive against China, India, and Argentina in this area.

4.4 Technology Transfer/Extension Partnerships

The Peanut CRSP was successful in establishing linkages with agencies interested in technology transfer and extension activities. This activity was not mandated by the program design, but this happened because the participants, especially in the host countries, were interested in development. The situation presents a dilemma for the future; if technology transfer is mandated as part of the program, then funds for these activities must be provided, or USAID must accept that there may be failures to realize the benefits and impact of the research outputs. It seems that both USAID and the Management Entity have to work harder to convince USAID missions to consider Peanut CRSP-developed technologies in their plans for agricultural development.

4.5 Integrating Socio-economics in the Program

The Peanut CRSP established a separate Socio-economic and Policy cluster of projects for the first time in this phase to focus on aspects of peanuts outside those relevant to production, food safety and nutrition, and post-harvest and utilization areas. These projects were successfully implemented and have generated significant data for policy making. But the projects, including the gender-focused projects, could have been better integrated with the other thematic clusters in the program. For a next phase, the integration of social, economic, and gender concerns in all the projects should be done early in the planning and design stage to better exploit the activities of the other Peanut CRSP projects.

4.6 Exploiting 'Graduate Program' Capacity

The experiment to exploit the "graduate-country" program of Thailand (graduate-country as presented in the CRSP guidelines, where research programs are no longer directly supported because of the increased economic development of a country), through Kasetsart University, was successful in furthering the broader development goals of the program in Asia. Thailand has become a center for excellence in training of trainers for the region. In a next phase, the program should consider continuing and expanding this approach to allow Bulgaria to support Peanut CRSP activities in Eastern Europe and the Balkans, and for students in Bolivia and Guyana to train in other Latin American countries such as Argentina and Brazil.

4.7 Dispersal/Concentration of Focus

There is very clearly a tension between the expectation by USAID that the program would leverage other resources to realize its goals, and the certainty of the achievement of the impact of the research results. In this program the critically important research that focused on the prevention of human aflatoxicosis should have been better funded to allow more rapid progress. As with most of the Peanut CRSP projects, the Principal Investigators needed to leverage significant amounts of the true cost of research to realize the progress that has been achieved, at the expense of the possible potential benefits from directly focusing on the research. In the future, the Management Entity should consider a more appropriate balance between resources and goals, and between the number of projects and funds provided to the program.

4.8 Information, Monitoring, and Evaluation

The Management Entity of the program has successfully established a Web-based information and reporting system. The Peanut CRSP Website is a key achievement that allows easy access by scientists, policy makers, development workers, and others to peanut information worldwide. The Website also provided an effective and cost-efficient tool for managing the program and highly dispersed cluster of projects. Monitoring and evaluation progress against the key performance indicators agreed during the planning and design stage needs to be reinforced.

V Key Conclusions

The Peanut CRSP has carried out research in the U.S.A. and host countries through imaginative, challenging, and ambitious multi-disciplinary projects. Additionally, there has been strong support from both U.S.A. 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 Principal Investigators in the U.S.A. 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 and human capacity of its partner research institutions (particularly in Africa where economic advancement has been elusive);
3. produced advanced 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 of 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 is now 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 socio-economic 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 is already addressing the new USAID strategic plan. One of the lessons learned from the past program was to match projects addressing production with projects creating demand.

The extensive list of achievements and benefits to both the U.S.A. and the host countries is 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.

VI Recommendations and Future Directions

6.1 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, socio-economic studies should continue addressing the impact, gender, and policy aspects of all projects.

The health benefits provided by peanuts 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 industry incubator model needs to be adapted and deployed in more locations to improve the value of peanuts to both producers and consumers.

Socio-economic, production, health, post-harvest, and utilization research should be integrated such that socio-economic 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 for 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 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.

6.2 Next Steps

6.2.1 Final Project Reports. The Principal Investigators need to take stock of their progress and ensure that their plans are executed and achievements are documented.

The Management Entity needs to review records to ensure that the full details of the program are documented. Lessons learned from the projects should be considered and incorporated into the policies and procedures for the next phase. Suggestions for improved implementation of the Peanut CRSP need to be solicited from the stakeholders to continue improvements into the next phase.

6.2.2 Final Program Report.

The Management Entity and participants must complete a final report summarizing their activities and achievements for the present grant.

6.2.3 RFP Preparation. Activities within key research areas that are not completed should be considered in the Request for Proposals (RFP) issued for the next Grant period.

Peanuts during the shelling process (left) and a locally manufactured roaster in a womens cooperative (below).

Dr. Tim Phillips awarded the BIFAD Chair's Award for Scientific Excellence (below).

School children help harvest in Guyana (above).

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Annex Table 1. Peanut CRSP Projects by Themes and Projects, 2001-2005

Food Safety: 5				
Project	**Project Investigator**	**U.S. State**	**Host Country(ies)**	**Region**
UAB56	P. Jolly	Alabama	Ghana	Western Africa
PUR10U	R. Mattes	Indiana	Ghana, Brazil	Western Africa
UGA22A	G. Hoogenboom	Georgia	Mali, Benin	Western Africa
UWI49F	N. Keller	Wisconsin	Botswana, Malawi, South Africa	Southern Africa
TAM50	T. Phillips	Texas	Ghana	Western Africa

Production Efficiency: 8				
UFL13P	K. Boote	Florida	Ghana, Benin	Western Africa
UFL16P	D. Gorbet	Florida	Bolivia	Latin America/Caribbean
TAM17P	Mark Burow	Texas	Burkina Faso, Senegal	Western Africa
NCS19P	R. Brandenburg	N Carolina	Ghana, Benin	Western Africa
UGA28P	M. Deom	Georgia	Malawi, Uganda	Southern Africa
UFL52	G. MacDonald	Florida	Guyana	Latin America/ Caribbean
NMX53	N. Puppala	New Mexico	Bulgaria	Eastern Europe
FAM51	M. Sheikh	Florida	India, Bangladesh	South Asia

Socio-economics: 5				
NCS07S	R. Moxley	N Carolina	Jamaica, Philippines, Thailand	Southeast Asia
VT09S	M. Bertelsen	Virginia	Senegal	Western Africa
AUB30S	C. Jolly	Alabama	Ghana	Western Africa
UCN36S	B. Bravo-Ureta	Connecticut	Senegal	Western Africa
VT54	C. Harris	Virginia	Uganda, Senegal	Southern Africa

Post-harvest and Utilization: 5				
Project	**Project Investigator**	**U.S. State**	**Host Country(ies)**	**Region**
UGA01A	D. Phillips	Georgia	Ghana	Western Africa
UGA04U	A. Resurreccion	Georgia	Philippines	Southeast Asia
UGA11U	M. Chinnan	Georgia	Bulgaria	Eastern Europe
NCA32U	M. Ahmedna	N Carolina	Jamaica, Senegal	Western Africa
OKS55	M. Hinds	Oklahoma	Ghana	Western Africa

Info./Tech. Transfer/Program Management: 6				
UGA05	R. Rhoades	Georgia	Global	Global
UGA37	A. Resurreccion	Georgia	Thailand	Southeast Asia
UGA38	J.H. Williams	Georgia	Global	Global
UGA40	J.H. Williams	Georgia	Global	Global
UGA39	J.H. Williams	Georgia	Global	Global
UGA41	J.H. Williams	Georgia	Global	Global

Source: Peanut CRSP Web Page

Annex Table 2. Annual Budget of Peanut CRSP by Themes and Projects, 2001-05.

Project ID	Year				
	2001-2002	**2002-2003**	**2003-2004**	**2004-2005**	**Total**
Food Safety: 5					
PUR 10U	91000	91000	91001	100000	373001
UGA 22A	81000	38975		40000	159975
UWI 49F	38333.33	120000	120000	120000	398333.3
TAM 50	10000	70000	82717.67	220000	382717.7
UAB 56		90001	129999	130001	350001
Sub-Total	276333.3	469976	483717.7	670001	1900028
Production Efficiency: 8					
UFL 13P	75000	75000	75000	75000	300000
UFL 16P	85000	52750	80005	80000	297755
TAM 17P	115000	115000	57500	115000	402500
NCS 19P	130000	105000	105000	105000	375000
UGA 28P	95000	95000	95000	95000	380000
FAM 51	60000	65000	63062		188062
UFL 52	50000	60000	33115.5	65000	208115.5
NMX 53	76000	76000	75000	60000	287000
Sub-Total	686000	643750	583682.5	595000	2508433
Socio-Economics: 5					
NCS 07S	35000	70000	45823		150823
VT09S	72000	72000	72000	70000	286000
AUB 30S	70000	80015	55000	115000	320015
UCN 36S	86000	86000	50660	95000	317660
VT 54	50000	60000	60000	70000	240000
Sub-Total	313000	368015	283483	350000	1314498
Post Harvest and Utilization: 5					
UGA 01A	56000	60000	60000	60000	236000
UGA 04U	125000	105000	105000	105000	440000
UGA 11U	107000	107000	57250	105000	376250
NCA 32U	60000	65000	41250	70000	236250
OKS 55	40000	40001	40000	50001	170002
Sub-Total	332000	317001	243500	330001	1222502
Info/Tech Transfer/ Program Management: 5					
UGA 05	53000	55000	55000	55000	218000
UGA 37		20000	20000	50000	90000
UGA 38	Nil*	Nil*	Nil*	Nil*	Nil*
UGA 39	52500	8750	28739	-2343	87646
UGA 40	15500	20000	20000	20000	66646
UGA 41	310000	368000	475261	434684	1587945
Sub-Total	362500	376750	504000	432341	1675591
Grand Total	**2038333**	**2270492**	**2193383**	**2502343**	**8995698**

Source: Peanut CRSP Database * This was an administrative mechanism to support trainings.

Budget Proposed 2005/06 Subject to Board approval

Food Safety/Nutrition	2005/06
AUB30	115000
OKS55	50000
PUR10	100000
TAM50	200000
UGA01	60000
UGA22	44000
UWI49	120000
VT54	70000
UAB56	178000
Production Efficiency	
FAM51 **	70000
NCS19	105000
NMX53	60000
TAM17	115000
UFL13	75000
UFL16	85000
UFL52	65000
UGA28	95000
Socio-economics	
NCS07 ***	
UCN36	95000
VT09	70000
Post-harvest/Utilization	
NCA32	70000
UGA04	110000
UGA11	110000
General	
UGA05 (Information)	55000
UGA37	21000
UGA38 (Training) *	
UGA40(Cooperation)	35000
Management	
UGA99 (Prog. Support)	0
UGA41 (ME)	400000

Annex Table 3. Top 20 Peanut Producing Countries Worldwide, 2004.

Groundnuts in Shell	**Year**
Area Harvested (Ha)	**2004**
India	8,000,000
China	5,125,000
Nigeria	2,800,000
Sudan	1,900,000
Indonesia	702,163
Senegal	640,000
Myanmar	580,000
United States of America	561,710
Chad	480,000
Ghana	470,000
Congo, Dem. Republic of	458,000
Burkina Faso	345,000
Mozambique	292,537
Niger	260,000
Zimbabwe	260,000
Viet Nam	255,000
Uganda	211,000
Guinea	210,000
Malawi	210,000
Mali	210,000

Groundnuts in Shell	**Year**
Production (Mt)	**2004**
China	14,075,000
India	7,500,000
Nigeria	2,700,000
United States of America	1,905,700
Indonesia	1,450,000
Sudan	1,200,000
Myanmar	715,000
Senegal	465,000
Chad	450,000
Ghana	439,200
Viet Nam	421,000
Argentina	414,285
Congo, Dem. Republic of	363,850
Burkina Faso	321,000
Guinea	252,000
Brazil	221,210
Niger	209,369
Cameroon	200,000
Egypt	191,000
Malawi	161,162

Source: FAO Database

Annex Table 4. Peanut CRSP Projects by Regions and Worldwide, 2001-2005.

Project	Project Investigator	U.S. State	Host Countries	Theme
Western Africa: 13				
UAB56	P. Jolly	Alabama	Ghana	Food Safety and Nutrition
UGA01A	D. Phillips	Georgia	Ghana	Post-harvest and Utilization
VT09S	M. Bertelsen	Virginia	Senegal, Uganda	Socio-Economics
PUR10U	R. Mattes	Indiana	Ghana, Brazil	Food Safety and Nutrition
UFL13P	K. Boote	Florida	Ghana, Benin	Production Efficiency
TAM17P	Mark Burow	Texas	Burkina Faso, Ghana, Mozambique, Senegal	Production Efficiency
NCS19P	R. Brandenburg	North Carolina	Ghana, Benin	Production Efficiency
UGA22A	G. Hoogenboom	Georgia	Mali, Benin	Food Safety and Nutrition
AUB30S	C. Jolly	Alabama	Ghana	Socio-Economics
NCA32U	M. Ahmedna	North Carolina	Senegal	Post-harvest and Utilization
UCN36S	B. Bravo-Ureta	Connecticut	Senegal	Socio-Economics
TAM50	T. Phillips	Texas	Ghana	Food Safety and Nutrition
OKS55	M. Hinds	Oklahoma	Ghana	Post-harvest and Utilization

Southern Africa: 3				
UGA28P	M. Deom	Georgia	Malawi, Uganda	Production Efficiency
UWI49F	N. Keller	Wisconsin	Botswana, Malawi, South Africa	Food Safety and Nutrition
VT54	C. Harris	Virginia	Uganda, Senegal	Socio-Economics

Project	Project Investigator	U.S. State	Host Country(ies)	Theme
South/Southeast Asia: 4				
UGA04U	A. Resurreccion	Georgia	Philippines	Post-harvest and Utilization
NCS07S	R. Moxley	North Carolina	Jamaica, Philippines, Thailand	Socio-Economics
UGA37	A. Resurreccion	Georgia	Thailand	Training
FAM51	M. Sheikh	Florida	India, Bangladesh	Production Efficiency
Latin America/Caribbean: 2				
UFL16P	D. Gorbet	Florida	Bolivia	Production
UFL52	G. MacDonald	Florida	Guyana	Production
Eastern Europe: 2				
UGA11U	M. Chinnan	Georgia	Bulgaria	Utilization
NMX53	N. Puppala	New Mexico	Bulgaria	Production
Global: 5				
UGA05	R. Rhoades	Georgia	Global	Information
UGA38	J.H. Williams	Georgia	Global	Training
UGA39	J.H. Williams	Georgia	Global	Program Support
UGA40	J.H. Williams	Georgia	Global	International Collaboration
UGA41	J.H. Williams	Georgia	Global	Program Management

Source: Peanut CRSP Database

Annex Table 5. Top Nine Peanut Producing States in the U.S., 2003

USA Peanuts: Area Harvested, Yield, and Production by State			
State	**Area Harvested**	**Yield**	**Production**
	1,000 Acres	*Pounds*	*1,000 Pounds*
Georgia	540.0	3,450	1,863,000
Texas	270.0	3,000	810,000
Alabama	185.0	2,750	508,750
Florida	115.0	3,000	345,000
North Carolina	100.0	3,200	320,000
Oklahoma	35.0	2,800	98,000
Virginia	33.0	2,900	95,700
South Carolina	17.0	3,400	57,800
New Mexico	17.0	2,700	45,900
United States	1,312.0	3,159	4,144,150

Source: Peanut CRSP Database

Annex Table 6. Peanut CRSP Projects by States in the U.S., 2001-2005.

Project	Project Investigator	Theme	Host Country(ies)	Region
Georgia: 10 (5 Research and 4 Management)				
UGA01A	D. Phillips	Post-harvest and Utilization	Ghana	Western Africa
UGA04U	A. Resurreccion	Post-harvest and Utilization	Philippines	Southeast Asia
UGA05	R. Rhoades	Information	Global	Global
UGA11U	M. Chinnan	Post-harvest and Utilization	Bulgaria	Eastern Europe
UGA22A	G. Hoogenboom	Food Safety and Nutrition	Mali, Benin	Western Africa
UGA28P	M. Deom	Production Efficiency	Malawi, Uganda	Southern Africa
UGA37	A. Resurreccion	Training	Thailand	Southeast Asia
UGA38	J.H. Williams	Training	Global	Global
UGA39	J.H. Williams	Program Support	Global	Global
UGA40	J.H. Williams	International Collaboration	Global	Global
UGA41	J.H. Williams	Program Management	Global	Global
Florida: 4				
UFL13P	K. Boote	Production Efficiency	Ghana, Benin	Western Africa
UFL16P	D. Gorbet	Production Efficiency	Bolivia	Latin America/ Caribbean
UFL52	G. MacDonald	Production Efficiency	Guyana	Latin America/ Caribbean
FAM51	M. Sheikh	Production Efficiency	India, Bangladesh	South Asia
North Carolina: 3				
NCS07S	R. Moxley	Socio-Economics	Jamaica, Thailand, Philippines	Southeast Asia
NCS19P	R. Brandenburg D. Jordan	Production Efficiency	Ghana, Benin	Western Africa
NCA32U	M. Ahmedna	Post-harvest and Utilization	Jamaica, Senegal	Western Africa

Texas: 2				
TAM17P	Mark Burow	Production Efficiency	Burkina Faso, Ghana, Senegal, Mozambique	Western Africa
TAM50	T. Phillips	Food Safety and Nutrition	Ghana	Western Africa

Virginia: 2				
VT09S	M. Bertelsen G. Norton	Socio-Economics	Senegal, Uganda	Western Africa
VT54	C. Harris	Socio-Economics	Uganda, Senegal	Southern Africa

Alabama: 2				
UAB56	P. Jolly	Food Safety and Nutrition	Ghana	Western Africa
AUB30S	C. Jolly	Socio-Economics	Ghana	Western Africa

Connecticut: 1				
UCN36S	B. Bravo-Ureta	Socio-Economics	Senegal	Western Africa

Indiana: 1				
PUR10U	R. Mattes	Food Safety	Ghana, Brazil	Western Africa

New Mexico: 1				
NMX53	N. Puppala	Production Efficiency	Bulgaria	Eastern Europe

Oklahoma: 1				
OKS55	M. Hinds	Post-harvest and Utilization	Ghana	Western Africa

Wisconsin: 1				
UWI49F	N. Keller D. Wilson	Food Safety and Nutrition	Botswana, Malawi, South Africa	Southern Africa

Source: Peanut CRSP Database

Annex Table 7. Project Evaluations and Site Visits Undertaken by EEP Members.

Project Code	U.S. University	Project Title/ Location	Host Country Site Visits	U.S. Site Visit
Food Safety & Nutrition				
UAB56	University of Alabama-Birmingham	Ghana	G Hildebrand & H Williamson (April 05)	John Gilbert (Dec 04)
PUR10U	Purdue University	Ghana, Brazil	G Hildebrand & H Williamson (April 05) John Gilbert (Jan 05)	John Gilbert (Dec 04) John Cherry (May-05)
UGA22A	University of Georgia-Griffin	Benin, Mali		John Gilbert (Dec 04)
UWI49F	University of Wisconsin	Botswana, Malawi, South Africa		John Gilbert (Dec 04)
TAM50	Texas A&M University	Ghana	John Gilbert (Jan 05)	John Gilbert (Dec 04)
Production Efficiency				
UFL13P	University of Florida	Benin, Ghana	G Hildebrand & H Williamson (APR 05)	Ron Gibbons & Geoff Hildebrand (Dec 04)
UFL16P	University of Florida	Bolivia	Dely P. Gapasin (Feb 05)	Ron Gibbons & Geoff Hildebrand (Dec 04) Howard Valentine
TAM17P	Texas A&M University-Lubbock	Burkina Faso, Ghana, Mozambique, Ghana	Geoff Hildebrand (Feb05)	Ron Gibbons & Geoff Hildebrand (Dec 04) Howard Valentine (Feb-05)
NCS19P	North Carolina State University	Benin, Ghana	G Hildebrand & H Williamson (Apr 05)	Ron Gibbons & Geoff Hildebrand (Dec 04)
UGA28P	University of Georgia-Athens	Malawi, Uganda	Geoff Hildebrand (April 05 - by email)	Ron Gibbons/ Geoff Hildebrand/12-04
UFL52	University of Florida	Guyana	John Gilbert & Ron Gibbons (Apr 05)	Ron Gibbons & Geoff Hildebrand (Dec 04)
NMX53	University of New Mexico	Bulgaria	Ron Gibbons (April 05)	Ron Gibbons/12-04 Geoff Hildebrand
FAM51	Florida A&M University	Bangladesh, India	Geoff Hildebrand (Jan 05)	Ron Gibbons & Geoff Hildebrand (Dec 04)

Socio-economics				
NCSO7S	North Carolina State University	Jamaica, Philippines, Thailand		Dely P. Gapasin Handy Williamson (Dec 04)
VTO9S	Virginia Tech. and State University	Senegal, Uganda		Dely P. Gapasin Handy Williamson (Dec 04)
AUB30S	Auburn University	Ghana, Senegal	G Hildebrand & H Williamson (Apr 05)	Handy Williamson (Dec 04)
UNC36S	University of Connecticut	Senegal		Handy Williamson/02/05
VT54	Virginia Tech and State University	Senegal, Uganda	Geoff Hildebrand (APR 05 - by email)	Dely P. Gapasin/ Handy Williamson/12-04
Post-harvest & Utilization				
UGA01A	University of Georgia at Griffin	Bulgaria	John Gilbert (Apr 05)	John Cherry & Dely P. Gapasin & John Gilbert (Dec 04)
UGA04U	University of Georgia at Griffin	Philippines	Dely P. Gapasin (Jan 05)	Dely P. Gapasin & Handy Williamson (Dec 04)
UGA11U	University of Georgia at Griffin	Bulgaria	Dely Gapasin (Jan 05) John Gilbert/ Ron Gibbons (Mar 05)	Dely P. Gapasin & John Cherry (Dec 04)
NCA32U	North Carolina Agricultural and Tech. University	Senegal		Dely P. Gapasin & Handy Williamson (Dec 04) John Cherry (Apr 05)
OKS55	Oklahoma State University	Ghana	G Hildebrand & H Williamson (Apr 05)	John Gilbert (Dec 04) John Cherry (May 05)
Info./Tech. Transfer/ProgManagement				
UGA05	University of Georgia-Athens	Global	Not Applicable	Darrell Nelson (Dec 04)
UGA37	University of Georgia-Griffin	Thailand	Dely P. Gapasin & Handy Williamson (Jan05)	Dely P. Gapasin & Handy Williamson (Dec 04)
UGA38	University of Georgia-Griffin	Global	Not Applicable	Darrell Nelson (Dec 04)
UGA39	University of Georgia-Griffin	Global	Not Applicable	Darrell Nelson (Dec 04)
UGA40	University of Georgia-Griffin	Global	Not Applicable	Darrell Nelson (Dec 04)
UGA41	University of Georgia-Griffin	Global	Not Applicable	Darrell Nelson (Dec 04)

Annex Table 8. Members of the 2005 External Evaluation Panel.

EEP Member	**Current Position**	**Expertise**	**Contact Address/Phone**	**Email**
Dr. Dely P. Gapasin, Coordinator	Consultant/Retired Senior Agriculturist The World Bank	Agricultural Research & Extension Management	2324 Heritage Hills Drive, Pleasant Hill CA 94523, USA +1-925-938-2455 (Ho) +1-925-285-7600 (Cell)	delygapasin@sbcglobal.net delygapasin@netzero.com
Dr. John Cherry	Eastern Regional Research Center, ARS-USDA	Food Science & Nutrition	600 E. Mermaid Lane Wyndmoor, PA 19038-8551, USA +1-215-233-6595 (Of)	jcherry@errc.ars.usda.gov
Prof. John Gilbert	Director Central Science Laboratory	Food Safety	Sand Hutton, York YO41 1LZ, UK +44-1904-462424 (Of)	j.gilbert@csl.gov.uk
Dr. Geoff Hildebrand	Groundnut Breeder Seed Co. Ltd. Rattray Arnold Research Station	Production & Plant Breeding	P.O. Box CH142 Chisipite, Harare Zimbabwe +263-91-232-968/969 (Of)	geoffhi@seedcogroup.com geoff@zimads.com
Dr. Darrell Nelson	Dean & Director Agric. Research Division University of Nebraska-Lincoln	Information, Communication & Management	207 Agricultural Hall Lincoln, NE 68583-0704, USA +1-402-472-2045 (Of)	dnelson1@unlnotes@unl.edu
Mr. Howard Valentine	Director The Peanut Foundation	US Peanut Industry & Research	Big Canoe, GA 30143, USA +1-706-579-1755 (Of)	pnuttech@alltel.net
Dr. Handy Williamson	Vice Provost Programs & Faculty Development U. of Missouri at Columbia	Socio-economics	211 Jesse Hall Columbia, MO 65211 +1-573-882-9061 (Of) +1-573-268-5682 (Cell)	williamsonha@missouri.edu
Consultants				
Dr. David Cummins	Consultant/Retired Director, PCRSP	Program & Research Management	1308 Cummins Mill Rd. Cookeville, TN 38501 +1-931-858-7582	dandjcummins@twlakes.net
Dr. Ron Gibbons	Consultant/Retired Breeder, ICRISAT	Production and Plant Breeding	12 Restormel Close Putnoe, Bedford MK 41 8PA, UK	Markgibbons.ifa@assureweb.com

Annex Table 9a. Number of Researchers who Completed ** M.S. and Ph.D. Degrees by Theme/Project, 2001-2005.

Theme/ Project	Number with M.S.	Number with Ph.D.	Men	Women	Total
Food Safety & Nutrition: 5					
UAB56	4	1	1	4	5
PUR10U	5	1	0	6	6
UGA22A		6	4	2	6
UWI49F	2		2	0	2
TAM50					
Sub-Total	**11**	**8**	**7/ 37%**	**12/ 63%**	**19**
Production Efficiency: 8					
UFL13P	0	0	0	0	0
UFL16P					
TAM17P	1	1	1	1	2
NCS19P					
UGA28P					
UFL52					
NMX53					
FAM51	5	1	3	3	6
Sub-Total	**6**	**2**	**4/ 50%**	**4/ 50%**	**8**
Socio-economics: 5					
NCSO7S					
VTO9S	4		2	2	4
AUB30S					
UNC36S					
VT54	1	1	1	1	2
Sub-Total	**5**	**1**	**3/ 50%**	**3/ 50%**	**6**
Post-harvest & Utilization: 5					
UGA01A	1	2			3
UGA04U	4			4	4
UGA11U					
NCA32U	5				5
OKS55					
Sub-Total	**10**	**2**	***0/ 0%**	***4/ 100%**	**12**
Information/Tech. Transfer/Program Management: 6					
UGA05					
UGA37					
UGA38					
UGA39					
UGA40					
UGA41					
Sub-Total					
TOTAL	**32**	**13**	***14/ 38%**	***23/ 62%**	**45**

Source: Peanut CRSP Database

*Number of men and women do not equal 45 because some gender disaggregated data are missing..

** In addition there are a number of researchers who have yet not completed the masters or doctorate degrees.

Annex Table 9b. Number of Researchers who Completed** M.S. and Ph.D. Degree by Region/Country, 2001-2005.

Theme/ Project	Number with M.S.	Number With Ph.D.	Men	Women	Total
Western Africa: 5					
Benin					
Burkina Faso		1	1		1
Ghana	7	2	3	6	9
Mali					
Senegal	2			1	2
Others	1				1
Sub-Total	**10**	**3**	***4/ 36%**	***7/ 64%**	**13**
Southern Africa: 5					
Botswana	1		1		1
Malawi					
Mozambique	1		1		1
South Africa					
Uganda	1	1	1	1	2
Others	1				1
Sub-Total	**4**	**1**	***3/ 75%**	***1/ 25%**	**5**
South & South Asia: 4					
Bangladesh	4		2	2	4
India		1	1		1
Philippines	1	1	1	1	2
Thailand		4	1	2	4
Sub-Total	**5**	**6**	***5/ 50%**	***5/ 50%**	**11**
Latin America/ Carribbean: 5					
Bolivia					
Brazil					
Guyana					
Jamaica	1				1
Sub-Total	**1**				**1**
Eastern Europe: 1					
Bulgaria					
Sub-Total					
Host Country Total	**20**	**11**	**13**	**13**	**31**
United States	**12**	**2**	**1/ 9%**	**10/ 91%**	**14**
TOTAL	**32**	**13**	***14/ 38%**	***23/ 62%**	**45**

Source: Peanut CRSP Database

*Number of men and women do not equal 39 because some gender disaggregated data are missing..

** In addition there are a number of researchers who have yet not completed the masters or doctorate degrees.

Annex Table 10a. Number of Researchers and Policy Makers who Participated in Non-degree Training by Theme/Project, 2001-2005.

Theme/ Project	Post-doctoral Fellowship	Internship (1 year or less)	Short Visits	Total
Food Safety & Nutrition: 5				
UAB56		8		8
PUR10U				
UGA22A	2	2	3	7
UWI49F			1	1
TAM50				
Sub-Total	**2**	**10**	**4**	**16**
Production Efficiency: 8				
UFL13P			4	4
UFL16P		15	3	18
TAM17P	1			1
NCS19P				
UGA28P				
UFL52				
NMX53	2	0	2	4
FAM51	3		1	4
Sub-Total	**6**	**15**	**10**	**31**
Socio-economics: 5				
NCSO7S		6	1	7
VTO9S	1			1
AUB30S			2	2
UNC36S				
VT54		29	45	74
Sub-Total	**1**	**35**	**48**	**84**
Post-harvest & Utilization: 5				
UGA01A	1			1
UGA04U	4	3	2	9
UGA11U		1		1
NCA32U				
OKS55				
Sub-Total	**5**	**4**	**2**	**11**
Information/Tech. Transfer/Program Management: 6				
UGA05				
UGA37				
UGA38				
UGA39				
UGA40				
UGA41				
Sub-Total				
TOTAL	**14**	**64**	**64**	**142**

Source: Peanut CRSP Database

Annex Table 10b. Number of Researchers and Policy Makers who Participated in Non-degree Training by Region/Country, 2001-2005.

Regions/ Countries	Post-Doctoral Fellowship	Internship (1 year or less)	Short Visits	Total
Western Africa: 5				
Benin			2	2
Burkina Faso		2	3	5
Ghana	1	8		9
Mali			2	2
Senegal	1		45	46
Sub-Total	**2**	**10**	**52**	**64**
Southern Africa: 5				
Botswana			1	1
Malawi				
Mozambique				
South Africa				
Uganda		29		29
Others	1			1
Sub-Total	**1**	**29**	**1**	**31**
South & South Asia: 4				
Bangladesh			1	1
India	1	1		1
Philippines		6	2	8
Thailand			1	1
Sub-Total	**1**	**7**	**4**	**12**
Latin America/Carribbean: 5				
Bolivia		15	3	18
Brazil				
Guyana				
Haiti				
Jamaica	1			1
Others	2			2
Sub-Total	**3**	**15**	**3**	**21**
Eastern Europe: 1				
Bulgaria	1	1	2	4
Sub-Total	**1**	**1**	**2**	**4**
Host Country Total	**8**	**62**	**62**	**132**
United States	**6**	**2**	**2**	**10**
TOTAL	**14**	**64**	**64**	**142**

Source: Peanut CRSP Database

Annex Table 11a. Number of Beneficiaries* who Participated in Training, Workshops, and Field Days by Theme/Project, 2001-2005

Themes/Project	Short term	Workshops	Field Days	Others	Total
Food Safety & Nutrition: 5					
UAB56				300	300
PUR10U					
UGA22A		68			68
UWI49F		42			42
TAM50					
Sub-Total		**130**		**300**	**430**
Production Efficiency: 8					
UFL13P			50		50
UFL16P					
TAM17P					
NCS19P	65		162		227
UGA28P			1,000		1,000
UFL52	2	349			351
NMX53	0	2	154	2	158
FAM51				1	1
Sub-Total	**67**	**351**	**1,366**	**3**	**1,787**
Socio-economics: 5					
NCSO7S					
VTO9S					
AUB30S					
UNC36S					
VT54		33			33
Sub-Total		**33**			**33**
Post-harvest & Utilization: 5					
UGA01A					
UGA04U		487			487
UGA11U		18			18
NCA32U		2			2
OKS55					
Sub-Total		**507**			**507**
Information/Tech. Transfer/Program Management: 6					
UGA05					
UGA37	133	342			475
UGA38					
UGA39					
UGA40					
UGA41			200		200
Sub-Total	**133**	**342**	**200**		**675**
TOTAL	**200**	**1,343**	**1,566**	**303**	**3,432**

Source: Peanut CRSP Database.
***Beneficiaries include farmers, villagers, extension staff, NGOs, private sector, and other stakeholders.**

Annex Table 11b. Number of Beneficiaries* who Participated in Training, Workshops, and Field Days by Region/Country, 2001-2005

Regions/Countries	Short Training	Workshops	Field Days	Others	Total
Western Africa: 5					
Benin		3	20		23
Burkina Faso					
Ghana	65	3	192	300	560
Mali					
Senegal		2			2
Sub-Total	**65**	**8**	**212**	**300**	**585**
Southern Africa: 5					
Botswana		36			36
Malawi			500		500
Mozambique					
South Africa					
Uganda		33	500		533
Sub-Total		**69**	**1000**		**1069**
South & South Asia: 4					
Bangladesh				1	1
India					
Philippines	2	398			400
Thailand	122	342			464
Others	7				7
Sub-Total	**131**	**740**		**1**	**872**
Latin America/Carribbean: 5					
Bolivia					
Brazil					
Guyana	2	349			351
Haiti					
Jamaica					
Sub-Total	**2**	**349**			**351**
Eastern Europe: 1					
Bulgaria	2	20	4	2	28
Sub-Total	**2**	**20**	**4**	**2**	**28**
Host Country Total	**200**	**1,186**	**1,216**	**303**	**2,905**
United States Total		**157**	**350**		**507**
TOTAL	**200**	**1,343**	**1,566**	**303**	**3,432**

Source: Peanut CRSP Database

Annex Table 12a. Number and Types of Publications by Theme/Project, 2001-2005.

Theme/ Project	Articles in Refereed Journals		Research Reports	Presentations	Extension Publications*	Total
	Published	In Manuscript				
Food Safety & Nutrition: 5						
UAB56	2	4		5		11
PUR10U	4	5		48		57
UGA22A	1	1	4	5		11
UWI49F	5			36	3	44
TAM50	8			2		10
Sub-Total	**20**	**10**	**4**	**96**	**3**	**133**
Production Efficiency: 8						
UFL13P	3	2		7		12
UFL16P	1		5	1	6	13
TAM17P	3		1	9		13
NCS19P	6		1	2	3	12
UGA28P	5					5
UFL52			1	1		2
NMX53	4	2	5	42	0	53
FAM51	2	2		7		11
Sub-Total	**24**	**6**	**13**	**69**	**9**	**121**
Socio-economics: 5						
NCSO7S		1	3	1		5
VTO9S		1	10	3		14
AUB30S						
UNC36S	4		2	4		10
VT54	1	2	2			5
Sub-Total	**5**	**4**	**17**	**8**		**34**
Post-harvest & Utilization: 5						
UGA01A	4	7	4	18		33
UGA04U	11	22	11	24		68
UGA11U	15	6	3	13		37
NCA32U	3		16	12		31
OKS55		2		3		5
Sub-Total	**33**	**37**	**34**	**70**		**174**
Information/Tech. Transfer/Program Management: 6						
UGA05						
UGA37			1			
UGA38						
UGA39						
UGA40						
UGA41	1	2	5	36	10	54
Sub-Total	**1**	**2**	**6**	**36**	**10**	**54**
TOTAL	**83**	**59**	**73**	**279**	**22**	**516**

Source: Peanut CRSP Database
Extension publications include brochures, posters, leaflets, farmers' manuals, etc.

Annex Table 12b. Number and Types of Publications by Theme/Project, 2001-2005

Region/ Country	Articles in Refereed Journals		Research Reports	Presentations	Extension Publications*	Total
	Published	Manuscript				
Western Africa: 5						
Benin	1	1		1		3
Burkina Faso				1		1
Ghana	8	12		55		75
Mali						
Senegal	7	2	12	5		26
Sub-Total	**16**	**16**	**12**	**62**		**106**
Southern Africa: 5						
Botswana	2			6		8
Malawi						
Mozambique						
South Africa				1		1
Uganda	1	1	2			4
Sub-Total	**3**	**1**	**2**	**7**		**13**
South & South Asia: 4						
Bangladesh			2			2
India	1	1				2
Philippines	11	23	14	25		73
Thailand			2	1		3
Sub-Total	**12**	**24**	**18**	**26**		**80**
Latin America/Caribbean: 4						
Bolivia	1		5	1	6	13
Brazil						
Guyana			1		2	3
Haiti						
Jamaica						
Sub-Total	**1**		**6**	**1**	**8**	**16**
Eastern Europe: 1						
Bulgaria	15	6	3	13		37
Sub-Total	**15**	**6**	**3**	**13**		**37**
Host Country Total	**47**	**47**	**41**	**109**	**8**	**252**
United States	**36**	**12**	**32**	**170**	**14**	**264**
TOTAL	**83**	**59**	**73**	**279**	**22**	**516**

Source: Peanut CRSP Database
Extension publications include brochures, leaflets, posters, farmers' manuals, etc.

ANNEXES 1-7
Table of Contents

The Peanut Collaborative Research Support Program

External Evaluation Panel 2005 Report

ANNEX 1

Socio-economic Sector Thrust Report

1. Research Approaches:

The principal reviewer for this sector was Handy Williamson, Associate Provost at the University of Missouri.

Dely Gapasin assisted in the review of NCS07, VT09 and VT54.

Also included in this annex are projects AUB30 (where John Gilbert was the lead reviewer) and NMX53 where (Geoff Hilderbrand was the lead reviewer) because they contain economic analysis of factors classified into other sectors.

Specific approaches followed by projects in the socioeconomic thrust were variable and included: assessing the socioeconomic impacts of vitamin A fortification of peanut butter; assessing the socioeconomic following adoption of new cultivars and integrated pest management; assessing the impacts of peanut related food processing, science innovations on processing, and marketability of peanuts.

Economic and policy studies were carried out to assess: economic and spatial equilibrium analysis of domestic and international trade policies; economic surplus analysis of peanut research on: (1) new variety La Fleur 11, (2) Aflatoxin research, and (3) new Rosette virus resistant varieties; poverty index analysis; and experimental economic analysis of environmental benefits of peanut research.

In Senegal, three departments of ENEA were involved in: the analysis of aflatoxin levels in peanut on farm, in storage, and in the markets; review of food preparation practices; farming, harvesting, and post-harvest practices related to minimizing aflatoxin contamination; and gender analysis of farming activities, experimental methodologies for health education, and health training.

Farm level surveys were carried out in selected rural communities in Senegal to collect data on farming, post-harvest processing, storage, and health issues related to aflatoxin. The survey involved first year students from ENEA who collected data as part of their official activities.

Nearly 500 farmers were surveyed to analyze the production function and determine the impact of changing factors of production (capital investments, fertilizers, pesticides, seeds, technology and labor) on yield per acre and overall production in the region.

The analytical approach used econometric techniques (e.g., Logit and Tobit regression, stochastic production, cost and profit frontiers, shadow cost and profit frontiers) and linear programming models to investigate: peanut production and farm efficiency; peanut cultivation and profitability; technology adoption; Aflatoxin, gender and health related aspects in peanut cultivation; and Meta analysis of farm-level efficiency studies.

In Ghana a survey was used to establish the extent of awareness of aflatoxins among producers, market participants (farmers, processors, consumers) and administrators and to assess the level of behavioral change as reflected by improved storage practices, modified consumption habits and marketing practices. Experiments were established to determine the cost of practices that manage aflatoxin content.

2. Outputs/Achievements

Consumers surveys of neighborhoods with stores selling the fortified peanut butter, in the Philippines showed that hundreds of Filipinos(15% of children) began consuming the new vitamin A fortified peanut butter, which would result, in the long-term, in reduction of vitamin A deficiency in the population (which is widespread especially among children).

A case study of Newborn Foods, Inc., the company involved in the adding Vitamin A to fortify peanut butter, showed that its brand is the second largest selling brand of peanut butter. The decision to fortify all its peanut butter product could have impact in the consuming public, especially children. It also showed that, while a number of additional employees (6) had to be hired, increased costs were outweighed by sales increase.

The case study of Marigold Commodities, Inc., a company involved in aflatoxin elimination by mechanical sorting, showed that it was able to export "*kare-kare*" sauce with peanut to the US causing its share of the export to increase from 9.9% in 1999 to 45% in 2001. Also, 17% of Filipino households surveyed consumed aflatoxin-free "kare-kare" sauce.

Preliminary results of a North Carolina peanut farmers' survey showed that among Peanut CRSP IPM funded practices, weather-based advisory for IPM adoption was preferred by farmers with usage rates of 43-52% in 1999-2003. Of the Peanut CRSP-developed varieties, farmers preferred NC V11 and NC 12C, which showed consistently high adoption rates of over 40% in 1999-2003. Perry variety reached this level in 2002-2003.

One Ph.D. student at NCSU is working on the NC peanut farmers' survey and an annotated bibliography of researches conducted at NCSU. Two U.S. graduate students at NCSU were trained on interviewing and survey methodology; and four graduate students at the University of the Philippines at Diliman were trained on methods of interviewing and survey methodology.

Workshops in the Philippines and Thailand were held to train non-social scientists and graduate students in social science research methods so they can assist in carrying out the planned surveys.
One Thai researcher visited NCSU to train ion statistical methods and questionnaire construction in preparation for the trainee's survey in Thailand.

Several publications based on CRSP results were produced and include: impact assessment of the Vitamin A fortification of peanut butter of an industry innovator (A. Lustre et al., 2004); Vitamin A fortification of peanut butter in the Philippines: Socio-economic impacts on families (F. C. Galvez, et al., 2004); eliminating aflatoxin in peanut-based products: socioeconomic impacts of the transfer of new sorting technology to a Philippine company (F.C. Galvez et al., 2004).

Technical papers generated from the research included: Impacts of the Peanut CRSP: An annotated bibliography of researches conducted at NCSU (R. Moxley and G. Thompson, 2004); paper (submitted): Knowledge of nutrition and health relations predicted by income, information access, and family solidarity (R. Moxley and K. Jicha, 2004); paper presentation to Rural Sociological Society meeting: Socio-economic impact assessment of Vitamin A fortification (R. Moxley et al.).

The economic analysis methodologies tested/used in the project, especially the poverty index analysis and experimental economic analysis of environmental benefits, are very good products of this projects. 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 to the West African region.

Ph.D. student James Gray (U.S.A., male) completed his degree in 2002 with research on economic spatial equilibrium analysis and international trade policies in Senegal and is now Assistant Provost at the University of Liberia.

M.Sc. student, Jason Bertgold (U.S.A., male), completed his degree in 2001 with research on Senegal's trade policies, economic impacts of Partnership Agreements between EU and the ACP states on Senegalese groundnut sector. Five M.Sc. students completed their degrees/internship at Virginia Tech. 2 Ph.D. students have ongoing studies at Virginia Tech.

Farm level and market surveys in Uganda showed low levels of aflatoxin contamination immediately after harvest and drying. However, processed nuts on sale in urban market centers contain aflatoxin levels of 2-3 times higher than the WHO allowable limits and 10 times higher than EU standards. That is an indication that aflatoxin contamination occurs during post-harvest handling and processing stages.

Aflatoxin issues were unknown to vast majority of Ugandan population surveyed, from university professors to illiterate farm families. Only health professionals and agronomists knew about aflatoxin contamination and their health effects. The Ministry of Health and the Bureau of Standards appreciated the results of the market survey which showed high level of aflatoxin contamination of peanut products sold in the local markets.

One M.S. student at Makerere University (MU), completed her research on farming, harvest, and post-harvest practices and relevant attitudes and knowledge in four peanut growing areas of Uganda. PIs at MU and VT have jointly advised her necessitating the appointment of Dr. Colette Harris as a Makerere University faculty.

One Ph.D. student is jointly supported by Makerere University, Peanut CRSP, and IPM CRSP. Some students from ENEA were trained on qualitative research methodologies. A total of 40 NGO members were trained in matters related to health education methodologies and gender.

Four agricultural extension students (all women) at Makerere University were trained on gender and health education issues. One female M.Sc. student was trained in ethnographical methodologies, qualitative data analysis and thesis writing. The Host Country PI (male) was trained on administrative and accounting skills. Three agricultural extension workers (all males) were trained on how to train farmers to reduce aflatoxin contamination. Two health supervisors (both men) and eight health workers (six women and two men) were trained on health and gender issues and innovative health education methodologies related to aflatoxin.

Two workshops in 2002 were attended by 40 NGO members (mainly women) on health education methodologies, gender, and aflatoxin contamination. One Workshop was held in April 2004 at Makerere University on health education methodologies and gender issues for 15 participants including faculty, students, and health workers. The Ministry of Health appreciated the training on aflatoxin since the staff was not aware of the health risks caused by aflatoxin contamination.

Knowledge of methods used in conducting economic analysis was gained through the use of the new software and interactive exchange visits to Alabama and Bulgaria. Plans for producing publications were developed. The PIs jointly arrived at the realization that analytical tools necessary for this project would need to be rebuilt based on assumptions appropriate for a non-centrally controlled economy. Also, assumptions relative to farm unit size and managerial capabilities of the new farm owners would need to be retooled. Hence, technology transfer and technology transformation would result from the CRSP endeavor.

ENEA was enabled to inaugurate better collection and use of farm level data, including the use of coding and data entry. This process became repeatable on a yearly basis and the focus shifted to a more rigorous system of data analysis. This new capability at data management has been used to increase the production of technical papers to disseminate the results. The papers encompass a range of topics, including the impact of technical innovation through new 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.

On the U.S. side of the technical benefits/achievements ledger, there were several outcomes: The University of Connecticut (UCONN) PI and his assistants gained additional experience in collecting, managing and analyzing data in situations with developing country conditions imposed. Other faculty at UCONN gained experience from working with and exposure to richer socio-economic data from the developing country setting.

Capacity development at UCONN has been the experience and ability to offer short term training to participants from less developed countries. They have developed the ability to bring short term visitors to campus as well as degree seeking students from Senegal. More recently UCONN has begun to receive more graduate students from Kenya. Involvement with this project has had a very positive impact on the professional development of several faculty members in different departments at UCONN.

The training of ENEA faculty at the University of Connecticut has had a huge positive impact. Many ENEA faculty members have graduated with an M.S. or a Ph.D. and others have been able to participate in short term training activities. These improved human resources, including both men and women, have provided ENEA with the needed capacity to respond to higher requirements.

A workshop, jointly sponsored by the Peanut (UCONN-ENEA) and soil Management (Montana State) CRSP's conducted by Drs. J. Antle (MSU) and J. Stoorvogel (University of Wageningen), was held in November 2003 in ENEA, Dakar. The workshop introduced the Tradeoffs Model developed by the SM CRSP to participants from Mali, Ghana, Kenya, ENEA, ISRA and UCONN. This conference set the foundation for an evolving collaboration between these two CRSP's in Senegal.

3. Demonstrated/Potential Impacts

One project improved the awareness of participating food industry companies in the Philippines that there are 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 also produce similar healthy and safe commercial products.

A potential impact of that project is 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 initiatives started by Peanut CRSP. It would also encourage the food industry to enhance commercialization of Peanut CRSP technologies within the private sector with their own funding and facilitation, a sustainability consideration.

Breeding research could result in potential savings ***of about USD 47 million*** by using Peanut CRSP released rosette resistant varieties in Uganda; ***poverty could be reduced by 1.3%*** resulting from the adoption of these Peanut CRSP developed technologies; and aflatoxin research in Senegal could result in potential ***savings of about USD 4 million***, to confectionary groundnut producers, not including health benefits.

The research in Senegal provided ENEA students and NGO member's skills in understanding health issues related to aflatoxin in peanuts. The research in Uganda is starting to show initial impact especially in the health aspect. It is expected that reduction of aflatoxin level of peanut on farm and in the market, and processed peanut products in the market would result to 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 has created greater awareness of 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 in 2003 and 2004. For example, the Ministry of Agriculture has hired an M.S. graduate to fill an Agriculture Inspector position. These impacts could increase farm incomes in Mubenda through export to Europe.

There has been an increase in the understanding of the importance of peanut production in Bulgaria and of potential market constraints introduced when aflatoxin contamination is prevalent (in Benin, Bulgaria and Ghana). The US and HC PIs have jointly established the importance of conducting market studies at the country level and in the context of regional trade within the European Union (EU). Bulgaria is now establishing goals for becoming the premier producer and exporter of quality peanuts within the EU and possibly beyond.

The project has involved working in Benin, Ghana and Bulgaria where collaboration has been successful. The links with this work and UAB56 are strong and efforts from both projects to develop rapport with locals in Ghana have been notably successful. There have been 3 workshops in Ghana involving large numbers (ca. 300 in each case) which followed up on the apparent lack of awareness amongst professionals of aflatoxin. These workshops have been successful in developing rapport at a local level and while the direct benefit to AUB30S is not obviously apparent, there is no doubt that this activity has facilitated work in UAB56 and will be vital if TAMU50 is to be successfully undertaken in terms of intervention studies.

Producers, consumers and processors (male and female) will have increased knowledge of the prevalence and health impact 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 stages, along the custody chain in the Host Country environments. Host Country scientists and producers have increased knowledge of the impact of aflatoxin on their expectations for gains form releasing increased quantities of peanuts into local and export markets. By reducing the volume of aflatoxin contaminated product released into the local market, HC's would be in a better position for reaping benefits from increased utilization. HC's would also benefit from increased utilization of local production for value added peanut products released into the marketplace.

The impact of the CRSP support to ENEA goes beyond the demonstrated effects on the data collection process and the subsequent output, and the professional growth of the researchers involved. The collaborating link 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 link and institution to institution familiarity can also sustain the flow and increase in graduate student education when future resources makes that permissible and possible.

4. United States/Host Country Beneficiaries and Benefits

The population/consumers benefited from increased Vitamin A nutrition through a safe and convenient medium, and the industry learned that they could expand market shares with enhanced products.

Policy-makers and top-level government decision-makers in the Philippines (in agriculture, health, trade, research, extension, and rural development), could utilize the results of the impact study and case studies to enhance transfer of healthy and safe (aflatoxin-free) peanut-based food products and improved processes to the private food industry. These include micro- and small-scale rural enterprises that are operated mainly by women, another target group of the project in the Philippines and Thailand.

Discussing the market for peanuts in Guyana with a local market maker.

Peanut CRSP PIs and collaborating institutions in other countries benefit from the use of impact assessment and case study methodologies, including developed survey instruments and questionnaires used in the Philippines and Thailand. The U.S. benefited from increased and more accessible information on the impacts on farmers who used Peanut CRSP developed varieties and IPM practices.

Main U.S. beneficiaries are policy makers and top-level government decision makers responsible for global/in-country trade, health, and agriculture issues. Results of economic and policy analysis by U.S. and

Host Country researchers would be useful within specific countries and at the regional level (i.e., West African region). The new initiatives to measure the benefits in poverty reduction and environmental impacts of peanut research are significant advancements.

Graduate students in U.S. and developing countries have been trained at Virginia Tech on various economic assessment and policy analysis methodologies. They could increase the agricultural economics capability in their research institutions once they return to their countries. Ugandan farmers and small-scale processors, traders, private medium-scale food processing business enterprises, and eventually consumers (because of the availability of aflatoxin-free peanuts and products) are key beneficiaries.

Collaborating institutions, like ENEA in Senegal and Makerere University in Uganda, have benefited from degree and non-degree training of faculty and students. Close collaboration between the H.C. and U.S. Project Teams improved their professional stature, sharing of research methodologies and information, and joint authorship of scientific papers.

The project has involved working in Benin, Ghana and Bulgaria where collaboration has been successful. The links with this work and UAB56 are strong and efforts from both projects to develop rapport with locals in Ghana have been notably successful. There have been 3 workshops in Ghana involving large numbers (ca. 300 in each case) which followed up on the apparent lack of awareness amongst professionals of aflatoxin. These workshops have been successful in developing rapport at a local level and while the direct benefit to AUB30S is not obviously apparent, there is no doubt that this activity has facilitated work in UAB56 and will be vital if TAMU50 is to be successfully undertaken in terms of intervention studies.

Producers, consumers and processors (male and female) will have increased knowledge of the prevalence and health impact 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 stages, along the custody chain in the Host Country environments. Host Country scientists and producers have increased knowledge of the impact of aflatoxin on their expectations for gains form releasing increased quantities of peanuts into local and export markets. By reducing the volume of aflatoxin contaminated product released into the local market, HC's would be in a better position for reaping benefits from increased utilization. HC's would also benefit from increased utilization of local production for value added peanut products released into the marketplace.

Research conducted through the Peanut CRSP is a significant contribution to the policy decision making process. ENEA works with several entities involved in community development, such as local governments, NGOs and various providers of technical services. The CRSP research has contributed to the improvement in the design of Local Development Plans (LDP) which are instruments that inform policy decisions regarding resource use at the village and rural community levels.

At the University of Connecticut, the Peanut CRSP has facilitated the interaction among a number of units within the CRSP but subsequently in various other efforts. This has made it possible to compete successfully for other projects. These types of benefits will go on well beyond the life of any particular project.

5. Building Partnerships

In the Philippines, partnerships were key to the success realized from using Peanut CRSP findings. The main collaborating institutions are: (1) the Food Development Center of the National Food Authority (FDC/NFA) and the University of the Philippines at Diliman (UP-D). The Host Country PIs, with inputs from NCSU PIs, developed the survey instruments and questionnaires, pre-tested them, and carried out the actual surveys.

In Thailand, the main collaborating institution is Kasetsart University, which benefited in increasing its capacity for socio-economic research. With support from NCSU PIs, the Thai PIs prepared the survey questionnaires and carried out survey and interviews of former trainees. A stronger partnership was forged between Kasetsart University and North Carolina State University in the socioeconomic area.

The main institutional partner of Peanut CRSP in Senegal is ISRA; in Uganda the partner is the National Agricultural Research Organization (NARO), and in Malawi it is Chitedze Agricultural Research Station and the International Center from Research in Semi-Arid Tropics (ICRISAT).

A Ugandan farmer and CRSP scientist view rosette resistant peanuts.

Virginia Tech-Peanut CRSP and Centre for International Cooperation in Agricultural Research for Development (CIRAD) collaboration has resulted in strong complementation in their research efforts in Senegal. For example, cost of production data has been collected for all CIRAD peanut trials with assistance from the Virginia Tech project team. One graduate student has started to use these data sets in his research.

Partnership with the ICRISAT-Mali Office, has developed a snag pending the approval of a Memorandum of Understanding (MOU) that would cover the collaboration. The planned regional workshop co-sponsored by ICRISAT-Mali and Peanut CRSP has been delayed.

In U.S., Peanut CRSP-Virginia Tech has collaborated with: (1) the University of Georgia on breeding using genetic manipulation; (2) the University of Connecticut on household surveys, and (3) the International Food Policy Research Institute (IFPRI) on the use of IFPRI's Uganda and Malawi data sets by graduate students; and (4) within Virginia Tech with the Integrated Pest Management (IPM) CRSP to share research sites in Uganda and access the program's information and experts.

Research partnership with the Ecole Nationale d'Economie Appliquee (ENEA) in Senegal did not remain viable. Experience with partnering with Makerere University in Uganda was more satisfactory. The multi-disciplinary team at Makerere University (Departments of Food Science and Technology, Agricultural Extension and Education, Anima Science, Gender Studies, and Medical School) and the National Agricultural Extension Services of the Ministry of Agriculture complements the multi-disciplinary approach of Virginia Tech.

Collaboration with the Ugandan Bureau of Statistics resulted in the preparation of baseline database on aflatoxin exposure levels in Ugandan population. This linkage should be strengthened to ensure maintenance of the data sets and make it accessible to local and regional researchers and policy makers.

In 2002, potential partnerships with an NGO (Tostan) and the *Association pour la Promotion de la Femme Senegalese* (APRPFES) were negotiated. APROPFES has 200 collaborating villages in the Peanut Basin region. Since these two NGOs did not continue their participation, as was also the case for the NGO Tostan, that also initially indicated willingness to participate in the project, the project was transferred from Senegal to Uganda. In Uganda, Peanut CRSP has linked with the National Association of Women in Uganda (NAWOU) and their sub-organizations. This provided access to local women's organizations to ensure their participation in the project. Women make up majority of peanut farmers and do most of the post-harvest and processing activities. Such linkages should be maintained and strengthened.

Host Country (Benin, Bulgaria, and Ghana) and US scientists have formed useful partnerships which will lead to developing appropriate tools for conducting market analysis, impact assessment and documenting behavioral changes on the part of producers, consumers and market participants. The partnerships should also lead to increased understanding as to the potential dangers of aflatoxin and of ways to achieve abatement of health risks. The partnerships would also lead to the development and flows of scientific and marketing information relevant to the US and HC's.

The first domain of partnerships developed is between ENEA and the University of Connecticut. This partnership has had many positive benefits for both institutions. The partnerships developed with other Peanut CRSP projects (i.e., Virginia Tech and Auburn) and with the Soil Management CRSP are also of significance. These collaborations have facilitated several activities including organizing workshops and joint research activities.

Within Senegal, the Peanut CRSP has made it possible to strengthen the collaboration with ISRA, the Ministries of Education and Agriculture, and with a variety of NGOs and local governments.

At the University of Connecticut, the Peanut CRSP has motivated several partnerships among faculty members in different departments that are deriving benefits and activities beyond the confines of this particular project.

6. Constraints and Recommended Solutions

Fund management: Bureaucracy in U.S. University and Host Country institution continue to cause delays in transfer of funds (also cited by last EEP). In Philippines, a check was sent to the wrong address causing considerable delay in implementation. In Thailand, there was excessive paperwork required to transfer of minimal funds from U.S. The fund reimbursement scheme used by NCSU caused additional problem. Usually, the Host Country institutions have very limited funds to pre-pay for the expenditures. These problems caused significant delays in carrying out the planned surveys. Other Peanut CRSP projects (i.e., NCA32), use advanced release of funds; further release is based on satisfactory accounting of already released funds. NCSU management can look at this scheme or other options.

Changes in Leadership: The UP-D PI left in December 2002, followed later by the FDC/NFA researcher who was working on the Vitamin A case study. There was considerable slow-down of activities which delayed data analysis and preparation of reports. The two Philippine collaborating institutions identified replacements but they needed to be trained.

Software problem: Electronically transferring data sets from the Philippines was difficult because of software incompatibility. Some statistical analysis cannot be duplicated in U.S. and Philippines. Encoded data had to be cleaned again at NCSU. In the future, trial runs should be done to ensure that data is transferable, both groups should use the same software, and NCSU PI should train the encoders.

Changes in PIs: Several turnovers of collaborating economists (PIs) in Senegal at ISRA resulted in a slowdown of project activities; and contributed to failure to broaden project coverage to include economic/policy work in other countries within West Africa.

Partnership problem: Collaborative work with ICRISAT-Mali Office was affected by delays in signing of an MOU, especially the planned joint ICRISAT-Peanut CRPS regional workshop on economic assessment. The PIs plan to negotiate with another partner in the region to carry out this workshop in 2005.

Graduate program problems included: (1) difficulty to recruit potential candidates because of English difficulty among Francophone candidates; and (2) many candidates had difficulty with the Economics Ph.D. program at Virginia Tech because of poor educational backgrounds.

Institutional problems: Some problems were encountered in identifying scientists to carry out collaborative research in Senegal, which resulted in very slow progress in two years. This necessitated transfer of the project VT54 to Uganda in 2003, with Makerere University as the collaborating institution. Considerable progress has been attained in one year and the collaborating scientists remain very active and committed.

Differing incentives: In Uganda, farmers are interested in collaborating with Peanut CRSP to reduce aflatoxin levels in peanut since they are the principal consumers of their produced. However, there is no incentive among traders to do the same. It is planned to work with the Ministries of Health and Agriculture to create greater awareness of the health risks of aflatoxin and availability of Peanut CRSP technologies to reduce contamination, such as manual sorting. The project has also to work with the Ministry of Trade in this respect.

Research v. technology transfer: There is tension between research and development work in Peanut CRSP. The program is trying to make impact by transferring Peanut CRSP technologies to farmers, traders, processors, and the general public, including the government. But technology transfer needs different type of activities and additional resources. It would also require traditional research partners such as extension providers, international and local NGOs, and private sector small- to large-scale food businesses.

The processing of samples of food, peanut products and other samples for aflatoxin analysis has been slowed due to the lack of agreement on who will do the analysis and lack of clarification on who will pay for that analysis. It seems that the economic analysis of plot trial data has been constrained by the pending analysis of aflatoxin in other samples.

The major constraint encountered within ENEA is the time management of activities to be performed. One solution could be freeing time for colleagues at ENEA who then devote more time in taking care of the Peanut CRSP activities. However, resource constraints make it difficulty to provide adequate incentives to faculty members in ENEA so that they can commit a more significant share of their time to research activities. This is the case not only within the Peanut CRSP, but in other research areas as well.

A major issue that has evolved has to do with the bureaucratic red tape that the US institutions have to negotiate associated with obtaining visas for the HC collaborators. One way to deal with this is to minimize or eliminate short term visits. However, this action eliminates the benefits of these short term visits in terms of making progress in the project objectives as well as other types of benefits already discussed. This is a difficult predicament and we need help in dealing with it.

7. Lessons Learned

In carrying out field surveys, joint planning involving U.S. and Host Country PIs should lead to early agreements on the: (1) design and construction of questionnaires; (2) methods of analysis, including common software for data encoding and analysis to ensure electronic transferability of data sets; (3) schedule of pre-testing and training of interviewers and encoders, (4) schedule of the main survey and responsibilities of groups concerned; and (5) reporting format and possible joint publications. Also, fiscal arrangements and bureaucratic inconsistencies should be discussed among the scientists and other collaborators early in the development of the activities.

Peanut butter labeled as Vitamin A-fortified will not cause rejection of the product by the consumer, which has application to other products.
Plans for impact assessment and case studies, where relevant, such as those carried out in the Philippines (food technologies) and Thailand (training), should be integrated into all Peanut CRSP projects. This requires early inputs from economists and sociologist, and would improve the design of the projects and facilitate the development of multi-disciplinary teams.

Using graduate students (8) to test and collect data sets for economic assessments and policy analysis, under close supervision by Virginia Tech faculty advisers, would develop longer-term capability for future economic/policy work in Africa (i.e., Senegal, Mali, Uganda, Zimbabwe), where the country's capacity for policy research is very critical.

There are existing data sets from previous household surveys carried out by other institutions in the countries (i.e., poverty surveys by the World Bank and IFPRI) that VT researchers and graduate students can use to facilitate economic and policy analyses through collaborative arrangements. Such extensive household surveys are costly and Peanut CRSP funds are better utilized for collecting additional or complementary data and analysis based on specific country needs.

The joint graduate program between Virginia Tech and Makerere University should be reviewed by Peanut CRSP for possible adoption in other projects because: (1) it cuts costs so more developing country graduate students would benefit; (2) it ensures relevance of research topic to host country problems because the research is carried out in the country; and (3) joint advisorship of graduate students would strengthen the professional linkage of U.S. and developing country professors.

The focus on differing roles of men and women in peanut production, post-production, and harvesting has given a new dimension to the project areas in Uganda. Discovery-based learning can work with health issues in villages. Trade issues are more complex than expected. Involving women in planning, training, and other key activities has been empowering to them. Peanut production, processing, and marketing are their main responsibilities. And women-headed households are the poorest in the rural areas.

Transferring analytical tools and concepts from the US - a competitive market driven economy (markets and production units) to Bulgaria - a recently decentralized economy is not a simple process. Assumptions underlying the production processes must be retooled and expectations regarding coefficients of production must be adjusted and indeed the basic input/output and product cost and return budget formulas must be developed for the Bulgarian situation (reflecting conditions in an open and atomistically competitive economy).

ENEA, as an institution has long been involved in community development, particularly in rural development. It has come to the conclusion that much effort has been skewed towards analyzing the means of development available to rural populations. In other words, ENEA has formerly focused on processes and now recognizes the importance of focusing on the people as the center of every development goal.

Another important lesson is that, while this CRSP project required a major commitment and much dedication, the institutional and professional rewards are far greater and of wider reach than anticipated.

In addition, it has become apparent that tighter collaboration between the socioeconomic and some of the other projects and thrusts is necessary. This can be done in a variety of ways and the UCONN PI has already begun to outline preliminary thinking on an avenue that will prove worthy of pursuing in the future.

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8. Next Steps and Future Directions

Complete data analysis and report for the impact assessment of training in Thailand. Disseminate report to all Peanut CRSP PIs so all projects with training components could learn lessons on evaluating training courses and their impact on the overall effort by Peanut CRSP and the Host Country institutions.

Complete analysis of the data sets from the Philippine impact study and facilitate preparation of joint papers for publication in refereed journals. Transfer the impact assessment and case study methodologies, including samples of survey instruments, to other Peanut CRSP projects in other regions, using the experiences in the Philippines and Thailand.

Carry out additional work on valuing environmental benefits using experimental economics techniques and assessing poverty reduction impacts of peanut research in West Africa. The economic and policy analysis methodologies used in this project should be transferred to other regions where Peanut CRSP is working, starting with stronger collaboration with other U.S. universities working on economic and policy areas (Auburn University, North Carolina State University, University of Connecticut).
Negotiate with other partners in the region (i.e., CIRAD) to carry out the planned West African Regional Workshop on economic assessment methodologies in 2005. The result of this workshop would be useful in identifying the specific needs for policy research in the region that Peanut CRSP can pursue in the future.

Establish a center of excellence for peanut research and education in Ghana. Given the level of advanced research and the multi-level commitment to the CRSP work, Ghana would be an excellent choice.

Technology and innovation would spread from Ghana.

Carry out an analysis of the impact on African countries of reducing support to U.S. peanut sector and impact of World Trade Organization's (WTO) changes on U.S. and West African countries; there is a need to look at SPS issues.

Makerere University professor of Animal Science (Dr. Connie Kyalisiima) has proposed to carry out research in managing aflatoxin using Bentonite clay in animal feeds in Uganda, to be funded by NORAD (Norway) and in collaboration from Peanut CRSP.

Experience working on gender issues in Peanut CRSP research in a host country like Uganda would provide strategies of mainstreaming gender in peanut research which Peanut CRSP could use in its work in developing countries. In the future, Peanut CRSP projects should include in their design strategies to ensure that women and children, who are usually disadvantaged groups in rural farming areas, would benefit directly from new technological interventions (i.e., resistant peanut varieties, aflatoxin-free peanut products, etc.) by Peanut CRSP.

The ongoing work in aflatoxin in peanut in Uganda/region is linked with the HIV/AIDS and other illnesses. Possible solution to the aflatoxin problem (i.e., use of Bentonite clay), has implications to people's health. Work on health issues would require critical participation of the Ugandan Ministry of Health and trained village health workers, an area where Peanut CRSP is not a traditional player. Partnership with the Ministry of Health, Ministry of Trade, and the Ugandan Board of Standards is required to tackle the health, trade, and related issues in a coherent manner.

In Ghana and Benin the analysis of samples should be moved off dead center and the level of awareness of health risks should be established. Forward steps should be taken to establish the link between aflatoxin and the possible abatement of the HIV Aids pandemic, as a basis for opening the flow of health funding toward agro/health (CRSP) research and outreach.

In Bulgaria, the framework, theoretical basis and tools for farm level analysis and market analysis should be put in place. The US and HC PI's should utilize the strong partnership to guide the development and transformation of those analytical tools and approaches appropriate for moving Bulgarian market understanding and production economic concepts and information to those deemed applicable for a non centrally controlled economy. These would prove to be valuable models and analytical tools not only for Bulgaria but also for other countries of the Eastern European region. This outcome would be valuable as projections and conjectures are made relative to expanded export/import marketing opportunities. They would also be essential to efforts to conduct economic impact analyses.

A future direction of high payoff potential for the UCONN-ENEA Peanut CRSP collaboration, to conduct economic analyses of the underappreciated and strategic link between production and the value chain, in several if not all countries supported by the Peanut CRSP. A guiding principle will be to design models that can be used to connect with analyses that might be done beyond the farm-gate, particularly those focusing on value-added activities.

A project along these lines would need to be adapted in response to the specific objectives pursued in the production projects to be funded in the next phase of the program. Specific activities that could be considered are: consolidating a network of economists involved and interested in productivity work, with special interests in the peanut production system; teamed with

PIs undertaking production oriented research, jointly design and implement impact evaluation procedures; incorporate relevant economic components in early stages of production oriented project development to insure their role in preparing to collect appropriate data; and conduct disciplinary economic work focusing on the competitive position of peanut production across CRSP countries with particular attention given to effects from WTO rulings as well as other major policy changes.

9. General Observations

Strengths: The NCSU Project Team worked well in spite of constraints met. The Philippine and Thai collaborating institutions initiated activities even with delayed release of funds from the U.S. For the North Carolina peanut farmers' survey, NCSU PIs partnered with an Extension Specialist from the NC State Extension Services. He facilitated the identification of respondents and data collection. Other Peanut CRSP PIs who plan to carry out similar impact surveys should consider linking with local extension providers who know the clients and local conditions intimately. The project implementation arrangement should not only include researchers but all other relevant stakeholders and linkages with them should be established early.

Strength: The CRSP work on economic assessment and policy analysis is critical and commendable. The senior economists in Virginia Tech involved in the project are world-experts with extensive experience in the region. The EEP noted that these professors spend very limited time (i.e., 15% fulltime equivalent) in project activities, which may be sufficient to advice graduate students, but would not allow them to discuss with top-level government officials the important global trade, economic, and policy issues in specific countries to ensure buy-ins by policy makers early. A strategy to involve younger economists, on mentoring arrangement, should be discussed within Virginia Tech. This could also be a replacement/training strategy for soon to retire PIs or those who are moving into administrative positions (i.e, VT PI).

Strength/Weakness: The choice of working with six African and two U.S. graduate students (probably the largest number among the Peanut CRSP projects) to collect data and carry out economic assessment and policy analyses is commendable. This solved the language problem in conducting farm-level surveys and in collaborating with in-country institutions. However, it created another problem resulting from delays in publishing completed thesis. One solution is for Virginia Tech to restructure theses more around journal article format and requirements. Spending 90% of the Peanut CRSP budget to support graduate students has to be examined by Peanut CRSP ME and Virginia Tech management if this is the best value for USAID funds. There may be a need for more input from Virginia Tech faculty to ensure that the recommended policy changes resulting from economic and policy analyses remain credible and acceptable by top-level government officials and policy makers.

Strength: Economic inputs should be mainstreamed into all relevant Peanut CRSP projects. Stand alone economic assessment projects, such as VT09, is okay but economic issues should be integrated into the design of technical projects to ensure that key performance indicators are considered in planning and design of the projects to ensure that benchmark information are collected to show a before scenario for the impact and economic analysis at the end of the project. To do this, VT economists should work closely with other Peanut CRSP projects and ensure that they provide assistance to technical PIs in periodic data collection, in critical discussions with in-country policy makers, and in training of local economists to partner with them. This will improve the multi-disciplinary nature of the Peanut CRSP projects.

Strength: The U.S. PI has to be commended for transferring the project to Uganda when it was determined that the institutional problems in Senegal were too difficult to solve and continuing to work in the country would result to failure. The Makerere University Team should start activities quickly to attain significant progress in one year.

Strength: The U.S. PI is a social and gender specialist with extensive experience working in developing countries. With her leadership, this project could provide experiences which other Peanut CRSP PIs could learn from in mainstreaming gender in peanut research and development efforts.

There were no issues raised regarding management or transfer of funds to beneficiary countries, and from the discussion with the administrators it was evident that there was good support provided to the PI.

Partnerships between the Host Country and US Principle Investigators will be an important part of the foundation for future Peanut CRSP efforts in Africa and Bulgaria. Economic analysis of potential market income and health gains should guide the scope and levels of all other research initiatives pertaining to peanuts.

Not enough progress was made in creating the regional link among the socio-economic projects (Peanut CRSP) in West Africa. Incentives should be considered to make that collaboration a reality as it would likely lead to: a) a more rapid development and spread of appropriate analytical techniques, b) improvement in the economic data and information relative to the economy of peanut production, processing, distribution and utilization, c) better understanding of the socio-economic and gender impacts from changes in peanut consumption, sales and export, and d) increased capacity to measure and describe the links between aflatoxin contamination and the prevalence of HIV/AIDS.

Weakness: The last EEP recommended that efforts should be made to encourage inter-Peanut CRSP collaboration to facilitate the transfer of information and strategies especially lessons learned from Asia to West Africa and other regions. This project (NC07) remained focused in Asia (specifically Philippines and Thailand). No impact studies by NCS07 are planned with Peanut CRSP projects in West Africa. This EEP reiterates that the experiences and lessons learned from carrying impact assessment and case studies in the Philippines and Thailand should be systematically transferred to West Africa and other regions where Peanut CRSP has intensive activities. Other projects, i.e. UCN36, have done impact studies in West Africa.

10. Recommendations

Specific: Peanut CRSP should continue NCS07 to the next phase. Shift the focus from Asia to West Africa and other regions where Peanut CRSP has intensive activities and where potential for impact is high (i.e., West Africa, Latin America). Results would improve understanding by policy-makers and top-level government decision-markers of the benefits (economic, social, environmental, institutional) resulting form the adoption of Peanut CRSP technologies in the country and the value of sustained collaboration (with funding) involving Host Country research institutions.

Specific: Continue VT09 in the next phase. Expand the use of economic assessment and policy analysis methodologies, especially those valuing poverty reduction effects and environmental benefits, to other regions where Peanut CRSP is working intensively. The Virginia Tech PIs should work closely with other Peanut CRSP PIs to ensure that economic, policy, and social aspects are considered early in planning and project design. Another option is to involve an economist from the implementing university as part of the project's multi-disciplinary team.

Specific: Peanut CRSP should continue VT54 in Uganda in the next phase. Develop/strengthen collaboration with other Ugandan institutions: NARO for research and development inputs, Ministry of Health (health workers' participation); Ministry of Trade (trade issues), and Ministry of Agriculture (for extension services), local and international NGOs, the private food industry, and men and women farmers, and women's organizations. The Ugandan experience could be used to expand gender mainstreaming initiatives in other countries of Africa or in other regions where Peanut CRSP has intensive collaborative activities. The experience of working with the National Association of Women in Uganda and its sub-organizations would provide a good practice on working with women in the continuum of production, post-production, processing, and marketing.

General: Improve socio-economic inputs in Peanut CRSP projects. Peanut CRSP Management Entity to develop a strategy to ensure that relevant impact assessment activities and case studies are considered in the planning and design stage of each project to ensure that key performance indicators are agreed and benchmark data are documented by the U.S. PIs and collected by Host Country collaborating institutions as a regular activity. This would require a change in the RPF format for proposal preparation by including a project logical framework (log frame) with clear key performance indicators identified and ways to collect data.

General: Improve economic inputs in Peanut CRSP projects. Peanut CRSP to develop a strategy to transfer the economic assessment and policy analysis methodologies, especially for valuing poverty reduction and environmental benefits of peanut research, to other regions where Peanut CRSP is working intensively. Impact assessment methodologies should be considered in the planning and design stage of each project to ensure that key performance indicators are agreed and benchmark data are documented by the U.S. PIs and collected by collaborating institutions. This would require a change in the RPF format for proposal preparation by including a project logical framework (log-frame) with clear key performance indicators.

General: Engender all Peanut CRSP projects. Gender concepts must be viewed in all Peanut CRSP projects as constraints/opportunities met by both men and women and principal investigators must understand how to define their research to ensure that solutions are relevant to the specific needs of both sexes. The VT54 PI could provide assistance to other Peanut CRSP project PIs to ensure that individual projects pay attention to social and gender issues and should be considered during planning and design of each project. This change would require that the RPF format for proposal preparation would include a project logical framework (log frame) with clear key performance indicators, including gender indicator. VT54 PI is currently preparing a Manual on Gender Mainstreaming in Research Projects for another USAID project implemented by Virginia Tech. This manual could be easily modified to suit the needs of Peanut CRSP PIs.

General: Enhance technology transfer activities. More Peanut CRSP projects should include technology transfer activities to ensure wider public awareness and impact of new initiatives, and directly link men and women farmers, traders, processors, health workers, and consumers to the research effort. These additional local-level activities should be incorporated in the project design and fully funded to ensure successful completion. Institutional arrangements should consider inclusion of public or private extension service providers, traders and processors, NGOs, farmers' and women's organizations, and other stakeholders**. Should the future focus of Peanut CRSP be research for development that would consider a stronger technology transfer component?**

1 Project Title and Investigators

NCS07S: Impact Assessment of and Socio-economic Contextual Influences on Adoption of Peanut CRSP Supported New Technologies

This project is a continuation of a study on the socio-economic impact of Peanut CRSP technologies focused on the adoption of new peanut varieties and improved production practices under Phase 1. This study concentrated on the impact of new peanut-based food products and a new process to detoxify aflatoxin from these products. The 2000 EEP recommended that the talents of the U.S. Project Investigators should be shared with West African countries where Peanut CRSP is working.

U.S. Principal Investigators	Dr. Robert L. Moxley (PI) Dr. David Jordan (Collaborator)	Dept. of Anthropology and Sociology, North Carolina State University, Raleigh, North Carolina North Carolina State University, Department of Crop Science, Extension, Raleigh, North Carolina
HC Principal Investigators-Philippines	Dr. Alicia Lustre (PI) Dr. Flor Galvez	Food Development Center of National Food Authority, Manila, Philippines College of Home Economics, University of the Philippines at Diliman, Quezon City, Philippines
HC Principal Investigators-Thailand	Dr. Penkwan Chompreeda (PI) Prof. Vichai Haruthaithanasan	Kasetsart University, Bangkok, Thailand Kasetsart University, Bangkok, Thailand

Host Countries: Philippines and Thailand

1.1 Project Objectives

Objective	Objectives	% Complete
1	Study the socio-economic impacts of Vitamin A fortified peanut butter on families and children and on collaborating companies.	100
2	Assess socio-economic impacts of Peanut CRSP supported research at North Carolina State University.	80
3	Study socio-economic impacts of food processing research technology transfer through 6 workshops in Thailand.	70

1.2 Annual Budget: In 2003-2004, the budget for this project was US$45,823, of which US$11,639 was allocated, with US$8,654 transferred to the Philippine collaborating institution the Food Development Center (FDC/NFA) through a subgrant agreement approved in August 2002, and US$2,280 to the University of the Philippines at Diliman (UPD) through a subcontract signed in January 2003. For Thailand a subgrant for US$6,325 was approved in April 2004.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

This project was designed around three primary thrusts. First, assess 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 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.

Other pertinent activities within the project were: (1) conduct a qualitative network pilot study to develop ideas for a network analysis instrument; (2) field test network methodologies, concepts and analytical techniques to help explain patterns of diffusion; and (3) test empirical relationships and patterns among variables from previous research to determine the most efficacious cross-cultural methods. Hypotheses generated by previous research on diffusion networks in the Philippines will be retested for expected cultural differences in Thailand.

Technical:

Philippines: In June 2002, the UPD food scientists, with NCSU Project Investigator (and a demographer), developed a survey instrument and questionnaire, prepared sampling plan, and trained four interviewers. They carried out pre-testing of the survey instrument in sample households in Metro Manila area. Questions about knowledge of aflatoxin were included, although this was not in the original plan.

Peanut butter had been determined to be an excellent medium for providing vitamin A to the children of the Philippines, but was not being used. The Peanut CRSP project UGA04 worked with a company to develop and market vitamin A fortified peanut butter. The main household survey and interview of family members, was carried out in late 2002 in selected households near stores selling the newly commercialized Vitamin A-fortified peanut butter. Draft report was submitted by the UPD Project Investigator in 2003 but additional data had to be collected.

In August 2002, a Subgrant Agreement with Food Development Center was approved to carry out institutional assessments of two Philippine food industry innovators. Two case studies were carried involving: (1) Newborn Foods Inc. on the impact of Vitamin A fortification of peanut butter, and (2) Marigold Commodities, Inc. on the use of mechanical sorting to reduce aflatoxin contamination in peanut-based food products. Draft report was submitted by the FDC/NFA Project Investigator in 2003 but additional data had to be collected.

Thailand: In November 2003, a meeting was held by Peanut CRSP and KAPI scientists to discuss the project plans. All participants were required to take part in a pre-test and a post-test exercise. A subcontract was signed in April 2004 with Kasetsart University (KU) to fund the collection of data on the impact of six food technology workshops held at KU in 2003. Workshop participants were interviewed and site visits were carried out to check the application of skills and technology obtained from the training. Impact on both individuals and cooperatives was determined. Data is currently being encoded.

United States: In 2004, a Peanut farmers' survey to determine adoption rates of Peanut CRSP supported technologies was carried out in North Carolina by the NCSU Principal Investigators in collaboration with an Extension Specialist from the NCSU Department of Crop Science. The farmers' survey was carried out by questionnaires sent to 1,747 potential peanut farmers, with a 25% rate of return (417 respondents).

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

Philippines: Consumers' surveys, 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, which would result, in the long-term, in reduction of 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 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 the export of "kare-kare" sauce increased from about 10% in 1999 to 45% in 2001. Also, 17% of Filipino households surveyed consumed the improved "kare-kare" sauce that is aflatoxin-free, making a healthy peanut product available widely in the domestic and foreign markets.

Thailand: No output was available during the review because data collected in the Thai survey are being encoded and yet to be analyzed.

3.2 Technical Outputs in United States

An annotated bibliography of over 200 publications from Peanut CRSP-funded research in North Carolina was completed and posted in the Peanut CRSP Website (http://peanut.crsp.org).

Preliminary results of a North Carolina peanut farmers' survey showed that of the Peanut CRSP-developed integrated pest management (IPM) practices, weather-based advisory for IPM adoption was preferred by farmers with usage rates of 43-52% in 1999-2003. Of the Peanut CRSP-developed peanut varieties, American farmers preferred NC V11 and NC 12C, which showed consistently high adoption rates of about 40% in 1999-2003. Perry peanut variety reached this level in 2002-2003.

3.3 United States Training and Capacity Development/Maintenance

Degree: One Ph.D. student at NCSU, Gretchen Thompson (American, woman), is currently working on the NC peanut farmers' survey and annotated bibliography of researches conducted at NCSU.

Non-degree: Two U.S. graduate students at NCSU were trained on interviewing and survey methodology used in this project. They were later involved in the North Carolina peanut farmers' survey.

3.4 Host Country Training and Capacity Development/Maintenance

Degree: No foreign graduate students were supported by the project to carry out a degree program.

Non-degree: Philippine and Thai researchers were only involved in short-term non-degree training courses. Four graduate students at the University of the Philippines at Diliman were trained on methods of interviewing and survey methodology that were used by the project. They were later involved in the consumers' survey carried out in the Metro Manila area. One Thai researcher visited NCSU to train on statistical methods and questionnaire construction in preparation for the trainees survey in Thailand.

3.5 Technology Transfer (workshops, publications, patents)

Workshops: Workshops in the Philippines and Thailand were held to train non-social scientists and graduate students in social science research methods so they can assist in carrying out the planned surveys.

Publications:

Philippines: There are three reports: **(1)** Impact assessment of the Vitamin A fortification of peanut butter of an industry innovator (A. Lustre et al., 2004); (2) Vitamin A fortification of peanut butter in the Philippines: Socio-economic impacts on families (F. C. Galvez, et al., 2004); and (3) Eliminating aflatoxin in peanut-based products: Socio-economic impacts of the transfer of new sorting technology to a Philippine company (F.C. Galvez et al., 2004)

Thailand: No report has been prepared yet since data from the survey of former Peanut CRSP training courses are currently being encoded.

United States: There are three papers: (1) A technical paper on the Impacts of the Peanut CRSP: An annotated bibliography of researches conducted at NCSU (R. Moxley and G. Thompson, 2004); (2) a paper (submitted) on Knowledge of nutrition and health relations predicted by income, information access, and family solidarity (R. Moxley and K. Jicha, 2004); and (3) a paper presentation on Socio-economic impact assessment of Vitamin A fortification (R. Moxley et al.) during the Rural Sociological Society meeting.

4 Demonstrated/Potential Impacts

This project improved the awareness of participating food industry companies in the Philippines that there are 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 is 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 initiatives started by Peanut CRSP. It would also encourage the food industry to enhance commercialization of Peanut CRSP technologies within the private sector with their own funding and facilitation, a sustainability consideration.

5 United States/Host Country Beneficiaries and Benefits

In the Philippines, the public/consumers, especially children, benefited from increased Vitamin A-fortified peanut butter, a healthy and safe product (aflatoxin-free), and the industry learned that they could expand market shares with enhanced products. Another beneficiary group of this project is the Philippine policy-makers and top-level government decision-makers (in agriculture, health, trade, research, extension, and rural development), who could utilize the results of the impact study and case studies to enhance transfer of healthy and safe (aflatoxin-free) peanut-based food products and improved processes to the private food industry. These include micro- and small-scale rural enterprises that are operated mainly by women, another target group of the project in the Philippines and Thailand.

Another group of direct beneficiaries are Peanut CRSP Principal Investigators and researchers in collaborating research institutions in the Philippines and Thailand who have been trained on impact assessment and case study methodology. Other potential beneficiaries are sociologists and economists in other participating developing countries where Peanut CRSP is currently working that would benefit from the use of the methodologies, including developed survey instruments and questionnaires, used in the Philippines and Thailand.

The United Stated benefited from increased and more accessible information on the impacts on farmers who used Peanut CRSP developed varieties and IPM practices.

6 Building Partnerships

In the Philippines, partnerships were key to the success realized from using Peanut CRSP findings. The main collaborating institutions are: (1) the Food Development Center of the National Food Authority (FDC/NFA) and the University of the Philippines at Diliman (UP-D). The Host Country Project Investigators, with inputs from NCSU Principal Investigators, developed the survey instruments and questionnaires, pre-tested them, and carried out the actual surveys.

In Thailand, the main collaborating institution is Kasetsart University, which benefited in increasing its capacity for socio-economic research. With support from NCSU Principal Investigators, the Thai Project Investigators prepared the survey questionnaires and carried out survey and interviews of former trainees. A stronger partnership was forged between Kasetsart University and North Carolina State University in the socioeconomic area.

7 Constraints and Recommended Solutions

Fund management: Bureaucracy in U.S. University and Host Country research institution continue to cause delays in transfer of funds (also cited by last EEP). In Philippines, a check was sent to the wrong address causing considerable delay in implementation. In Thailand, there was excessive paperwork required to transfer of minimal funds from U.S. The fund reimbursement scheme used by NCSU caused additional problem. Usually, the Host Country institutions have very limited funds to pre-pay for the expenditures. These problems caused significant delays in carrying out the planned surveys. Other Peanut CRSP projects (i.e., NCA32), use advanced release of funds; further release is based on satisfactory accounting of already released funds. NCSU management can look at this scheme or other options.

Changes in Leadership: The UPD Project Investigators left in December 2002, followed later by the FDC/NFA researcher who was working on the Vitamin A case study. There was considerable slow-down of activities that delayed data analysis and preparation of reports. The two Philippine collaborating institutions identified replacements but they needed to be trained which took time.

Software problem: Electronically transferring data sets from the Philippines was difficult because of software incompatibility; some statistical analysis cannot be duplicated in U.S. and Philippines. Encoded data had to be cleaned again at NCSU. In future, trial runs should be done to ensure that data is transferable, both groups should use the same software, and NCSU Principal Investigator should train the encoders.

8 Lessons Learned

In carrying out field surveys, joint planning involving U.S. and Host Country Principal Investigators should lead to early agreements on the: (1) design and construction of questionnaires; (2) methods of analysis, including common software for data encoding and analysis to ensure electronic transferability of data sets; (3) schedule of pre-testing and training of interviewers and encoders, (4) schedule of the main survey and responsibilities of groups concerned; and (5) reporting format and possible joint publications. Also, fiscal arrangements and bureaucratic inconsistencies should be discussed among the scientists and other collaborators early in the development of the activities.

Peanut butter with a label that indicates that the product is Vitamin A-fortified will not cause rejection of the product by the consumer, which has application to other products.

Plans for impact assessment and case studies, where relevant, such as those carried out in the Philippines (food technologies) and Thailand (training), should be integrated into all Peanut CRSP projects. This requires early inputs from economists and sociologists, and would improve the design of the projects and facilitate the development of multi-disciplinary teams.

9 Next Steps and Future Directions

Data analysis and reporting for the impact assessment of training in Thailand should be completed. The report should be disseminate all Peanut CRSP Principal Investigators so all projects with training components could learn lessons on evaluating training courses and their impact on the overall effort by Peanut CRSP and the Host Country institutions.

Analysis of the data sets from the Philippine impact study should be completed and facilitate preparation of joint papers for publication in refereed journals. Transfer the impact assessment and case study methodologies, including samples of survey instruments, to other Peanut CRSP projects in other regions, using the experiences in the Philippines and Thailand.

Instead of implementing a stand alone socio-economic study, such as NCSO7, the Peanut CRSP Management Entity should consider integrating the social and economic aspects into all Peanut CRSP projects in the next phase. The NCSU Project Team could collaborate with other Principal Investigators to do this. Another option is for specific Project Team to include a sociologist and an economist in its multi-disciplinary team (i.e., UGA11). The trend should be to build multi-disciplinary teams within an implementing university or within an inter-university team (i.e., UFL16). The role of socio-economic teams, such as in NCS07, would be to carry out pre-test and post-test types of project impact evaluation. A cluster approach to a group of projects in a Region could include a project such as NCS07 to carry out this work.

10 General Observations

Weakness: The last EEP recommended that efforts should be made to encourage inter-Peanut CRSP collaboration to facilitate the transfer of information and strategies especially lessons learned from Asia to West Africa and other regions. This project (NC07) remained focused in Asia (specifically Philippines and Thailand). No impact studies by NCS07 are planned with Peanut CRSP projects in West Africa. This EEP reiterates that the experiences and lessons learned from carrying impact assessment and case studies in the Philippines and Thailand should be systematically transferred to West Africa and other regions where Peanut CRSP has intensive activities. Other projects, i.e. UCN36, have done impact studies in West Africa.

Strengths: The NCSU Project Team worked well in spite of constraints met. The Philippine and Thai collaborating institutions initiated activities even with delayed release of funds from the U.S. For the North Carolina peanut farmers' survey, NCSU PIs partnered with an Extension Specialist from the NC State Extension Services. He facilitated the identification of respondents and data collection. Other Peanut CRSP Principal Investigators who plan to carry out similar impact surveys should consider linking with local extension providers who know the clients and local conditions intimately. The project implementation arrangement should not only include researchers but all other relevant stakeholders and linkages with them should be established early.

11 Recommendations

Specific: Peanut CRSP to continue supporting impact assessment projects in the next phase. The program should shift focus from Asia to West Africa and other regions where Peanut CRSP has intensive activities and where potential for impact is high (i.e., West Africa, Latin America). Results would improve understanding by policy-makers and top-level government decision-markers of the benefits (economic, social, environmental, institutional) resulting form the adoption of Peanut CRSP technologies in the country and the value of sustained collaboration (with funding) involving Host Country research institutions.

General: Improve socio-economic inputs in Peanut CRSP projects. Peanut CRSP Management Entity should develop a strategy to ensure that relevant impact assessment activities and case studies are considered in the planning and design stage of each project to ensure that key performance indicators are agreed and benchmark data are documented by the U.S. Principal Investigators and collected by Host Country collaborating institutions as a regular activity. This would require a change in the RFP format for proposal preparation by including a project logical framework (logframe) with clear key performance indicators identified and ways to collect data.

A village in Ghana's main peanut belt.

1 Project Title and Investigators

VT09S: Analysis of Response of Peanut Production in French West Africa: Policy Implications of Currency Devaluation

This project would allow Peanut CRSP to measure its contribution to the achievement of two Millennium Development Goals (MDGs): (1) poverty reduction, and (2) Environmental sustainability. It has carried out significant number of impact assessments (5) and policy studies (2) in four years. The economic analysis methodologies used would be very useful in determining the economic impact and policy implications of Peanut CRSP technologies and processes, in the U.S. and in Host Countries. Two methodologies are note worthy, (i) poverty index analysis that determines poverty reduction effects, and (ii) experimental economic analysis to value environmental benefits from Peanut CRSP technologies. The 2000 EEP recommended that the Senegalese Project Investigator be trained and that a stronger inter-regional cooperation in West Africa be facilitated.

U.S. Principal Investigators	Dr. Michael Bertelsen (PI) Dr. George Norton	Virginia Polytechnic Institute and State University, Blacksburg, Virginia Virginia Polytechnic Institute and State University, Blacksburg, Virginia
HC PI-Senegal	Dr. Matar Gaye (PI until 2000)	ISRA, Dakar, Senegal
HC PI-Uganda HC Collaborator - Malawi	Dr. Charles Busolo-Bulafu (PI from 2000) Mr. Tobius Kapewa	Serere Agricultural and Animal Protection Research Institute (SAARI), National Agricultural Research Organization, Uganda Chitedze Agricultural Research Station, Lilongwe, Malawi

Host Countries: Senegal until 2000 and then transferred to Uganda.

1.1 Project Objectives

Objective	Description	% Completed
1	Analyze domestic and international policies affecting peanut production in West Africa.	90
2	Determine economic impact of improved peanut technologies, including Peanut CRSP technologies, in West Africa.	90

1.2 Annual Budget:

In 2003-2004, the budget for this project was US$72,000, of which US$35,923 (50%) was allocated for use of the Host Country collaborating institutions in Senegal and Uganda. About 90% of the budget was utilized to support graduate students who carried out the economic assessment and policy studies in selected West African countries.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

Economic and policy studies were carried out by graduate students at Virginia Tech under the close supervision of two senior economists from the Department of Agricultural Economics: (1) Dr. George Norton, and (2) Dr. Dan Taylor. The following economic analysis methodologies were used:

1. Economic and spatial equilibrium analysis of domestic and international trade policies in Senegal;
2. Economic surplus analysis of peanut research on: (1) new variety La Fleur 11, (2) Aflatoxin research, and (3) new Rosette virus resistant varieties;
3. Poverty index analysis; and
4. Experimental economic analysis of environmental benefits of peanut research.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

The economic analysis methodologies tested/used in the project, especially the poverty index analysis and experimental economic analysis of environmental benefits, are 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 to the West African region.

3.2 Technical Outputs in United States

No technical outputs expected in the United States.

3.3 United States Training and Capacity Development

One Ph.D. student James Gray (U.S.A., male) completed his degree in 2002 with research on economic spatial equilibrium analysis and international trade policies in Senegal; he is now Assistant Provost at the University of Liberia.

One M.S. student, Jason Bertgold (U.S.A., male), completed degree in 2001 with research on Senegal's trade policies, economic impacts of Partnership Agreements between EU and the ACP states on Senegalese groundnut sector; he has returned to ARS/Auburn University.

3.4 Host Country Training and Capacity Development/Maintenance

It was decided early in Phase 2 that a significant amount of the budget for the project will be used to support graduate students from developing countries, especially those from West Africa. Graduate students from the region know the language and could easily collaborate with local institutions in field data collection. Long-term degree training would also ensure sustainability of economic and policy expertise in regional institutions. When asked how many graduates will return to their countries, the Principal Investigator indicated that there was a high rate of return to Africa (about 90%) based on the experience of another Virginia Tech USAID-funded project (IPM CRSP).

Five M.S. graduate students completed their degrees/internship at Virginia Tech:

1. Eberechukwu Akobundu (Senegal, female) completed her thesis on farm-household analysis policies affecting groundnut production in Senegal;
2. Charlene Brewster (Jamaica, female), a post-doctoral intern, carried out research on economic surplus analysis of aflatoxin;

3. Louis Boakye-Yiadom (Ghana, male) completed his degree in 2003 with research on impact surplus evaluation of aflatoxin-reducing practices in Senegal; he is doing Ph.D. at University of Reading, UK;
4. Widad Soufi (Tunisia, female) completed her MSc degree in 2001 with research on economic surplus analysis of peanut *Fleur* 11 peanut variety in Senegal; she is now doing a Ph.D. at Wisconsin State University;
5. Sibusiso Moyo (Zimbabwe, male) completed his MSc degree in 2004 with research on the economic impact of peanut research on the poor: a case of resistance strategies to control peanut viruses in Uganda.

Two Ph.D. students are undergoing graduate studies at Virginia Tech:
1. Sibusiso Moyo is continuing his Ph.D. degree on a related peanut topic using the same data sets collected in Uganda and Malawi.
2. Jackie Bona-bona-Wabbi (faculty member at Makerere University, Uganda, female), is working on her Ph.D. on experimental economic analysis of environmental benefits of peanut research.

The EEP members met with two graduate students (Sibusio Moyo and Jackie Bona-bona-Wabbi), and were impressed with the knowledge of these Ph.D. students on the methodology to measure the economic impact of Peanut CRSP research on poverty reduction (virus resistant varieties), and in determining environmental benefits of peanut research. The methods in their analytical work would be useful for researchers in other countries where Peanut CRSP is working.

3.5 Technology Transfer (workshops, publications, patents)

There is no published paper in a refereed journal to date, although one paper has been accepted for publication. Most of the publications from the project are theses of graduate students and articles derived from them. The following are the papers/reports/presentations produced by the project:
1. seven thesis reports, five on impact assessment and two on policy analysis (six from host countries and 2 from U.S.); 2 under preparation;
2. one accepted paper in refereed journal on Lome to Cotonou Conventions: Trade policy alternatives for the Senegalese groundnut sector; 2 papers under preparation;
3. three papers and presentations during the American Agricultural Economics Association meetings; and
4. three other related reports.

4 Demonstrated/Potential Impacts

The following potential impacts were cited as a result of various policy studies:

4.1 Policy decisions soon to be made in West African countries, including Senegal, whether to join an economic partnership with the EU or to enter into a Generalized System of Preferences; the latter is better for the groundnut sector.

4.2 Breeding research could result to potential savings of about USD47.0 million by using Peanut CRSP developed rosette resistant varieties in Uganda.

4.3 In groundnut producing areas of Uganda, poverty could be reduced by 1.3% resulting from the adoption of Peanut CRSP developed technologies.

4.4 Results of aflatoxin research in Senegal could result to potential savings of about USD4.0 million, to confectionary groundnut producers, not including health benefits.

5 United States/Host Country Beneficiaries and Benefits

The main U.S. beneficiaries are policy makers and top-level government decision makers responsible for global/in-country trade, health, and agriculture issues. Results of economic and policy analysis by U.S. and Host Country researchers would be useful within specific countries and at the regional level (i.e., West African region). The new initiatives to measure the benefits in poverty reduction and environmental impacts of peanut research are significant advancements. Another group of beneficiaries are U.S. and developing country graduate students who have been trained at Virginia Tech on various economic assessment and policy analysis methodologies. They could increase the agricultural economics capability in their research institutions once they return to their countries.

6 Building Partnerships

Main institutional partners of the Peanut CRSP are: ISRA in Senegal, the National Agricultural Research Organization (NARO) in Uganda, and the Chitedze Agricultural Research Station and the International Center for Research in the Semi-Arid Tropics (ICRISAT) in Malawi.

Virginia Tech-Peanut CRSP and the Centre for International Cooperation in Agricultural Research for Development (CIRAD) collaboration had resulted to strong complementation in their research efforts in Senegal. For example, cost of production data has been collected for all CIRAD peanut trials with assistance from the Virginia Tech project team. One graduate student has started to use these data sets in his research.

Partnership with ICRISAT-Mali, has developed a snag pending the approval of a Memorandum of Understanding (MOU) that would cover the collaboration. The planned regional workshop co-sponsored by ICRISAT-Mali and Peanut CRSP has been delayed.

In U.S., Peanut CRSP-Virginia Tech has collaborated with: (1) the University of Georgia on breeding using genetic manipulation; (2) the University of Connecticut on household surveys, and (3) the International Food Policy Research Institute (IFPRI) on the use of IFPRI's Uganda and Malawi data sets by graduate students; and (4) within Virginia Tech with the Integrated Pest Management (IPM) CRSP to share research sites in Uganda and access the program's information and experts.

7 Constraints and Recommended Solutions

7.1 Changes in Project Investigators: Several turnovers of collaborating economists (Project Investigators) in Senegal at ISRA resulted to slow down of project activities; broaden project coverage to include economic/policy work in other countries within West Africa.

7.2 Partnership problem: Collaborative work with ICRISAT-Mali was affected by delays in signing of an MOU, especially the planned joint ICRISAT-Peanut CRSP regional workshop on economic assessment. The Principal Investigators plan to negotiate with another partner in the region to carry out this workshop in 2005.

7.3 Graduate program problems: The following problems were met: (1) difficulty to recruit potential candidates because of English difficulty among Francophone candidates; and (2) many candidates had difficulty with the Economics Ph.D. program at Virginia Tech because of poor background. Solutions: (i) recruit only African students that already speak English; other Peanut CRSP projects (i.e. Food Technology in NCAT brought Senegalese student to do intensive English course before starting formal degree program); (ii) Virginia Tech has focused on training M.S. students (six) and one is continuing for Ph.D. degree; Virginia Tech prefers to fund Ph.D. candidates who have completed their M.S. degree at Virginia Tech for continuity; and (iii) consider sandwich program to reduce cost where graduate students take courses in Virginia Tech and do their research in-country, under joint degree offering with a local university (i.e, Makerere University).

8 Lessons Learned

Using graduate students (in this project 8 students were involved) to test and collect data sets for economic assessments and policy analysis, under close supervision by Virginia Tech faculty advisers, would develop longer-term capability for future economic/policy work in Africa (i.e., Senegal, Mali, Uganda, Zimbabwe), where the country's capacity for policy research is very critical.

There are existing data sets from previous household surveys carried out by other institutions in the countries (i.e., poverty surveys by the World Bank and IFPRI) that Virginia Tech researchers and graduate students can use to facilitate economic and policy analyses through collaborative arrangements. Such extensive household surveys are costly and Peanut CRSP funds are better utilized for collecting additional or complementary data and analysis based on specific country needs.

9 Next Steps and Future Directions

More work has to be carried out on valuing environmental benefits using experimental economics techniques and assessing poverty reduction impacts of peanut research in West Africa. The economic and policy analysis methodologies used in this project should be transferred to other regions where Peanut CRSP is working, starting with stronger collaboration with other U.S. universities working on economic and policy areas (Auburn University, North Carolina State University, and University of Connecticut).

Peanut CRSP and the Host Countries involved should negotiate with other partners in the region (i.e., CIRAD or ICRISAT) to carry out the planned West African Regional Workshop on economic assessment methodologies in 2005. The result of this workshop would be useful in identifying the specific needs for policy research in the region that Peanut CRSP can pursue in the future.

Carry out an analysis of the impact on African countries of reducing support to U.S. peanut sector and impact of World Trade Organization's (WTO) changes on U.S. and West African countries; there is a need to look at SPS issues.

10 General Observations

Strength: This work on economic assessment and policy analysis is critical and commendable. The senior economists at Virginia Tech involved in the project are world-experts with extensive experience in the region. The EEP noted that these professors spend very limited time (i.e., 15% fulltime equivalent) in project activities, which may be sufficient to advice graduate students, but would not allow them to discuss with top-level government officials the important global trade, economic, and policy issues in specific countries to ensure buy-ins by policy makers early. A strategy to involve younger economists, on mentoring arrangement, should be discussed within Virginia Tech. This could also be a replacement/training strategy for soon to retire Principal Investigators or those who are moving into administrative positions (i.e, Virginia Tech Principal Investigators).

Strength/Weakness: The choice of working with six African and two U.S. graduate students to collect data and carry out economic assessment and policy analyses is commendable. This solved the language problem in conducting farm-level surveys and in collaborating with in-country institutions. However, it created another problem resulting from delays in publishing completed thesis. One solution is for Virginia Tech to structure theses more around journal article format and requirements. Spending 90% of the Peanut CRSP budget to support graduate students has to be examined by Peanut CRSP Management Entity and Virginia Tech management to determine if this is the best value for USAID funds.

There may be a need for more input from Virginia Tech faculty to ensure that the recommended policy changes resulting from economic and policy analyses remain credible and acceptable by top-level government officials and policy makers.

Strength: Economic inputs should be mainstreamed into all relevant Peanut CRSP projects. Stand alone economic assessment projects, such as VT09, is okay but economic issues should be integrated into the design of technical projects to ensure that key performance indicators are considered in planning and design of the projects to ensure that benchmark information are collected to show a before scenario for the impact and economic analysis at the end of the project. To do this, Virginia Tech economists should work closely with other Peanut CRSP projects and ensure that they provide assistance to technical Project Investigators in periodic data collection, in critical discussions with in-country policy makers, and in training of local economists to partner with them. This will improve the multi-disciplinary nature of the Peanut CRSP projects.

11 Recommendations

Specific: Peanut CRSP to continue economic assessment and policy studies in the next phase. Expand the use of economic assessment and policy analysis methodologies, especially those valuing poverty reduction effects and environmental benefits, to other regions where Peanut CRSP is working intensively. The Virginia Tech Project Investigators should work closely with other Peanut CRSP Principal Investigators to ensure that economic, policy, and social aspects are considered early in planning and project design. Another option is to involve an economist from the implementing university as part of the project's multi-disciplinary team.

General: Improve economic inputs in Peanut CRSP projects and the overall program. Peanut CRSP needs to develop a strategy to transfer the economic assessment and policy analysis methodologies, especially for valuing poverty reduction and environmental benefits of peanut research, to other regions where Peanut CRSP is working intensively. Impact assessment methodologies should be considered in the planning and design stage of each project to ensure that key performance indicators are agreed and benchmark data are documented by the U.S. Principal Investigators and collected by collaborating institutions. This would require a change in the RFP format for proposal preparation by adding to the project logical framework (log-frame) economic/poverty alleviation performance indicators.

1 Project Title and Investigators

AUB30S: Production Efficiency and Market Development of Peanuts and Peanut Products for Ghana, Benin, and Bulgaria

U.S. Principal Investigators	Dr. Curtis Jolly (PI)	Auburn University, Auburn, Alabama
	Dr. Pauline Jolly (Co-PI)	University of Alabama at Birmingham, Alabama
H.C. Principal Investigator-Ghana	Dr. Richard Awuah	Kwame Nkrumah University of Science and Technology, Ghana
H.C. Principal Investigator-Bulgaria	Dr. Nelly Bencheva	Agricultural University, Plovdiv, Bulgaria
H.C. Principal Investigator-Bulgaria	Dr. Stanko Delikostadinov	Institute of Introduction and Plant Genetic Resources, Sadovo, Bulgaria
H.C. Principal Investigator-Benin	Dr. Emmanuel Prophete	*Cenre de Recherche de Documentation Agricole* (CRDA), Benin

Host Countries: Benin, Bulgaria (the economic component of NMX53) and Ghana

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Evaluate the degree of awareness of the health risks of producers, market participants, and consumers of aflatoxin on humans and animals and behavioral changes in groundnut production, marketing and consumption practices employed to minimize these risks.	Completed
Objective 2	Examine the extent and financial impact of groundnut aflatoxin contamination by areas and by levels of production and consumption.	Continuing
Objective 3	Evaluate the economic effects of adoption of improved, indigenous, groundnut, storage-technologies on producers, market participants and consumers of groundnuts.	Continuing
Objective 4	Conduct a cost/benefit analysis of the adoption of new technologies, designed to reduce aflatoxin contamination in groundnut storage, in animals and humans, and in market products.	Continuing
Objective 5	Evaluate the impact of aflatoxin groundnut contamination reduction on the agricultural economies of Ghana and Benin	Continuing
Objective 6	Training of participants in appropriate techniques	Pending

1.2 Budget:
The budget for 2004-2005 was $115,000.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

Although the project is multi-faceted only two areas were described in depth during an EEP member's visit to Auburn:

(1) The questionnaire approach to establishing the extent of awareness of aflatoxin among producers, market participants, processors, consumers, and administrators involved in the peanut sector in Ghana and Benin. It was designed to assess the level of behavioral change as reflected by improved storage practices, modified consumption habits and marketing practices and examine the impact on peanut production and marketing. Although the statistical treatment of the data obtained on awareness was sophisticated, the questions themselves were simplistic and there was no evidence that adequate controls typical for this type of polling had been used. That awareness of aflatoxin was low was unsurprising, and although the three workshops held in Ghana were probably helpful in building trust (and thereby assisting other Peanut CRSP projects) the effort in itself seems to be of doubtful justification.

(2) A comparison was being undertaken of peanut production in two trial plots using different harvesting techniques and also use of a clove-based product as an insect and anti-fungal agent during storage. Although data has been collected on a number of parameters including presence of fungi, plot yields of peanuts and moisture content, the key determination of aflatoxin levels in the samples had not been carried out at the time of the visit (December 2004). No economic data analysis was presented and the impression was given that this was awaiting the aflatoxin results. It was not clear if a provision for the not insubstantial costs of the analytical work had been made using the Peanut CRSP budget nor indeed who would be doing the analysis.

Work in Bulgaria on economic and financial analysis of growing peanuts post-breakdown of collective farms had evidently been carried out in this project but the results were not presented. The project set out to establish the costs and returns to producing peanuts in the key peanut growing region of Plovdiv. The Principal Investigators in Bulgaria were to conduct a field survey of 456 producers, establish the production function, and determine the impact of changing factors of production (capital investments, fertilizers, pesticides, seeds, technology and labor) on yield per acre, and overall production in the region. Additional information on this project was obtained in a site visit to Bulgaria.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Dr. Nelly Bencheva has undertaken an economic analysis of peanut production in Bulgaria. The economic analysis, based on a questionnaire approach sent to farmers and through one-to-one interviews, has collected a lot of information (e.g., yields of peanut varieties being cultivated, size of cultivated areas, age distribution of farmers, etc). While some conclusions were self-evident, a more detailed analysis was going to be undertaken when new statistical tools were provided (including training) from collaboration with the U.S. Principal Investigator (Dr. Curtis Jolly).

The EEP member was very impressed with the amount of information that had been rigorously collected and this economic analysis will be essential in terms of feeding into development of the Business Plan (intended 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 in very small farms mainly for 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 '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 effectively '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.

3.2 Technical Outputs in United States

No technical benefits were foreseen for the U.S.

3.3 United States Training and Capacity Development/Maintenance

Drs. Jolly and Ligeon have acquired new knowledge concerning peanut production in Bulgaria, accumulated useful resource documents on production practices, gained increased understanding of farming systems practices through the visit to the host country, and held extensive discussions with Bulgarian scientists and other key individuals in the country.

3.4 Host Country Training and Capacity Development/Maintenance

Drs. N. Bencheva and S.G. Delikostadinov (from Bulgaria) visited Auburn University and received practical training in data collection, preparation, and analysis. The host country principal investigators also visited peanut growing areas in Alabama and received 10 days training on data coding and interpreting results. They also benefited from the training provided by Drs. Jolly and Ligeon during their visit to Bulgaria.

When the recently purchased software package for economic analyses is installed, it will enhance the capabilities of the Bulgarian Principal Investigators in economic analyses.

3.5 Technology Transfer (workshops, publications, patents)

Knowledge and skills of methods used in conducting economic analysis was gained through the use of the new software and interactive exchange visits to Alabama and Bulgaria by the Principal Investigators. Plans for preparing joint publications were developed. The Principal Investigators jointly arrived at the realization that analytical tools necessary for this project would have to be rebuilt based on assumptions appropriate for a non-centrally controlled economy. Also, assumptions relative to farm unit size and managerial capabilities of the new farm owners would need to be retooled. Hence, technology transfer and technology transformation would result from the Peanut CRSP endeavor.

4 Demonstrated/Potential Impacts

There has been an increase in the understanding of the importance of peanut production in Bulgaria and of the potential market constraints introduced when aflatoxin contamination is prevalent (in Benin, Bulgaria, and Ghana). The U.S. and host country Principal Investigators have jointly established the importance of conducting market studies at the country level and in the context of regional trade within the European Union. Bulgaria is now establishing goals for becoming the premier producer and exporter of quality peanuts within the European Union and possibly elsewhere.

5 *United States/Host Country Beneficiaries and Benefits*

The project has been working in Benin, Ghana, and Bulgaria where collaboration has been successful. The linkages with this work and UAB56 are strong and efforts from both projects to develop rapport with local researchers in Ghana have been notably successful. There were three workshops in Ghana involving large numbers of people (about 300 in each case) that followed up on the apparent lack of awareness among professionals of the health problem associated with aflatoxin. These workshops have been successful in developing rapport at a local level, and while the direct benefit to AUB30S is not obviously apparent, there is no doubt that this activity has facilitated work in UAB56 and will be vital if TAM50 is to be successfully undertaken in terms of intervention studies.

Producers, consumers, and processors (male and female) will have increased knowledge of the prevalence and health impact 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 stages, along the custody 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 local and export 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.

6 Building Partnerships

Host country (Benin, Bulgaria, and Ghana) and U.S. scientists have formed useful partnerships which will lead to developing appropriate tools for conducting market analysis, impact assessments, and documenting behavioral changes producers, consumers, and market participants. The partnerships should also lead to increased understanding of the potential dangers of aflatoxin and ways to reduce health risks. The partnerships should also lead to the development and flow of scientific and marketing information relevant to the U.S. and the host country policy makers.

7 *Constraints and Recommended Solutions*

The processing of food samples, peanut products, and other samples for aflatoxin analysis has been slow due to the lack of agreement on who will do the chemical analysis and a lack of clarification as to who will pay for this. It seems that the economic analysis of plot trial data has, therefore, been constrained by the pending analysis of aflatoxin in other samples. There is a lack of capacity for conducting laboratory analyses of food samples and other samples in the host country facilities; hence, all analysis is done in the U.S.

8 Lessons Learned

The transfer of analytical tools and concepts from the U.S. (a competitive market-driven economy in terms markets and production units) to Bulgaria (a recently decentralized economy) is not a simple process. Assumptions underlying the production processes must be retooled and expectations regarding coefficients of production must be adjusted, and indeed the basic input/output and product cost and return budget formulas must be developed for the Bulgarian situation (reflecting conditions in an open and atomistically competitive economy).

9 Next Steps and Future Directions

In Ghana and Benin,, the analysis of samples for aflatoxin should be moved off dead center and the level of awareness of health risks should be established. Forward steps should be taken to establish the linkage between aflatoxin and the possible abatement of the HIV Aids pandemic, as a basis for opening the flow of health funding toward agro./health (CRSP) research and outreach.

In Bulgaria, the framework, theoretical basis, and tools (computer software package) for farm level analysis and market analysis should be put in place. The U.S. and host country Principal Investigators should utilize the strong partnership to guide the development and transformation of these analytical tools and approaches appropriate for Bulgaria and those techniques deemed applicable for a non-centrally controlled economy. These would prove to be valuable models and analytical tools not only for Bulgaria, but also for other countries of the Eastern European region. This outcome would be valuable as projections and conjectures are made relative to expanded export/import marketing opportunities. They would also be essential to efforts to conduct economic impact analyses.

10 General Observations

There were no issues raised regarding management or transfer of funds to beneficiary countries, and from the discussion with the administrators it was evident that there was good support provided to the Principal Investigators.

Partnerships between the host country and U.S. Principal Investigators will be an important part of the foundation for future Peanut CRSP efforts in Africa and Bulgaria. Economic analysis of potential market income and health gains should guide the scope and levels of all other research initiatives pertaining to peanuts.

11 Recommendations

Accelerate analytical work on aflatoxin to complete during the last year the work underway to establish the awareness of health risks in Ghana and Benin. In Bulgaria, complete the installation and training on the economic analysis software, and use the strong partnership to guide the development of information related to the conversion of the economy for centralized to free market.

Working with women farmers in Ghana

Research on foliar disease in Ghana.

1 Project Title and Investigators

UCN36: Socioeconomic Impacts of Alternative Peanut Production Marketing Systems in Senegal

U.S. Principal Investigator	Dr. Boris Bravo-Ureta	Office of International Affairs & Department of Agriculture & Resources Economics, University of Connecticut
H.C. Principal Investigator	Prof. Ibrahima Hathie	Ecole Nationale d'Economie Appliquee, Dakar, Senegal

Host Country: Senegal

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Foster the use of farm level data collected by ENEA in order to enhance the understanding of the economics of peanut production in Senegal.	Continuing
Objective 2	Measure the potential of increasing farm output and profits by increasing productivity in peanut production.	Continuing
Objective 3	Evaluate the impact of adopting alternative farming practices and emerging technologies in peanut production on farm profitability.	Continuing
Objective 4	Implement the West Africa Peanut Web Site (WAPWEB).	Continuing
Objective 5	Train ENEA faculty members, with priority given to areas in agricultural economics, education and economic geography.	Continuing

1.2 Budget:

The budget for 2004-2005 was $95,000.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

Human capacity development was the foundation of this Peanut CRSP project. The Principal Investigators set out to achieve progress through improving the way ENEA conducts research. This would be evidenced by the more scientific approach introduced and utilized in the data collection aspects as well as the publications to have come out of the data collected over the life of this project (five years)

The analytical approach called for the use of econometric techniques (e.g., Logit and Tobit regression, stochastic production, cost and profit frontiers, shadow cost and profit frontiers) and linear programming models to investigate a variety of topics including: (1) Peanut production and farm efficiency; (2) Peanut cultivation and profitability; (3) Technology adoption; (4) Aflatoxin, gender and health related aspects in peanut cultivation; and (5) Meta analysis of farm-level efficiency studies.

Other themes identified for investigation were democracy and decentralization, community development, soil management, and fertilizer use (in collaboration with the SOIL CRSP Trade-off Project).

Overall the project specified a broad agenda to be covered by the resources allocated to the project.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Resulting from this project the Ecole Nationale d'Economie Appliquee (ENEA) was able to practice better collection and use of farm level 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.

3.2 Technical Outputs in United States

In the U.S., several outcomes are worth reporting. First, the University of Connecticut (UCONN) Principal Investigator and his assistants gained additional experience in collecting, managing, and analyzing data in situations with developing country conditions imposed. This enhanced capability would be transferable to and useful in other countries of the immediate region. Other faculty members (in other departments) at the university have gained experience from working with and exposure to richer socio-economic data from a developing country setting. These faculty members represent several departments including: Economics, Nutritional Sciences, Agricultural and Resource Economics, the Environmental Research Institute, and Educational Leadership. Overall, the expertise of faculty and students in conducting developing country farm level analyses has been improved considerably.

The increased expertise developed among faculty at UCONN and ENEA will increase their ability to conduct rural development and socio-economic impact research in Senegal, other African countries, and in other developing regions of the world.

3.3 United States Training and Capacity Development/Maintenance

U.S. capacity at the University of Connecticut has developed through the experience and ability to offer short-term training to participants from developing countries. They have maintained the ability to bring short-term visitors to the university campus as well as degree-seeking students from Senegal. More recently, UCONN has begun to receive more graduate students from Kenya. Involvement with this project has had a very positive impact on the professional development of several faculty members in different departments at the university including: Economics, Nutritional Sciences, Agricultural and Natural Resources Economics, and the Environmental Research Institute. Their involvement in this Peanut CRSP project has brought significant benefits to other students from the U.S. and from many other countries that are enrolled at the University of Connecticut.

In addition, the possibility to interact with researchers from different universities in the U.S. and abroad and from different disciplines is a very enriching experience that goes far beyond the technical work related to peanut production. Under this Peanut CRSP project, these benefits have accrued to both U.S. and Senegalese collaborating scientists.

3.4 Host Country Training and Capacity Development/Maintenance

The training of ENEA faculty at the University of Connecticut has had a huge positive impact. Many ENEA faculty members have graduated with an M.S. or a Ph.D. degree and others have been able to participate in short-term training activities. These improved human resources, including both men and women, have provided ENEA with the needed capacity to respond to higher requirements. Indeed, the school is receiving several students with a "maitrise" who are seeking a professional experience. Endowed with these human resources, ENEA is now looking forward to implementing an M.S. program in natural resource management in Senegal.

The Peanut CRSP has also contributed to the upgrading of equipment (computers, LCD-projectors) that brought tremendous positive changes in the pedagogical environment at ENEA.

3.5 Technology Transfer (workshops, publications, patents)

The Peanut CRSP support for ENEA faculty members to pursue graduate studies has enabled the preparation of M.S. and Ph.D. thesis reports. In addition, a number of journal articles, poster presentations, conference papers, and technical reports have been produced in close cooperation between collaborating scientists from both the University of Connecticut and ENEA.

Workshops:

A workshop, jointly sponsored by the Peanut (UCONN-ENEA) and soil Management (Montana State University) CRSPs conducted by Drs. J. Antle (MSU) and J. Stoorvogel (University of Wageningen), was held in November 2003 in ENEA, Dakar. The workshop introduced the Tradeoffs Model developed by the SM CRSP to participants from Mali, Ghana, Kenya, ENEA, ISRA and UCONN. This conference set the foundation for an evolving collaboration between these two CRSPs in Senegal.

Publications:

Hathie, I, Lopez, R A: 2002 "The Impact of Market Reforms on the Senegalese Peanut Economy." Journal of International Development
Abdou Ndoye: 2003 Experiential Learning, Self-Beliefs and Adult Performance in Senegal International Journal of Lifelong Education
C Harris, I Hathie, C Brewster, B E Bravo-Ureta, and H Cocchi: 2003 Farm Practices Related to Aflatoxin Contamination Among Peanut Producers in Senegal. Peanut CRSP Research Report. October 2003.
Cisse, A, B E Bravo-Ureta, P Fuentes and A Thiam: 2003 An Economic Analysis of Agricultural Production in Senegal: A Case Study of the Thies and Diourbel Regions Journal of Developing Societies (Under Review)
Hathie, I and R A Lopez: 2003 Political Economy of Structural Adjustment Programs: The Case of Peanut Pricing in Senegal Agricultural Economics

Saila-Ngita, D, B E Bravo-Ureta, and R Perez Escamilla: 2003 Fertility Desires and Sample Selection Bias: The Case of Senegal Journal of Asian and African Studies	
Thiam, A and B E Bravo-Ureta: 2003 Technical Efficiency Measures for a Sample of Senegalese Peanut Producers Using Pooled Cross-Section Time-Series Data International Arachis Newsletter	

4 Demonstrated/Potential Impacts

The impact of the Peanut CRSP support to ENEA 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.

5 United States/Host Country Beneficiaries and Benefits

The research conducted through the Peanut CRSP is a significant contribution to the policy decision-making process. ENEA works with several entities involved in community development, such as local governments, NGOs, and various providers of technical services. The Peanut CRSP research has contributed to the improvement in the design of Local Development Plans (LDP) that are instruments to inform policy decisions regarding resource use at the village and rural community levels.

Several LDP's have been developed over the years especially within areas covered by the peanut basin. These LDP's helped the communities involved in identifying their development needs as well as the required resources and potential partners.

At the University of Connecticut, the Peanut CRSP has facilitated the interaction among a number of projects within the Peanut CRSP that subsequently resulted in various other efforts. This has made it possible to compete successfully for other projects. These types of benefits will go on well beyond the life of any particular project.

6 Building Partnerships

The first domain of partnerships developed is between ENEA and the University of Connecticut. This partnership has had many positive benefits for both institutions. The partnerships developed with other Peanut CRSP projects (i.e., Virginia Tech and Auburn) and with the Soil Management CRSP are also of significance. These collaborations have facilitated several activities including organizing joint workshops and research activities.

Within Senegal, the Peanut CRSP has made it possible to strengthen the collaboration with ISRA, the Ministries of Education and Agriculture, and with a variety of NGOs and local governments.

At the University of Connecticut, the Peanut CRSP has motivated several partnerships among faculty members in different departments that are deriving benefits and activities beyond the confines of this particular project.

7 Constraints and Recommended Solutions

The major constraint encountered within ENEA is the time management of activities to be performed. One solution could be freeing time for colleagues at ENEA who then devote more time in taking care of the Peanut CRSP activities. However, resource constraints make it difficult to provide adequate incentives to faculty members in ENEA so that they can commit a more significant share of their time to research activities. This is the case not only within the Peanut CRSP, but in other research areas as well.

A major issue that has evolved has to do with the bureaucratic red tape that the U.S. institutions have to negotiate associated with obtaining visas for the host country collaborating scientists. One way to deal with this is to minimize or eliminate short-term visits. However, this action eliminates the benefits of these short-term visits in terms of making progress in the project objectives as well as other types of benefits already discussed. This is a difficult predicament and assistance is needed in dealing with this issue.

8 Lessons Learned

ENEA, as an institution, has long been involved in community development, particularly in rural settings. It has come to the conclusion that much effort has been skewed towards analyzing the means of development available to rural populations. In other words, ENEA has formerly focused on processes and now recognizes the importance of focusing on the people as the center of every development goal.

Another important lesson is that, while this Peanut CRSP project required a major commitment and much dedication, the institutional and professional rewards are far greater and of wider reach than anticipated.

In addition, it has become apparent that close collaboration between the socio-economic and some of the other CRSP projects and thrusts is necessary. This can be done in a variety of ways and the University of Connecticut Principal Investigator has already begun to outline preliminary thinking on an avenue that will prove worthy of pursuing in the future.

9 Next Steps and Future Directions

A future direction of high payoff potential for the UCONN-ENEA Peanut CRSP collaboration is to conduct economic analyses of the underappreciated and strategic links between production and the value chain in several, if not all, countries supported by the Peanut CRSP. A guiding principle will be to design models that can be used to connect with analyses that might be done beyond the farm-gate, particularly those focusing on value-added activities.

A project along these lines would need to be adapted in response to the specific objectives pursued in the production projects to be funded in the next phase of the program. Specific activities that could be considered are:

(1) Consolidating a network of economists involved and interested in productivity work, with special interests in the peanut production system.

(2) With the active participation of those Principal Investigators undertaking production-oriented research, jointly design, and implement impact evaluation procedures.

(3) Working with production-oriented projects in order to incorporate relevant economic components in early stages of project development to insure that their role in preparing to collect appropriate data is recognized.

(4) Conducting disciplinary economic work focusing on the competitive position of peanut production across Peanut CRSP countries with particular attention given to effects from the World Trade Organization's (WTO) rulings as well as other major policy changes.

(5) Linking up with various participants in peanut research in order to incorporate some of their concerns into the economic analysis as well as to disseminate project results at various levels (e.g., farmers, farm groups, local and national governments, universities, national and international research centers).

The direct collaboration between the University of Connecticut and ENEA, encompasses work on the consolidation of the latter institutions capabilities to undertake socio-economic and resource management research. This would link with current efforts at ENEA to develop a M.S. program in this area that is a component of another project between the two institutions (UCONN and ENEA) supported by the U.S. State Department. ENEA should play a major role in the network mentioned in (a) and in the work that would be undertaken throughout Africa under items (b) through (e) above.

10 General Observations

Not enough progress was made in creating the regional linkages among the socio-economic projects (Peanut CRSP) in West Africa. Incentives should be considered to make that collaboration a reality as it would likely lead to: (a) a more rapid development and spread of appropriate analytical techniques, (b) improvement in the economic data and information relative to the economy of peanut production, processing, distribution and utilization, (c) better understanding of the socio-economic and gender impacts from changes in peanut consumption, sales and export, and (d) increased capacity to measure and describe the links between aflatoxin contamination and the prevalence of HIV/AIDS in the region.

11 Recommendations

This project should continue in the future. Suggested directions and improvements in the project are detailed in Sections 9 and 10 above.

1 Project Title and Investigators

VT54: Gender Issues in Aflatoxin Incidence and Control in Groundnut Production Systems of West Africa

This is a new project in Phase 2, replacing VT35 which was not continued after 2001 which also addressed gender issues in peanut production and marketing. The project would allow Peanut CRSP to contribute to the attainment of two Millennium Development Goals (MDGs): (1) Empowerment of women, and (2) Poverty reduction. The experiences in Senegal and Uganda would provide information to other Peanut CRSP projects in other countries on how to work with men and women farmers, traders, and processors to ensure that they benefit from Peanut CRSP technologies. All Peanut CRSP projects must address social and gender concerns, in addition to economic and environmental aspects (VT54) in their design and work plans, with clear key performance indicators.

U.S. Project Investigators	Dr. Colette Harris Dr. Kathleen Stadler (until 2004) Dr. William Eigel (Co-PI)	Virginia Polytechnic Institute and State University, Blacksburg, Virginia
HC Project Investigator – Senegal	No PI designated	Ecole Nationale d'Economie Appliquee, Dakar, Senegal
HC Project Investigators-Uganda	Dr. Archieleo Kaaya Dr. Margaret Mangheni (Co-PI) Dr. Connie Kyalisiima (Co-PI)	Dept. of Food Science and Technology, Dept. of Agricultural Extension, Dept. of Animal Science, Makerere University, Kampala, Uganda

Host Countries: Senegal initially, then Uganda in mid-2003

1.1 Project Objectives and Budget

Objectives	Objectives	% Complete
1	Provide online access to gender-related databases on aflatoxin.	100
2	Identify current and traditional practices in peanut growing, harvesting, and post-harvest in Uganda related to aflatoxin contamination	100
3&4	Educate women farmers and housewives on health risks of aflatoxin and how to reduce levels of contamination	80
5	Evaluate costs of achieving European standards to allow peanut export	0
6	Establish baseline for present human exposure to aflatoxin	40
7	Survey aflatoxin content of groundnuts for sale in Kampala market	90
8&9	Support farmers to form associations and facilitate contact with European peanut processing firms	10
10,11,& 14	Support Ministry of Health and relevant Ugandan institutions to carry out information campaigns (IEC) on health issue related to aflatoxin	0
12 & 13	Disseminate findings on aflatoxin levels and protocol to the Bureau of Standards and assist in formulating practical approaches to reduce aflatoxin contamination levels.	0

1.2 Annual Budget: In 2003-2004, the budget for this project was USD60,000 of which USD27,126 (45%) was transferred to Uganda to the Host Country partner institution (Makerere University).

2 Research Approaches

The overall research approach at Virginia Tech has been multi-disciplinary, in close collaboration with the Host Country Project Team. In Senegal, three departments were involved in this project: (1) Department of Food Science for the analysis of aflatoxin levels in peanut on farm, in storage, and in the markets; and review of food preparation practices; (2) Department of Agronomy on farming, harvesting, and post-harvest practices related to minimizing aflatoxin contamination; and (3) Social Sciences Department on gender analysis of farming and related activities, experimental methodologies for health education, and gender and health training.

In 2002, farm level surveys were carried out in selected rural communities in Senegal to collect data on farming, post-harvest processing, storage, and health issues related to aflatoxin. The survey involved first year students from ENEA who collected data as part of their official activities; a report was prepared in 2003. Due to slow progress, the project was transferred to Uganda in June 2003 and project coordination was transferred to the Department of Food Science and Technology at Makerere University in Kampala.

A field-level mini-survey was carried out in May 2003 in three villages to collect farming and post-harvest practices related to peanuts and aflatoxin. The survey was carried out by two Virginia Tech Teams and the Makerere University coordinator. Then a farm-level survey was carried out in 2003-2004 in four villages in the peanut growing areas of Uganda (in Mubende, Iganga, and Mayuge Districts) to assess the aflatoxin level in peanuts which was initially determined to be high by the IPM CRSP team. The survey carried out by a Ugandan graduate student.

Another survey was carried out in 2003-04 on knowledge, attitudes, and practices of peanut traders, wholesalers and retailers in Uganda, in selected markets in Uganda. Analysis of the aflatoxin content of peanut samples collected on farm, in storage, and in five market centers were carried out by the Ugandan Project Investigator.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Senegal: Very little progress resulted from the work in Senegal in 2002-2003 due to inability to identify suitable partners; hence, in June 2003 the project was transferred to Uganda. The full report on the Senegal survey related to aflatoxin and the health of peanut farmers in the Peanut Basin conducted by ENEA is available on the Peanut CRSP website.

Uganda: Farm level and market surveys in Uganda showed low levels of aflatoxin contamination immediately after harvest and drying. However, processed nuts on sale in urban market centers contain aflatoxin levels of 2-3 times higher than the WHO allowable limits and 10 times higher than EU standards, an indication that aflatoxin contamination occurs during post-harvest handling and processing stages.

Results should that aflatoxin issues were unknown to vast majority of Ugandan population surveyed, from university professors to illiterate farm families. Only health professionals and agronomists knew about aflatoxin contamination and their 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.

Several surveys were completed in the Host Countries: (1) ENEA conducted a survey related to aflatoxin and the health of peanut farmers in the Senegal peanut basin region; (2) Colette Harris and others conducted a mini-survey on farming and post harvest practices related to peanut and aflatoxin; (3) Archileo Kaaya conducted a survey of the knowledge, attitude, and practices of peanut traders, and other participants in the wholesale and retail markets in Uganda; and (4) Beatrice Namalobo conducted a qualitative survey of peanut farming harvest and post-harvest practices and relevant attitudes and knowledge in four villages in the districts of Mubende, Igabga, and Mayuge.

3.2 Technical Outputs in United States

No research activities were carried out in the U.S.

3.3 United States Training and Capacity Development/Maintenance

Three Virginia Tech professors from the Nutrition and Food Science Departments were involved in the project, and two traveled to Uganda to understand the local situations. No degree training has been initiated at Virginia Tech involving American students.

3.5 Host Country Training and Capacity Development/Maintenance

Degree training, Uganda: One M.S. student at Makerere University, Beatrice Namaloba (Ugandan, female), completed her research on farming, harvest, and post-harvest practices and relevant attitudes and knowledge in four peanut growing areas of Uganda; Project Investigators in Makerere University and Virginia Tech have jointly advised her necessitating the appointment of Dr. Colette Harris as a Makerere University faculty. One Ph.D. student was jointly supported by Makerere University, Peanut CRSP, and IPM CRSP, a good example of partnership in capacity building.

Non-degree training in Senegal: Some students from ENEA were trained on qualitative research methodologies. A total of 40 NGO members were trained in matters related to health education methodologies and gender.

Non-degree training in Uganda: The following persons benefited from training carried out by the project:

1. Four agricultural extension students (all women) at Makerere University were trained on gender and health education issues. A female M.S. student was trained in ethnographical methodologies, qualitative data analysis, and thesis writing.
2. The Host Country Project Investigator (male) was trained on administrative and accounting skills.
3. Three agricultural extension workers (all males) were trained on how to train farmers to reduce aflatoxin contamination.
4. Two health supervisors (both men) and eight health workers (six women and two men) were trained on health and gender issues and innovative health education methodologies related to aflatoxin.

3.5 Technology Transfer (workshops, publications, patents)

Workshops: In **Senegal**, two **w**orkshops were held in 2002 participated by 40 NGO members (mainly women) on health education methodologies, gender, and aflatoxin contamination.

In **Uganda,** the following workshops were held: (1) one **w**orkshop in April 2004 at Makerere University on health education methodologies and gender issues for 15 participants including faculty, students, and health workers. The Ministry of Health appreciated the training on aflatoxin since the staff was not aware of the health risks caused by aflatoxin contamination; (2) two workshops were held in November 2004, the first in Iganga/Mayuge and the second in Mubende, to finalize the Health Education Program. Each had four health workers and a supervisor as participants. The workshops were facilitated by Dr. Colette Harris and Dr. Archileo Kaaya with support from two Makerere students (women). Total participants: Iganga/Mayuge workshop four women plus four men plus the two facilitators (1 man, 1 woman), and Mubende: five women and a man with two facilitators.

Publications: Seven publications, reports, thesis reports were produced by U.S. and Host Country Project Teams:

1. A paper in international newsletter on aflatoxin contamination in groundnuts in Uganda.
2. A manuscript submitted on Aflatoxin levels on farms and in markets in Uganda, submitted to Peanut Science on aflatoxin and women farmers, entitled: 'Aflatoxins in Peanuts, the health risk versus the economic costs: Some reflections on local viewpoints from the Senegalese Peanut Basin' in *Proceedings of Women's Worlds 2002 Conference*. Kampala: Makerere University (Fountain Publishers, in press).
3. A working paper on critical issues for aflatoxin contamination among peanut producers in Senegal.
4. Two reports: ENEA 2002 Aflatoxin Survey Report in Senegal; 2003 Mini survey in three villages in Uganda.
5. An M.S. thesis report by Ugandan graduate student on Assessment of farm families' farm practices on and health risks in groundnuts (in prep.).
6. A bibliography on aflatoxin with about 1,000 entries; in Virginia Tech OIRED website and incorporated into the ICRISAT bibliography on aflatoxins.

Patents:

No patent is expected from this project.

4 Demonstrated/Potential Impacts

The research in Senegal provided ENEA students and NGO members' skills in understanding health issues related to aflatoxin in peanuts. The research in Uganda is starting to show initial impact especially in the health aspect. It is expected that reduction of aflatoxin level of peanut on farm and in the market, and processed peanut products in the market would result to 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 has created greater awareness of 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 in 2003 and 2004. For example, the Ministry of Agriculture has hired an M.S. graduate to fill an Agriculture Inspector position. These impacts could increase farm incomes in Mubenda through export to Europe.

5 United States/Host Country Beneficiaries and Benefits

Main beneficiaries in Uganda are farmers and small-scale processors, who are mainly women, traders, private medium-scale food processing business enterprises, and eventually consumers because of the availability of aflatoxin-free peanuts and products.

Collaborating research institutions, like ENEA in Senegal and Makerere University in Uganda, have benefited from degree and non-degree training of faculty and students. Close collaboration between the H.C. and U.S. Project Teams improved their professional stature, sharing of research methodologies and information, and joint authorship of scientific papers.

U.S. university partners gained experiences in actual field situations in Africa; these professors worked together in Peanut CRSP and IPM CRSP sites in Uganda.

6 Building Partnerships

Research partnership with the Ecole Nationale d'Economie Appliquee (ENEA) in Senegal did not remain viable. Experience with partnering with Makerere University in Uganda was more satisfactory. The multi-disciplinary team at Makerere University (Departments of Food Science and Technology, Agricultural Extension and Education, Animal Science, Gender Studies, and Medical School) and the National Agricultural Extension Services of the Ministry of Agriculture complements the multi-disciplinary approach of Virginia Tech.

Collaboration with the Ugandan Bureau of Statistics resulted on the preparation of baseline database on aflatoxin exposure levels in Ugandan population. This linkage should be strengthened to ensure maintenance of the data sets and make it accessible to local and regional researchers and policy makers.

In 2002, potential partnerships with an NGO (Tostan) and the Association pour la Promotion de la Femme Senegalese (APRPFES) were negotiated. APROPFES has 200 collaborating villages in the Peanut Basin region. Since these two NGOs did not continue their participation, as was also the case for an NGO Tostan, that also initially indicated willingness to participate in the project, the project was transferred from Senegal to Uganda. In Uganda, Peanut CRSP has linked with the National Association of Women in Uganda (NAWOU) and their sub-organizations. This provided access to local women's organizations to ensure their participation in the project. Women make up majority of peanut farmers and do most of the post-harvest and processing activities. Such linkages should be maintained and strengthened.

7 Constraints and Recommended Solutions

Institutional problems: Some problems were encountered in identifying scientists to carry out collaborative research in Senegal, which resulted in very slow progress in two years. This necessitated transfer of the project to Uganda in 2003, with Makerere University as the collaborating institution. Considerable progress has been attained in one year and the collaborating scientists remain very active and committed.

Differing incentives: In Uganda, farmers are interested in collaborating with Peanut CRSP to reduce aflatoxin levels in peanut since they are the principal consumers of their produced. However, there is no incentive among traders to do the same. It is planned to work with the Ministries of Health and Agriculture to create greater awareness of the health risks of aflatoxin and availability of Peanut CRSP technologies to reduce contamination, such as manual sorting. The project has also to work with the Ministry of Trade in this respect.

Research vs. technology transfer: There is tension between research and development work in Peanut CRSP. The program is trying to make impact by transferring Peanut CRSP technologies to farmers, traders, processors, and the general public, including the government. But technology transfer needs different type of activities and additional resources. It would also require traditional research partners such as extension providers, international and local NGOs, and private sector small- to large-scale food businesses.

8 Lessons Learned

The joint graduate program between Virginia Tech and Makerere University should be reviewed by Peanut CRSP for possible adoption in other projects because: (i) it cuts costs so more developing country graduate students would benefit; (ii) it ensures relevance of research topic to host country problems because the research is carried out in the country; and (iii) joint advisorship of graduate students would strengthen the professional linkage of U.S. and developing country professors.

The focus on differing roles of men and women in peanut production, post-production, and harvesting has given a new dimension to the project areas in Uganda. Discovery-based learning can work with health issues in villages. Trade issues are more complex than expected. Involving women in planning, training, and other key activities has been empowering to them. Peanut production, processing, and marketing are their main responsibilities. And women-headed households are the poorest in the rural areas.

9 Next Steps and Future Directions

Makerere University professor of Animal Science (Dr. Connie Kyalisiima) has proposed to carry out research in managing aflatoxin using Bentonite clay in animal feeds in Uganda, to be funded by NORAD (Norway) and in collaboration from Peanut CRSP.

Experience working on gender issues in Peanut CRSP research in a host country like Uganda would provide strategies of mainstreaming gender in peanut research that Peanut CRSP could use in its work in developing countries. In the future, Peanut CRSP projects should include in their design strategies to ensure that women and children, who are usually disadvantaged groups in rural farming areas, would benefit directly from new technological interventions (i.e., resistant peanut varieties, aflatoxin-free peanut products, etc.) by Peanut CRSP.

The ongoing work in aflatoxin in peanut in Uganda/region is linked with the HIV/AIDS and other illnesses. Possible solution to the aflatoxin problem (i.e., use of Bentonite clay), has implications to people's health. Work on health issues would require critical participation of the Ugandan Ministry of Health and trained village health workers, an area where Peanut CRSP is not a traditional player. Partnership with the Ministry of Health, Ministry of Trade, and the Ugandan Board of Standards is required to tackle the health, trade, and related issues in a coherent manner.

10 General Observations

Strength: The U.S. Project Investigator has to be commended for transferring the project to Uganda when it was determined that the institutional problems in Senegal were too difficult to solve and continuing to work in the country would result to failure. It was encouraging to see how fast the Makerere University Team was to start activities and to attain significant progress in one year.

Strength: The U.S. Project Investigator is a social and gender specialist with extensive experience working in developing countries. With her leadership, this project has experience that other Peanut CRSP Project Investigators could learn from in mainstreaming gender in peanut research and development efforts. The CRSP program exploited this by having her as the 'Gender' representative on the Technical Advisory panel.

11 Recommendations

Peanut CRSP should continue gender-related projects in the next phase. Develop/strengthen collaboration with other Ugandan institutions: NARO for research and development inputs, Ministry of Health (health workers' participation); Ministry of Trade (trade issues), and Ministry of Agriculture (for extension services), local and international NGOs, the private food industry, and men and women farmers, and women's organizations. The Ugandan experience could be used to expand gender mainstreaming initiatives in other countries of Africa or in other regions where Peanut CRSP has intensive collaborative activities. The experience of working with the National Association of Women in Uganda and its sub-organizations would provide a good practice on working with women in the continuum of production, post-production, processing, and marketing.

Making peanut butter in a women's group village factory;
the butter is used for school feeding or sold at local shops.

1. Project Title and Investigators

NMX53: Valencia Peanut Breeding For High Yield, Early Maturity, and Resistance to Fungal Diseases, and Good Quality

USA Principal Investigator	Naveen Puppala	New Mexico State University, Clovis, NM
HC Principal Investigator	Stanko Delikostadinov	Institute of Introduction and Plant Genetic Resources, Sadovo, Bulgaria
USA Co-Principal Investigator	Dr Curtis Jolly	Auburn University, Auburn AL
HC Co-Principal Investigator	Dr. Nelly Bencheva	

Host Country : Bulgaria

1.1 2004-2005 Phase II Project Objectives

Objective	Goals	Status
1	Economic analysis of peanut production and its efficiency in Bulgaria	Active
2	Peanut germplasm enhancement with new accessions and traits using molecular marker approach	Active
3	Investigation of USA varieties in Bulgaria and Bulgarian varieties in USA for yield, maturity, and fungal disease resistance.	Active

1.2 Annual Budget:

This project is also reported in AUB30 where economic analysis has been conducted as a sub-activity of this project.

The budget for 2004/05 totaled $75000 (NMSU $60,000 and AUB30 $15,000)

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

This is a well-planned, well-consolidated project with clear objectives to improve yield and quality of Valencia peanut types that are grown in New Mexico and Bulgaria.

Although molecular biological research is somewhat longer-term, it has already provided cluster analysis of a wide range of Valencia lines and given new information on genetic relationships among germplasm lines. This technique should also aid in introgression of beneficial traits.

There is a strong collaboration with the host country, with free exchange of germplasm.

3. Outputs/Achievements

3.1 Technical Outputs in Host Country:

A good range of Valencia lines has been assembled for evaluation in Bulgaria and Bulgarian lines have been brought to NM for evaluation. Some new Valencia material appears to be performing well in Bulgaria but the growth cycle may be too long.

In Bulgaria, US Valencia cvs. were compared to Bulgarian Valencias, characters assessed included maturity, yield and fungal disease resistance. The US cvs. were compared to Kalina, the standard Bulgarian check.

US Accessions were later maturing than Kalina and were also lower yielding. *Fusarium* was the most important disease followed by *Alternaria* and *Phyllosticta*. The US cvs. were also more susceptible to carbonate chlorosis.

Average yields of Kalina in the field were 4824 kg/ha and the best of the US cvs. was Sunland at 3591 kg/ha. Kalina also had larger seeds.

Expertise in processing and food technology of this type of peanut in the U.S. will be of benefit to Bulgaria.

Crosses between NM Val A and C, and Kalina and Rossitzka, have been made. Selections are currently being advanced.

3.2 Technical Outputs in US:

A good range of Valencia lines has been assembled for evaluation in Bulgaria and Bulgarian lines have been brought to NM for evaluation. Some new Valencia material appears to be performing well in Bulgaria but the growth cycle may be too long.

The Sadovo lines are performing well in New Mexico. However, they are 2-3 seeded, of shorter stature, and earlier than the US material. S3663 is performing well in US, even in Nebraska.

Crosses between NM Val A and C, and Kalina and Rossitzka, have been made. Selections are currently being advanced.

Molecular biology techniques and use of cluster analysis has given insight of germplasm grouping. Hopefully this will help in identifying more widely differing genotypes for hybridization.

3.3 US Training and Capacity Development/Maintenance:

There have been no US trainees. The US PI has benefited by the contact and interaction with Dr. Stanko Deliostadinov the Bulgarian PI, because of the competence of Stanko as a breeder of Valencia type peanuts.

3.4 HC Training and Capacity Development/Maintenance:

HC scientists and technical support staff have benefited from training and capacity building.

It would be desirable to have a graduate student from Bulgaria study at NMSU, but the current visa restrictions are a major stumbling block. Dr Stanko was also concerned about language difficulties for Bulgarian students in the US. There is potential for U.S. and HC graduate student training in molecular biology techniques.

Processing technology (in-shell roasting) advances could be of benefit to processors. The use of cluster analysis techniques could be of use to breeders.

3.5 Tech Transfer:

A number of publications have been published or submitted. These include results on the development and use of markers, and cluster analysis of germplasm groups.

Publications:
A. Muitia, M.Burow, J. Aiyers, N. Puppala: 2004 "Selection for Early Maturity and High-Oleic from Valencia x Spanish Lines". Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

Bencheva NA, Delikostadinov SG, Jolly CM and Puppala N: 2003 Peanut Production Development in Bulgaria. Proc. Amer. Peanut Res. Edu. Soc. [Publication type: ABSTRACT]

Bencheva, N, C.M Ligeon, Sg Delikostadinov, N Puppala, and CM Jolly: 2004 Economic and Financial Analysis of Peanut Production in Bulgaria. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

Delikostadinov, SG, and Puppala N: 2003 Evaluation of Valencia Peanut Varieties Investigated in Bulgaria. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

GK Krishna, J Zhang, and Puppala N: 2003 Estimating Genetic Diversity in Valencia Peanuts Using SSR Markers. Agron. Abstract [Publication type: ABSTRACT]

Krishna, GK and N Puppala: 2004 Cross-taxa transferability of Sequence Tagged Micro-satellite Site (STMS) primers from Pulses to Peanut *in* Fischer T et al. New directions for a diverse planet: Handbook and Abstracts for the 4th ICSC; Brisbane, Australia, 26 Sept. - 1 Oct. 2004. [Publication type: PROCEEDINGS]

Krishna, GK, and Puppala N: 2004 Transferability of Sequence Tagged Micro-satellite Site (STMS) Primers from Pulses to Peanut. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

Krishna, GK, J Zhang, L Yingzhi, G He, RN Pittman, M Burow, SG Delikostadinov and Puppala N: 2003 Detection of Genetic Diversity in Valencia Peanuts using Microsatellite Markers Proc. Amer. Peanut Res. Edu. Soc. [Publication type: ABSTRACT]

Krishna, GK, J Zhang, M Burow, RN Pittman, SG Delikostadinov, Y Lu and N Puppala.: 2004 Genetic diversity analysis in Valencia peanut (Arachis hypogaea L.) using micro-satellite markers Cellular and Molecular Biology Letters [Publication type: JOURNAL]

Ligeon, CM, N Bencheva, SG Delikostadinov, CM Jolly and N Puppala.: 2004 Production Function for Peanuts in Bulgaria. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

Manivannan, N and N Puppala.: 2004 Performance of Crosses between Bulgarian and Valencia Peanut Varieties. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

N. Puppala*, N. Manivannan, S. G. Delikostadinov, R. Kirksey, A. Scott and J. Irwin: 2005 Genotype X Environment Interaction for Pod Yield of Valencia Peanut Varieties Prospects and Emerging Opportunities for Peanut Quality and Utilization Technology. [Publication type: ABSTRACT]

Puppala, N and SG Delikostadinov: Evaluating the Performance of Bulgarian Peanut Lines for Yield and Disease Resistance. [Publication type: ABSTRACT]

Puppala, N and SG Delikostadinov: 2004 Evaluating the Performance of Bulgarian Peanut Lines for Yield and Disease Resistance Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

Puppala, N.: 2004 Valencia Peanut Breeding for High Yield and Disease Resistance Peanut Update 2004, Queensland Government, Department of Primary Industries and Fisheris, Kingaroy, Australia [Publication type: POWERPOINT]

Rowland, D, P Blankenship, N Puppala, J. Beasley, M. Burow, D Gorbet, D Jordan, H. Melouk, C Simpson, and J Bostick: 2004 Variation in water-use efficiency of peanut varieties across peanut production regions *in* Fischer T et al. New directions for a diverse planet: Handbook and Abstracts for the 4th ICSC; Brisbane, Australia, 26 Sept. - 1 Oct. 2004.: [Publication type: PROCEEDINGS]

Rowley, DM, Puppala N and YD Cho: 2003 Nictotinic Acid Betaine in Stressed and Non-Stressed Genotypes of Peanut (Arachis hypogaea) Agronomy Abstract [Publication type: ABSTRACT]

Stanko G. Delikostadinov and Naveen Puppala: 2005 Collaborative Valencia Peanut Breeding between Bulgaria and USA. *In* Prospects and Emerging Opportunities for Peanut Quality and Utilization Technology [Publication type: ABSTRACT]

There are questions on the use of jointly developed germplasm in terms of IPR. Apparently breeders in Bulgaria receive royalties and the implication of IPR on this practice needs clarification.

4. Demonstrated/Potential Impacts:

The release of a cultivar in the US from Bulgarian germplasm will have great impact for New Mexico.

5. US/HC Beneficiaries and Benefits:

In the U.S.: Development of new varieties could stimulate production and quality for the in-shell market. Improved disease resistance, particularly to pod rots, will reduce yield losses and improve quality, which will benefit processors and consumers. Use of the Sadovo lines in breeding may improve quality and yield. These are shorter-season and shorter-stature and generally do not have 3- and 4-seeded pods, but have good quality. U.S. growers will benefit from a wider range of improved genotypes, and the potential for development of new varieties.

Improved molecular biology and cluster analysis techniques will be useful for scientists and Refinement of techniques will benefit researchers. In Bulgaria: Development of new varieties will stimulate production of the crop and improved quality will add value to production for the in-shell market. Improved pod rot disease resistance will improve quality. This will result in improved farmer income and better quality, safer food, especially for children.

The Bulgarian industry will benefit from improved processing technology, and scientists and institutions will benefit from exposure to molecular biological capacity and techniques. Improved pest and disease resistance will reduce the use of pesticides and risk of environmental degradation.

Seed production agencies will benefit from the stimulation of seed production technology.

Increased production of better quality groundnuts will have important benefits to industry, both in the U.S. and Eastern Europe.

6. Building Partnerships:

There is good collaboration with Mark Burow, TAM 17 project, and NMSU has developed good relationships with growers and processors and work very closely with end users.

The food science group at Griffin is monitoring nutritional aspects.

Expertise in processing and food technology of this type of peanut in the U.S. will be of benefit to Bulgaria.

7. Constraints and Recommended Solutions:

There have been difficulties and delays in the transfer of funds to Bulgaria.

8. Lessons Learned:

Collaboration between competent scientists in the US and HC is profitable.

9. Next Step:

Good progress is being made, and the project should continue with emphasis on:

Pathology investigations into the control of pod rots as these could have a major effect on pod and seed quality

Agronomy and mechanization - harvesting of plants of different stature may require system changes

Improved collaboration with food science and food quality projects, since sugar contents appear to be of importance in this type of processing.

Molecular biology work should continue in collaboration with the TAM 17 project, as this would provide nearby expertise and institutional capacity

10. General Observations:

The Bulgarian varieties are very short in stature, and are earlier than the NM Valencia varieties; this may have implications for mechanized harvesting, and may require changes in production technology.

Pod rots have been shown to be a major constraint in both countries, and effort needs to be directed towards reducing this risk to quality. Black hull is included in the list of diseases in NM and needs to be addressed.

Training of Bulgarian graduate students is highly desirable, but visa restrictions and language difficulties may be constraints.

Dr Stanko is due to retire shortly and risks losing some of his benefits if he continues. However, there is no clear succession procedure, and he is concerned with the continuation of the project. He would like to continue to be involved, even if exclusively with P-CRSP only, if possible.

It appears that the US is getting more benefit than Bulgaria at this stage in the project.

CRSP partners from project NMX53 in the USA.

The Peanut Collaborative Research Support Program

External Evaluation Panel 2005 Report

Annex 2

Peanuts infected with *Aspergillus* fungi are the source of aflatoxin which is a primary problem for peanuts worldwide. The toxin is carcinogenic, immune suppressing, anti-nutritional and is a major barrier to trade in peanuts.

Food Safety and Nutrition Sector Report

Overview of projects

Although only eight of the twenty in the Peanut CRSP are in this cluster it was apparent that it is a wide portfolio of projects and contains some which are very ambitious, and which have the potential to have a large impact. Clearly spreading the available funds widely means that the Peanut CRSP in some senses is only 'pump-priming' in some areas and achievement of a critical mass for a specific project is highly dependant on leverage of funding from other sources. A number of the Principal investigators made the point that involvement with the Peanut CRSP was prestigious and it stimulated working with developing countries (which they might otherwise not do) but that the funding was in some cases so small, that without funding from other sources, it could achieve very little alone. Whilst with an exciting array of projects offering relevant and attractive opportunities for peanut research, it is tempting to fund a wide portfolio; the question nevertheless arises whether a more focused approach, funding a smaller number of projects, might not be advisable for the next funding period. The prevention, detection and amelioration of the adverse health effects of aflatoxins in peanuts features large in the food safety 'cluster' of projects'.

The lead reviewer of this cluster of projects was John Gilbert, Director of the Central Science Laboratories, York, UK.

Handy Williamson assisted in the review of the economics components of project AUB30.

John Cherry participated in the review of PUR10 and OKS55 focusing on the food components.

Prevention and detection of aflatoxins

The prevention aspect goes back to basics, as far as understanding the mechanisms of fungal attack on peanut plants at a molecular level (UW149F – Nancy Keller) and trying to understand the triggering of secondary metabolism.
This work is very fundamental and whilst academically exciting, is many years away from exploitation in practical terms. Linking with a host country has been difficult due to the need to find a country with scientific sophistication to match UW – although a recent link with South Africa has been achieved.

The prevention aspect is covered by prediction of aflatoxin risk by the use of early warning systems based on remote sensing and ground observations (UGA22A – Gerrit Hoogenboon). This work is ambitious but 'proof of principle' has already been established elsewhere. The novelty here is to attempt to use low cost or 'free' access to satellite information. The host country link with Benin is weak and it is doubtful that the technology would really be transferable as it is probably too sophisticated.

Evaluating different agronomic practices in terms the influence on aflatoxin levels has been carried out in AUB30S (Curtis Jolly). Using two trial plots for peanut production in Ghana different winnowing techniques have been assessed and a number of different samples taken for analysis. Also treatments such as use of clove-based products as anti-fungal agents during storage have been tested. This work has been primarily observational assessing economic impact rather than technology driven in terms of developing innovative practices.

Improved storage of peanuts has been covered by UW149F at University of Georgia – David Wilson. Working in Botswana an approach using silica-based materials to incorporate with stored peanuts is practical, low-cost and has been shown to be effective.

These sharp-edged materials work through penetrating the shell of hard-bodied insects, effectively killing then and preventing damage, and minimizing subsequent fungal infection.

Two projects address the need for low-cost analytical methods for screening and analyzing mycotoxins. In UW149F at University of Georgia (David Wilson) a low-cost alumina-based column has been developed made from locally available materials. Using bromination of the extract and analysis by fluorimetry, up to 300-400 samples a day can be screened at a limit of 5 ppb. This test system is very practical and sufficient work has been undertaken for a validation to be pursued. This simple output needs to be exploited through interlaboratory validation and involvement in a wider community in developing countries. A similar approach has been proposed in TAM50 (Tim Phillips) using NovaSil clays for analytical clean-up. However, in TAM50 this is peripheral to the main thrust of the funded work and has not progressed as far as the work at University of Georgia with which it effectively competes.

Amelioration of the adverse health effects of aflatoxins

The main 'cluster' of food safety projects all centre around demonstrating the effectiveness of using clay in the human diet to reduce bioavailability of aflatoxins and thus leading to health improvements through reduced exposure. Monitoring biomarkers of human exposure to aflatoxins, such as aflatoxin M_1 in urine and other clinical parameters of disease and nutritional status are being used for initial benchmarking (UAB56 – Pauline Jolly). The intention of TAMU50 (Tim Phillips) is to use an intervention strategy with inclusion of NovaSil clay in the diet in capsule form to adsorb aflatoxins. Preliminary work in terms of demonstrating no adverse effects of NovaSil clay in a rat study (e.g. no absorption of nutritional components) has been completed as well as a human study in the USA. Planning is well advanced for an intervention study in Ghana for a population group which has already been identified as being highly exposed to aflatoxins through peanuts (possibly as well as other dietary components such as corn). Prior to the intervention, during the intervention and after ceasing to take the clay capsules, Pauline Jolly will undertake monitoring of clinical parameters (including immune status) looking for changes indicating the effectiveness of the clay in making aflatoxin unavailable.

It was recognised from an early stage in this 'cluster' that if the intervention study using capsules proved effective, it would be necessary to introduce clay into the diet in a less obtrusive form. Again working with Ghana (OKS55 – Margaret Hinds) a number of 'traditional' peanut products have been reformulated to incorporate NovaSil clay (at 0.5-1.0%). This food/consumer science project has looked not only at practical considerations (e.g. grittiness) but storage parameters and ways of making these traditional products more attractive and acceptable to consumers in Ghana.

There are some notable features regarding this cluster of projects. Firstly, that the partnership and establishing collaboration in Ghana is outstanding. This has partly been achieved through early work on AUB30S (Curtis Jolly) where work on the ground in Ghana on consumer awareness of aflatoxins established rapport with local people. This building of confidence in the host country was re-enforced by the health studies (including workshops for health officials) carried out as part of UAB56 (Pauline Jolly). Secondly the co-ordination and collaboration between projects TAMU50, UAB56, OKS55, AUB30 is highly commendable especially bearing in mind the interdisciplinary nature of the work – chemists, toxicologists, health workers, economists and food scientists. Thirdly, the high potential for impact in heath terms must be emphasized. Notwithstanding, the controversial debate as to the relevance of aflatoxins with regard to HIV/AIDS, unquestionably reducing dietary exposure to aflatoxins in the developing world will have a significant health impact. Finally the fact that Peanut CRSP funding alone would have achieved only a fraction of what has been achieved so far must be acknowledged – considerable ingenuity in terms of getting samples analyzed and success in leverage of funding from elsewhere has been critical in the successes so far.

Other health aspects of peanut consumption

A mixture of food chemistry and food processing has been carried out in UGA01A (Dixon Phillips) again working with Ghana as the Host country. Work carried out has had a food safety thrust, in terms of examining whether decontamination can be achieved through chemical treatments (various nucleophiles) and through extrusion cooking. This work has also recently attempted to link into the project cluster (above) through looking at incorporation of clays in extrusion cooked peanut products. The weakness of excursion cooking based project is that it is a technology of developed countries and whilst it 'adds value' through processing, one wonders if the time is right for technology transfer to HOST COUNTRY or whether it is premature. The most interesting feature and probably more novel has been the attempt to produce hypoallergenic peanut butter, This has involved making peanut butter from extruded peanut flour and peanut oil, but whilst allergenicity was reduced, there was an adverse effect on sensory quality.

Work has been undertaken in PUR10U (Rick Mattes) studying the health effects of peanut consumption. Work to date has indicated that peanut oil does not hold stronger satiety properties than oil rich in monounsaturated or polyunsaturated fatty acids. While significant dietary compensation from peanuts was observed, daily energy and fat intake were significantly increased with addition of oils to the diet. No differences were observed in responses between countries (USA, Ghana and Brazil). On energy balance there were no significant differences in resting energy expenditure, thermogenenic effect of feeding or physical activity among participants ingesting peanut oil, olive oil, safflower oil or supplemental oil. Body weight increased significantly in all intervention groups but not the no-oil control group. Findings on the effects of peanut oil on plasma lipids are still being evaluated. Taken overall it is concluded that the strong effects of whole peanuts on appetite, energy levels and lipid levels are not replicated through ingestion of oil alone. This suggests that other fractions in the nuts are responsible and these need to be identified. This project is novel, could have a significant impact for the peanut industry in terms of heath benefits and has a good link with Brazil as the HOST COUNTRY.

Conclusions

Overall it can be concluded that a wide and exciting portfolio of projects have been funded with all showing some success and in some instances potential for having a high impact. For the future I would recommend more focus of resources through funding a smaller portfolio and would recommend terminating some projects not because they have been performing badly but simply based on a prioritising to achieve critical mass elsewhere. My recommendations would be as follows:-

- UW149F Funding at UW should <u>not</u> be continued as too academic, not strongly linked with a HOST COUNTRY and unlikely to provide practical outcomes in the foreseeable future. The successes at UG particularly in terms of the analytical screening method should be completed with method validation and wider dissemination. Low priority.

- UGA22A – Funding at UG should <u>not</u> be continued as will require significant further funding to achieve anything, no leverage of funding has been achieved and links with HOST COUNTRY are weak. Low priority.

- AUB30S – This project had a horizontal economics component and has been different in terms of activities undertaken. My recommendation is at the Yes/No interface for continued funding. Future funding of economics-projects should be more tightly focussed than has been the case to date. Medium/low priority.

- TAMU50 – Funding should be increased in this area which has a potential for high impact but must achieve a critical mass to be effective. This is strongly linked with the HOST COUNTRY (Ghana) with a strong track-record of collaboration. High priority.

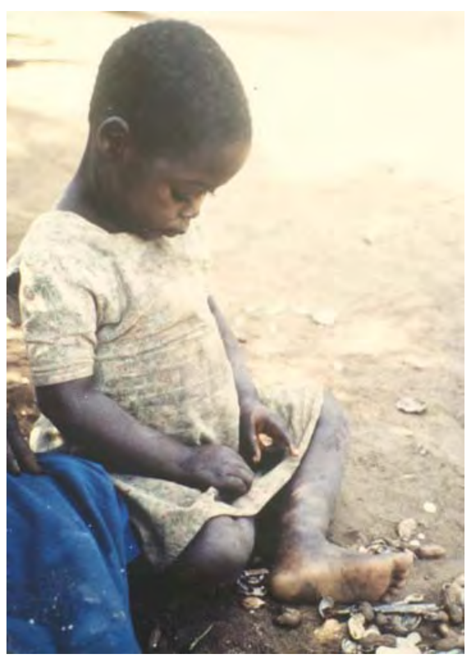
- UAB56 – Funding should be increased in terms of monitoring clinical parameters as this is inextricably linked to TAM50 and without monitoring for any changes it is impossible to show whether feeding clays has had any effect. High priority.

- OKS55 – Funding should be maintained but not increased for this food science project. Again it is linked to TAM50 and will be critically important in terms of exploitation. OKS55 needs to continue to operate in parallel to TAM50 and UAB56. Medium priority.

- UGA01A – Funding should be continued focussed exclusively on the allergenicity aspects of the work which may have maximum benefit in the USA and for the industry as a whole if a successful outcome is achieved. Medium/low priority.

- PUR10U – Funding should be continued. This work is novel and distinct from the other funded safety/health projects. There is potential for a high impact and good links with a HOST COUNTRY. High priority

Dr. Tim Phillips was awarded the BIFAD Chair's Award for Scientific Excellence for his discovery of aflatoxin binding food additives. He also was awarded the President Bush Award for Research Achievement at Texas A&M University.



Research in this area showed that human immunity is decreased by chronic exposure to aflatoxin. This and other research which showed nutritional impacts indicate that aflatoxin can modulate up to 44% of the burden of disease in developing countries.

1 Project Title and Investigators

UAB56: Aflatoxin impacts on immune systems

U.S. Principal Investigator	Dr. Pauline Jolly	University of Alabama, Birmingham, Alabama
H.C. Principal Investigator	Dr. William Otoo Ellis	Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Host Country: Ghana

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Analyze baseline demographic data, information on health history/status, and food consumption habits of study participants.	Continuing
Objective 2	Determine the level of AFM1 in urine and AF-albumin adducts in plasma of study participants.	Completed
Objective 3	Determine cellular immune function (percentages and function of CD4+ and CD8+ T lymphocytes, B lymphocytes, macrophages, and NK cells) of study participants and evaluate association with aflatoxin levels obtained in objective 2.	Continuing
Objective 4	Determine the titers of aflatoxin-specific antibody in plasma of study participants and examine the association with aflatoxin levels.	Pending
Objective 5	Determine liver function in relation to aflatoxin levels of study participants; conduct a hepatic function panel that includes levels of alanine transaminase (ALT), aspartate transaminase (AST), bilirubin, urea, alkaline phospahtase, albumin, and total protein in plasma.	Completed
Objective 6	Determine the relationship between aflatoxin level and infection with other immunosuppressive diseases such as malaria and HIV in study participants.	Continuing
Objective 7	Determine the relationship between aflatoxin levels, hepatitis B or C infection.	Continuing
Objective 8	Conduct vitamin A analysis on plasma samples collected in Ejura and correlate with aflatoxin levels, liver function, and immune status.	Continuing
Objective 9	Examine the relationship between AF levels, vitamin A and E levels, immune status and progression to AIDS in HIV-infected individuals.	Continuing
Objective 10	Determine the rates of malaria, hepatitis B, hepatitis C, and other infections in HIV positive individuals and examine the association between these infections, aflatoxin levels and HIV/AIDS progression.	Continuing
Objective 11	Determine the proportion of HIV-infected individuals who are co-infected with tuberculosis and examine the relationship between TB/HIV co-infection, aflatoxin levels and progression to AIDS.	Continuing

1.2 Budget:
The budget for 2004-2005 was $130,001.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches

The main objective of this project is to analyze baseline demographic data, information on health history/status, and food consumption habits of study participants. The main thrust in Ghana is to establish the extent of aflatoxicosis and to establish the relationship with immune system diseases. This project, which is essentially epidemiological, involves working with a well-defined volunteer group in Ghana (from 90-140 individuals) who are continuously exposed to aflatoxin through contaminated maize and peanuts in their diet.

Other activities include investigations into socio-economic aspects of groundnut production, and raising awareness to the risk of aflatoxicosis. It was established that there was a general ignorance about aflatoxin and three interactive workshops have been conducted to raise awareness.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Aflatoxin B_1 adducts levels in plasma and aflatoxin M_1 in urine have been determined. Additionally, vitamin A and E levels in plasma, hepatitis B, C and HIV status, as well as cellular immune functions and hepatic functions in a well-defined study Group in Ghana. Analysis has been carried out to look for correlations with not only the above clinical parameters but also examining some socio-economic factors.

The science being undertaken was determined as being of a high quality and from an epidemiological perspective is unique in the respect that previous work has focused only on correlating aflatoxin exposure with the incidence of liver cancer and hepatitis. This project is ambitiously looking at a much wider range of clinical, nutritional and socio-economic parameters. The proposition that reduced immune function through exposure to aflatoxin may be linked to susceptibility to HIV infection is new and whilst both difficult to prove and controversial, is nevertheless a significant hypothesis.

This is the first study that has addressed several critical health issues related to aflatoxin contamination in Ghana and elsewhere in the world. The trail blazing results are detailed below:

(1) This is 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. This study 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 high 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, 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 is 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 rates of both hepatitis B and C infections and of aflatoxin in this region is significant information

that will be useful in establishing the relationship between these infectious and toxic agents and development of liver cancer and other liver problems.

(4) This is 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 and 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.

3.2 Technical Outputs in United States

Technical outputs in the U.S. consisted of project planning and laboratory analysis of samples collected in Ghana.

3.3 United States Training and Capacity Development/Maintenance

Not applicable

3.4 Host Country Training and Capacity Development/Maintenance

It seems there is a general ignorance of affects of aflatoxin on human health and 3 interactive workshops have been conducted to raise awareness.

3.5 Technology Transfer (workshops, publications, patents)

Significant number of publications have been submitted to International Immunology and Environmental Health Perspectives.

4 Demonstrated/Potential Impacts

The potential impact of this work is great and has applicability beyond Ghana where the original studies were carried out. It also supports the work of Peanut CRSP in Ghana (TAM50) 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.

5 United States/Host Country Beneficiaries and Benefits

The results of this project would benefit many people in Ghana and elsewhere especially in Africa through a reduction in the suppression of the immune system in humans and improvement in overall health of developing country populations. Their application would have positive implications to health workers who are involved in this area in terms of providing with basic scientific information as basis for follow-up research work.

6 Building Partnerships

The links with Ghana (Nkwanta) and the work that has been carried out in establishing a volunteer network is impressive. Enormous goodwill has been established in Ghana and there appears to be good appreciation of local sensitivities and how best to achieve co-operation which is not easy when working with sampling of blood and urine. The well-characterized cohort in Ghana is a considerable asset and it makes good sense to use the same group for any future planned clay intervention work.

7 Constraints and Recommended Solutions

The project has relied on a range of funding sources and considerable goodwill of others to enable all the analysis to be undertaken in partnership with many groups including: (1) aflatoxin B_1 adduct levels in plasma have been measured at Texas Tech (not funded by Peanut CRSP), (2) aflatoxin M_1 in urine has been determined at Texas A&M (unclear whether funded), (3) Vitamin A and E levels in plasma have been determined by post-doctoral interns at the University of Alabama-Birmingham (UAB) Department of Biochemistry, and (4) hepatitis B, C, and HIV status, as well as cellular immune functions and hepatic functions have been determined at the Department of Medicine at UAB (treated as regular clinical samples to minimize costs). The Principal Investigator has to be commended for her effort in building these partnerships and using the Peanut CRSP funds as seed money to leverage additional funds to complete many of the analyses.

8 Lessons Learned

The extensive and costly sample analysis in the Host Country should be well planned for and resources identified early in the process. The strategy to build partnerships with other health workers in the U.S. to complete the analyses could be tried in Ghana and other developing countries where future similar studies could be carried out.

9 Next Steps and Future Directions

The progress to date in this project has only been achieved through managing to get much of the necessary analytical work undertaken by others through goodwill or by back-door mechanisms and leverage of funding from MIRT, and CaRES. The work is important but to extend to a much larger epidemiological study, to extend to children, to include breast milk and to monitor progress of any clay intervention work will require substantial funding.

10 General Observations

The management has been very successful bearing in mind the logistical difficulties in getting samples out of Ghana, dividing and distributing to different centers in the USA and collating and analyzing results.

11 Recommendations

It is recommended that this work be continued in the future but with enhanced funding from Peanut CRSP and donor partner(s) to ensure that sufficient resources are available to carry out the essential analysis of biological samples in the U.S. as well as in the host country, if this is feasible and cost-effective.

1 Project Title and Investigators

PUR10U: Effects of Peanut Consumption on Hunger, Ingestive Behaviour, Energy Expenditure, and Coronary Heart Disease Risk.

U.S. Principal Investigator	Dr. Richard Mattes	Purdue University, Indiana
H.C. Principal Investigator-Ghana.	Dr. Phoebe Lokko	Food Research Institute, Accra, Ghana
H.C. Principal Investigator-Brazil	Dr. Josephina Bressan	Federal University of Viscosa, Brazil

Host Country: Senegal

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Document the effects of peanut oil consumption on energy balance and blood lipid profiles.	Continuing
Objective 2	Document the effects of peanut oil consumption on hunger, food intake and total diet quality.	Continuing
Objective 3	Evaluate potential mechanisms that account for the less than predicted influence of peanut consumption on body weight.	Continuing
Objective 4	Explore the effects of peanut consumption as a snack versus meal component on hunger, satiety and daily food intake.	Continuing
Objective 5	Provide training in methods for human dietary behavior research.	Continuing

1.2 Budget:
The budget for 2004-2005 was $100,000.

This evaluation covers the period from 1 August 2001 to the present.
Seventeen million people worldwide die of cardiovascular disease (CVD) each year. Low and middle-income countries contribute 85% of CVD deaths. By 2010, CVD will be the leading cause of death in developing countries. There are over 300 million obese adults and 1.1 billion overweight people worldwide. In the U.S., obesity and CVD are among the leading causes of health problems and death. Hence, the scientific/technical importance of this project's objectives is very relevant economically, socially and environmentally.

2 Research Approaches

The overall aim of this project's objectives is 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.

Planned human subjects research was instituted via a single multi-center study in the U.S.A., Ghana, and Brazil. Studies included the effects of peanut oil consumption on hunger, food choice, energy balance and

CVD risk. Included were studies assessing the lipid profiles. Approval by the Human Subject Review Committees at each site was obtained. To ensure the data from all sites can be combined for the final analyses, it was essential that all participants be tested with the identical stimuli, or oil. Thus, the U.S.A. site sent the test oils to Brazil and Ghana. In addition, a study was initiated in the U.S.A. to explore the energetics of peanut product consumption. The objective is to better understand the less than predicted weight gain by peanut consumers. It was predicted that 20% of the energy from whole nuts was left in the stool.

A complementary effort was also completed in Brazil comparing lean and obese individuals on the same outcome variables. In the U.S.A., the scope of the work was expanded to explore selected physiological mechanisms that may underlie the effects of peanuts on the outcome variables. A clinical trial was carried out on the energy absorption efficiency from various peanut fractions including protein, fiber, minerals (zinc, magnesium, folic acid), and phytochemicals (resvertrol). A randomized feeding study evaluated fecal macronutrient loss when provided whole peanuts, peanut butter, peanut oil or peanut flour. And, the effects of peanuts ingested with a meal or as a snack on subjective hunger ratings and pleasure in healthy adults were examined.

At Purdue University, facilities are available to support the execution of human studies. The core services include study volunteer recruitment, volunteer screening, biological sample collection and processing, and managing the dietary unit. The dietary unit is primarily designed for planning, preparing and serving specialized controlled diets to free-living adults. Volunteers consume their meals (one to three times per day) in dining areas, following research guidelines. Specific areas and equipment include: conference room for information meetings and sensory testing; subject waiting room; physician exam and procedure room; diet interview rooms; phlebotomy room; biological processing room; body composition evaluation – dual energy X-ray absorptiometry, body pod, hydrodensitometry, bioelectrical impedance, and scales and stadiometers.

3. Outputs/Achievements

Recently, the Food and Drug Administration (FDA) approved a health claim for nuts, including peanuts. The FDA approved qualified health claim stated: "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 fat and cholesterol may reduce the risk of heart disease". The research work of this Peanut CRSP supported project PUR10, was among work reviewed by FDA in consideration of the claim. This claim is promoting increased peanut consumption by supporting recommendations to include peanuts in the diet and by increasing consumer demand, a major impact in support of the U.S.A. peanut industry, and worldwide.

It was noted that peanut consumption was associated with increased dietary intake of magnesium, vitamin E and folate, all of which may help to reduce CVD risk. Studies were added to conduct biochemical analyses to determine whether this was reflected in plasma levels of these nutrients plus homocysteine.

3.1 Technical Outputs in Host Country

Prior research suggested that approximately 17% of the energy from whole peanuts was lost in the stool. Substantial losses were also observed with peanut butter (7%) and peanut oil (4.5%). However, this was tested in only 10 individuals under extreme conditions when the peanut products constituted 95% of the participant's daily fat intake. This project suggested one mechanism by which peanuts may not contribute to positive energy balance is through poor absorption efficiency. The present trial further tested this hypothesis by measuring fecal fat levels following consumption of whole peanuts, peanut butter, peanut oil and peanut flour under more natural conditions. The research is still in progress.

Findings from the U.S.A. support a substantive loss with whole peanut ingestion and lesser losses with peanut butter, flour or oil. However, this is preliminary as the sample size from the U.S.A. alone is insufficient to draw sound conclusions. Data are expected from Ghana shortly and the trial will begin in Brazil soon. If the data from the U.S.A. hold, they will support the evidence that peanuts may be incorporated in the diet with little impact on body weight. This is an important observation since it has been shown by Purdue and others that peanut consumption is associated with reduced cardiovascular disease risk and a health claim has recently been approved by the U.S. Food and Drug Administration (FDA) recognizing this association (data obtained through CRSP support were used to support the claim). Thus, dietary recommendations are expected to shift and encourage inclusion of peanuts in the diet. No comments on the health effects of ingesting peanuts with meals or as snacks are possible at this time. All studies were conducted in the three countries and advances to date including pending or resulting impact are discussed in the next section. .

3.2 Technical Outputs in United States

Research in the past years has resulted in new insights on the health effects of peanut consumption. The findings have begun to be disseminated through presentations at professional meetings, interviews with the media, and publication of reports in peer-reviewed journals. With respect to the latter, four manuscripts have been generated in the past year. The principal findings reported in the first manuscript are that: (1) peanut oil does not hold stronger satiety properties than other oils rich in monounsaturated or polyunsaturated fatty acids; (2) while significant dietary compensation (45-50% of energy) was observed, daily energy and fat intake were significantly increased with addition of the oils to the diet; and (3) no differences in responses were observed between countries.

The principal findings reported in the manuscript on energy balance are that: (1) there were no significant differences in resting energy expenditure, thermogenenic effect of feeding or physical activity among participants ingesting peanut oil, olive oil, safflower oil, or no supplemental oil; (2) body weight increased significantly in all intervention groups, but not the no-oil control group; and (3) there were no significant differences across countries.

Findings on the effects of peanut oil on plasma lipids are undergoing further consideration. The comparison of appetitive responses to peanut oil consumption in lean and obese individuals did not reveal significant differences. Taken together, the findings suggest that the strong effects of whole peanuts on appetite, energy balance, and lipid levels were not replicated through ingestion of the oil alone. This suggests other fractions of the nuts are responsible for these effects. Likely candidates are the protein and fiber content as well as a number of minerals (e.g., zinc, magnesium, folic acid) and phytochemicals (e.g., resveratrol). The findings suggest that to realize the health benefits demonstrated in the Peanut CRSP earlier research and those by others, it may be necessary to consume whole nuts. Whether there is a difference if it is in the form of whole nuts or butter has not been evaluated, but warrants investigation.

In the U.S.A., 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. These observations are consistent with findings from whole peanuts and support 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 gain. Findings from the work in Ghana are being developed. 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 in responses were observed between countries.

A study examined the effects of chronic peanut oil consumption on appetite and food choice. Healthy adults (129) from the U.S.A., Ghana, and Brazil were randomly assigned to one of four treatments, consumption of peanut oil or safflower oil or no dietary test sample for eight weeks. They completed subjective appetite questionnaires on hunger, fullness, desire to eat and prospective consumption during all waking hours for selected time periods. No significant differences across countries were observed in appetite ratings or dietary compensation. These data suggest that components other than the lipid fraction in peanuts play a role in promoting satiety.

Moreover, other principal observations from the studies on energy balance relative to oil intake showed no significant differences in resting energy expenditure, thermogenic effect of feeding or physical activity among participants ingesting peanut, olive or safflower oil or no supplemental oil. Body weight increased significantly in all intervention groups, but not in the control group, and there were no significant differences across countries.

In another study, the effects of chronic peanut consumption on diet composition as well as serum lipids, 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.

The health benefits of peanuts and peanut products are growing more obvious with each experiment run by the team of nutrition scientists on project PUR10U. The data show the strong effects on whole peanuts on appetite, energy balance and lipid levels are not replicated via ingestion of just oil. Other nutrients may be responsible for these effects. In any case, peanut consumption promotes strong energy compensation, increased energy expenditure and upon further study results in fecal fat loss. Peanuts contributed 12% to fecal fat while peanut butter and peanut oil contributed 2.7% and 2.2%, respectively. Hence, eating peanuts is good for you because this may lead to energy balance (weight maintenance) via high satiety value, possibly increase in energy expenditure and an increase in fecal fat loss most likely due to the physical properties of the whole peanut, i.e., just the efficiency of chewing the peanuts while eating them will affect the level of nutrient absorption and affect the three factors noted above.

Chronic consumption of peanuts did not lead to a decline in pleasantness or hunger ratings for peanuts nor did it lead to any pleasure shifts for selected snack foods with other taste qualities. These data are supporting the evidence that peanuts may be incorporated in the diet with little impact on body weight. This is important since it has been shown that peanut consumption is associated with reduced CVD risk and the health chain has been approved by the U.S. FDA in recognition this association (note: data obtained through Peanut CRSP support were used for the claim). Thus, dietary recommendations are expected to shift and encourage inclusion of peanuts in the diet.

New studies supported by Peanut CRSP are comparing peanut consumption patterns, "with meals," specifically lunch, versus "as snacks," relative to optimal intake pattern(s) and energy balance. In the peanut meal treatment, hunger during the 2-hour post-lunch interval was suppressed. This research supports a role for peanuts in reducing subjective hunger ratings, and possibly reducing additional snacking during a common mid-afternoon eating time. This is another beneficial outcome of the Peanut CRSP research program. 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. A high consumption frequency of a common snack food (peanuts, in these studies) has been related to lower Body Mass Index (BMI) (obesity), i.e., including peanut snacks in the diet may reduce subjective ratings of hunger and in time reduce BMI.

3.3 United States Training and Capacity Development/Maintenance

In the U.S.A., four students have been supported by Peanut CRSP funds; three at the M.S. and one Ph.D. levels. Two M.S.-theses reports include : (1) Peanut Digestion and Energy Balance, C. Traoret, 2004 and (2) Effects of Peanut Oil on Appetite, Food Choice, Energy Balance and Cardiovascular Disease Risk Profiles, S.S. Iyer, 2003. Two dissertations are: (1) Effects of Chronic Peanut Consumption on Indices of Cardiovascular Disease Risk Energy Balance and Hedonics, C.M., Alper, 2001, and (2) Effects of Peanuts Ingested With a Meal or As a Snack on Subjective Hunger Ratings and Plasma Glucose in Healthy Adults, A.A. Devitt, 2005.

The graduate students and U.S. Principal Investigator continually make presentations of their research findings at scientific meetings and publish abstracts. A series of manuscripts are in various stages of publication in peer review nutrition journals. Funds from grants leverage the Peanut CRSP research program.

3.4 Host Country Training and Capacity Development/Maintenance

The U.S.A. Principal Investigator has worked closely with the host country Principal Investigator to set in place a research capability, including an infrastructure at the Food Research Institute, Accra, Ghana. Emphasis has been to develop the nutrition program at the Food Research Institute that includes building a core of students, local collaborations and equipped laboratory to allow the conduct of independent nutrition studies in Ghana. Subscriptions to key nutrition journals were set in place at the Institute as science resources or learning tools for the field of nutrition. The objective was to conduct similarly designed experiments at both the U.S.A. and Ghana institution.

The mentor of the graduate students in Ghana was trained in the past with Peanut CRSP support. The mentors of students in Brazil have been able to present the work at professional meetings raising visibility of their abilities and those of their university.

A third site, Vicosa University in Brazil, was added to the program and the experimental design was structured so that the same work was conducted as a single multi-center study. Brazil is particularly attractive for matched clinical studies as there is no established pattern of peanut consumption providing a good control group to complement matched studies in the U.S.A. and Ghana.

The first study was designed to explore the effects of peanut oil on appetite, food choice, energy balance and selected cardiovascular disease risk factors. Collaborative plans were set in place, graduate students identified, training of students in human subject research conducted and the pilot studies required to develop the testing materials and protocols undertaken and completed with the final procedures submitted and approved by the Human Subject Review Committees (IRB's) at each site. To ensure the data from all three sites could be combined for the final analyses, all participants were to receive the same test materials, peanut oils. Despite obtaining all recommended approvals and paying tariffs, the experimental oils were impounded by customs in both Ghana and Brazil (this occurred in 2002 and persisted nearly one year). Despite the delays, the test oils were delivered and experiments in all three countries were conducted. The data were brought together for analyses within and among countries and the results discussed in section 3.2 ((Technical in U.S.A.).

The training of clinical researchers is being accomplished. It is hoped that they will continue in the field of science furthering understanding of the health effects of peanut consumption and training additional scientists to support life science research more generally in the host countries. The work to date has provided the basis for three master's theses - one in Ghana and two in Brazil. Two additional students (one from each country) are involved with the clinical trials currently underway. All these students are female.

3.5 Technology Transfer (workshops, publications, patents)

During the past year, the U.S. FDA approved a health claim for nuts, including peanuts. The work at Purdue University, supported by the Peanut CRSP, was reviewed in consideration of the claim. It is anticipated that this claim will promote increased peanut consumption by supporting recommendations to include peanuts in the diet and by increasing consumer demand.

The work of PUR10 has attracted considerable professional, industry, and consumer attention that has vastly expanded the research efforts at other locations on peanuts and peanut products described in the project objectives. The U.S.A. 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, is being widely disseminated. It is translating into stronger consumer demand for peanuts and peanut products as nutritious and healthy foods.

Keys to these developments are that (1) Peanut consumption is associated with reduced CVD risk (lower total cholesterol, LDL-cholesterol and triglycerides); (2) Peanuts have a high satiety value (data is showing that including peanut snacks in the diet may reduce subjective hunger ratings, and possibly reduce additional snacking during the common mid-afternoon eating time); and peanut consumption, although associated with increased energy intake, is not associated with increased body weight.

A recent publication has attracted a lot of attention on Peanut Consumption Improves Indices of Cardiovascular Disease Risk in Healthy Adults, C.M. Alper, R.D. Mattes, Journal of the American College of Nutrition 22(2):133-141(2003). This project shows that peanut consumption lowers serum triacylglycerides, augments consumption of nutrients associated with reduced cardiovascular disease (CVD) and increases selected nutrients in the serum important to lowering CVD risk.

4 Demonstrated/Potential Impacts

The demonstrated impact of this research is major due to its 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". As a result of this health claim, and the continued groundbreaking discoveries made from each ongoing experiment in the PUR10 project, peanut consumption is growing because of consumer demand, a major impact to the U.S. peanut industry (>10% annual growth), the collaborative host countries, Ghana and Brazil, and for that matter worldwide.

5 United States/Host Country Beneficiaries and Benefits

An additional benefit is the strength of the U.S.A. Principal Investigator as a strong, accomplished educator for students at Purdue University, the Food Research Institute in Ghana, and Viscosa University in Brazil. He has helped the host country Principal Investigators of the collaborating research institutes become strong mentors of human nutrition students and guided development of nutrition curriculum and research laboratories, including the capacity to conduct human studies. Men and women farmers, processors, consumers, human, and research institutions are greatly benefiting from the PUR10 project.

6 Building Partnerships

The U.S.A. Principal Investigator's concept of addressing the objectives of the PUR10 project via single-multi-center studies, a team concept has resulted with the three partnering institutions, Purdue University in U.S.A, the Food Technology Institute in Ghana, and Viscosa University in Brazil. In these countries, close relationships have been developed with consumers who participate in the studies as Subjects and benefit from the learning experience about their personal health relative to diet and nutrition. In Accra, Ghana, researchers have developed a partnership between the Food Research Institute and the Noguchi Memorial Institute for Medical Research. The partnership is helping to understand the nutritional needs of populations in three parts of the world, North America, South America and West Africa. Much of the nutrition technology coming from these studies show our problems and ways to overcome them are similar, at least in these three parts of the world.

It is noted that the Purdue University Administrators are strong supporters of international programs. Peanut CRSP is a highly regarded program at the university, and the U.S.A. Principal Investigator (Dr. Richard Mattes), is highly regarded by his colleagues. He is a collaborating scientist on three CRSP programs (Peanut, Bean-Cowpea, and Sorghum-Millet). Dr. Mattes brings his nutrition expertise to these programs and a number of University Departments as he serves on key committees. Recently, he was instrumental in the development of a Nutragrain Bar made with bean paste fitting the sensory and nutritional needs of the peoples of Honduras, Central America.

7 Constraints and Recommended Solutions

There have been a number of logistical problems in Ghana and Brazil such as getting equipment and samples into both countries. Materials going into Brazil have been delayed for 11 months at the customs and particularly in Brazil there are complicated and bureaucratic procedures that seem to involve excessive paperwork. These problems have slowed progress.

8 Lessons Learned

A unique feature of this Peanut CRSP project (PUR10) is that the U.S.A. Principal Investigator. has structured the research work as a single multi-center project including the U.S.A., Ghana, and Brazil. The objectives are set up to conduct similarly designed experiments at the three sites. The U.S.A. Principal Investigator trains researchers at all sites in nutrition research, experimental design, and analyses of data. This way, all three experimental sites benefit. The result is that the Ghana host country Principal Investigator is in a graduate program for a Ph.D. Moreover, the U.S.A. Principal Investigator is active as a nutrition educator for the Bean-Cowpea CRSP and Sorghum and Millet CRSP. This is expanding nutrition studies throughout CRSP programs, which is very important.

9 Next Steps and Future Directions

This project is unique in being quite different and discrete from other projects in the food safety/food science Peanut CRSP cluster, which is dominated by food safety goal of controlling or reducing exposure to aflatoxins. In contrast, the focus in this project is on nutritional aspects related to peanuts and satiety, which arguably has a stronger level of interest in the U.S.A. than in developing countries. But the training and transfer of scientific skills and knowledge in the nutrition field has much wider relevance. The research being undertaken is very novel and has potential for promotion of peanut consumption as a healthy food, hence had great potential impact. This is a sound project area and the translation of the outcomes for practical benefit is obvious and shows potential impact.

10 General Observations

Purdue University seemed to be a model in terms of financial management and dealing with host countries. Handling of all international work through the International Programs office in the College of Agriculture is a sensible and effective approach. The Principal Investigators have minimal involvement in handling budgets and finance and auditing of invoices from overseas institutes is dealt with efficiently and highly effectively. Purdue is exemplary with respect to providing very effective management support leaving the Principal Investigators free for research and other responsibilities.

Purdue has 4,000 international students (1,000 from India) out of a total of 38,000 students (85% from Indiana) and manages projects from five CRSP programs through the same office. Edie Doland in the International Programs Office has first-hand experience of working in developing countries and this awareness of problems/issues was very apparent. The level of support to the Principal Investigators assisting them in budget preparation and transferring funds to the host countries extends also to visa handling and providing general advice and assistance.

11 Recommendations

Continuation of the research on satiety and nutritional effects of peanut consumption is strongly recommended. PUR10 should be transferred to the Post-Harvest and Marketing Research Cluster. This cluster of projects focuses on utilization research of peanuts and peanut products as major sources of value-added foods for small-, medium-, and large-scale businesses. Quality and nutrition relative to human health responses to peanut and peanut products in the diet are closely related. The nutrition of new foods has relevancies, regionally and globally, especially in living a healthy life style and where protein-deficient diets exist especially in weanling children.

Peanuts in a market in Indonesia – throughout the developing world peanuts sold in local markets are contaminated with aflatoxin. This constitutes the highest priority for this industry.

1 Project Title and Investigators

UGA22A: Systems Research to Assess Risk of Preharvest Aflatoxin Contamination and to Develop Technologies to Reduce Aflatoxin Contamination of Peanut

U.S. Principal Investigator	Dr. Gerrit Hoogenboom	University of Georgia
H.C. Principal Investigator	Dr. Bamory Diarra	*Institut Economie Rurale*, Food Technology Laboratory, Bamako, Mali
H.C. Principal Investigator	Dr. Bonaventure Ahohuendo	*Université Nationale du Benin*

Host Country: Benin and Mali

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Improve model of peanut-A. *flavus*/aflatoxin responses to environmental conditions under field conditions.	Continuing
Objective 2	Map risk of aflatoxin contamination in response to sowing date, cultivar duration, and environment.	Continuing
Objective 3	Identify and test technologies that reduce risk of aflatoxin contamination while increasing crop yields.	Continuing
Objective 4	Develop model of peanut-A. *flavus*/aflatoxin evolution during storage in response to temperature and humidity.	Continuing
Objective 5	Apply model of aflatoxin contamination in storage to develop maps that identify zones with high risk of contamination and to identify and test storage technologies that may reduce risk of aflatoxin contamination.	Continuing
Objective 8	Linkage of remotely sensed data and aflatoxin risk models to develop an aflatoxin risk early warning system	Continuing

1.2 Budget:

The budget for 2004-2005 was $40,000.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

This project was redirected in Phase 2. The project aims to develop early warning systems for determining aflatoxin risk, based on remote sensing and ground observations. The shift 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. A post-doctoral fellow (partially paid from the Peanut CRSP and also from U.S.D.A.) is working on the project at the University of Georgia, but achievements to date have been very limited.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

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 is 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 relations 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 am aflatoxin risk early warning system

3.2 Technical Outputs in United States

There was no evidence of progress in the U.S., but an early warning system for aflatoxin contamination has great applicability to the U.S.

3.3 United States Training and Capacity Development/Maintenance

Presently, a post-doctoral student is working on the project, partially funded by U.S. Department of Agriculture (USDA).

3.4 Host Country Training and Capacity Development/Maintenance

A graduate student from Thailand (Janjira Puntare) started her Ph.D. program in 2001 and completed it in 2004. A post-doctoral fellow from Bangladesh (M. Murshidhul Hogue) was at the University of Georgia for a year in 2001-2002.

3.5 Technology Transfer (workshops, publications, patents)

Since 2001, there has been one journal article and seven presentations at conferences resulting in published abstracts.

4 Demonstrated/Potential Impacts

Pre-and post-harvest aflatoxin contamination of peanuts continues to be a major problem, both in the USA as well as in developing countries. Although U.S. farmers are equipped to clean their peanuts, a warning system that can provide specific details with respect to the risk of aflatoxin contamination for certain environmental (e.g., weather, soil, etc.) and management conditions would allow for preventive action prior to harvest, such as separating high- and low-risk peanuts. Developing countries, in most cases, are unable to remove aflatoxin-contaminated peanuts due to lack of resources and skills. Being able to provide them with a warning system that would allow for identifying regions that have the potential for pre-harvest aflatoxin contamination would allow local governments to take preventive actions.

5 United States/Host Country Beneficiaries and Benefits

Peanut farmers in the US and Africa could benefit from the development of an early warning system for aflatoxin development in the crop.

6 Building Partnerships

Collaboration has been with Mali and Benin but has not been very fruitful due to very poor communication and an apparent lack of commitment in Benin. A training workshop on computer modeling of yield, pests and diseases in crops was held at Griffin, Georgia and another is planned in 2006. A workshop was held in 2003 in Florida that facilitated interactions between modelers from Australia, India and UK. Host countries did not participate in these workshops.

The development of decision support systems is a key component of the Principal Investigators' research program. Leveraging has been somewhat limited due to the change in project leadership. Limited funding has also been received through the NASA Space Grant Consortium for the last three years. A recent proposal submitted to the Southern Peanut Research Initiative might also provide some limited resources in collaboration with Auburn University

7 Constraints and Recommended Solutions

Communications with Benin have been very difficult. Sometimes for several months there has been no contact, and the Principal Investigator in Benin has been sick since July. Transfer of funds from the University of Georgia to the host countries has been slow and difficult and Principal Investigator is made personally liable for the funds. The aspect of handling overseas payments should be improved. It seemed that payment based on actual expenditure was not working well and payment based on results would be better. More could be achieved if there was better interaction with other CRSP programs and with a more strategic approach across the region with respect to peanut growing countries.

The operation of UGA22 has been somewhat of a struggle due to recent changes in leadership. In 2002, the University of Georgia did not review the contract of the original U.S. Program Investigator (Dr. Keith Ingram). The Co-Principal Investigator of the project (Dr. Gerrit Hoogenboom) was then assigned the responsibility of the project and the account was transferred from the Department of Crop and Soil Sciences to the Department of Biological and Agricultural Engineering. There were some accounting problems due to errors with the calculation of indirect costs and overspending.

The collaborating scientists in Mali and Benin were not informed of the transition and continued their activities as planned. The new Principal Investigator (Dr. Gerrit Hoogenboom), was not aware of any obligations due to lack of communication within this project. On top of that the leadership of the Peanut-CRSP decided to discontinue funding of the project. In addition, it was decided to change the direction of the activities towards the development of an early warning system for aflatoxin risk. This has required a significant change in activities at the University of Georgia with elimination of all experimental data collection and an emphasis on computer-based analysis of remote sensing data and modeling. The focus of the activities in West Africa will also be redirected, although communications with the collaborating scientists, especially in Benin, have been very difficult.

8 Lessons Learned

The day-to-day management of the project seems to have been satisfactory, but handling of finances to host countries could be improved with better University of Georgia support.

9 Next Steps and Future Directions

Scientifically this is an area that is attractive and could, if brought to fruition, offer practical assistance to minimizing pre-harvest aflatoxin levels in peanuts. There is no doubting the scientific competence of the Principal Investigator and his ability to make a success of this demanding area. However, the change in the Principal Investigator, change of direction scientifically, and poor interactions with host countries have all hampered progress in this project. The funding from Peanut CRSP has been limited and there is not much evidence that there has been leverage to gain further funds from other sources. Significant effort over the next 5-10 years will be required to achieve success in this demanding field. The project will also need to find a motivated collaborating scientist in Benin to meet the Peanut CRSP requirements.

10 General Observations

This project suffered when there was a change of Program Investigator from Dr. Keith Ingram to Dr. Gerrit Hoogenboom. It appeared to take some time to inform host countries of the changes in the U.S., and there appeared to be outstanding financial commitments which took time to resolve. There has also been a major change in direction of the project so progress has been slow.

11 Recommendations

In view of all of these problems summarized in 9 and 10 above and the fact that this project is still really in its infancy, and if a decision were taken to focus on a smaller number of projects, then it is recommended that UGA22A should be discontinued.

Empty beds in a children's' nutrition rehabilitation ward at Ejura, Ghana.

1 Project Title and Investigators

UWI49F: Genetic Approaches to Eliminate Aflatoxin Contamination of Peanuts.

U.S. CO-Principal Investigators	Dr. Nancy Keller	University of Wisconsin, Madison, Wisconsin
	Dr. David Wilson	University of Georgia, Coastal Plain Experiment Station, Georgia
H.C. Principal Investigators	Dr. A Siame	University of Botswana
	Dr. Binesh Somai	Department of Biochemistry and Microbiology, University of Port Elizabeth

Host Country: Botswana

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Develop and improve chemical and immunochemical methods of aflatoxin measurement.	Continuing
Objective 2	Define the physiology of aflatoxin biosynthesis at the molecular, biological, and chemical levels, and to apply the principal findings to interactions between *A. flavus* and peanut.	Continuing
Objective 3	Evaluate storage of peanut in Botswana and develop new and improved storage systems in Botswana and the U.S. to control insect and microbial deterioration.	Continuing
Objective 4	Evaluate promising fungal, drought and insect resistant peanut germplasm in the field under drought conditions in Botswana.	Continuing
Objective 5	Provide training for Botswana students and technical personnel by assisting with student research projects and to provide training for students and technical personnel in the U.S.	Continuing

1.2 Budget:

The budget for 2004-2005 was $120,000.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches

This project falls into two discrete parts at the University of Georgia (Dr. David Wilson, CO-Principal Investigator) and at the University of Wisconsin (Dr. Nancy Keller, CO-Principal Investigator). These parts are to be considered separately as follows:

(1) Concerning the work undertaken at the University of Georgia, there is unquestionably a need in developing countries for low-cost robust methods of analysis for aflatoxins. There are

requirements both to screen out highly contaminated peanuts to remove from the food chain and in some cases to screen for purposes of export. Existing commercial affinity column based semi-quantitative screening methods work extremely well but are very expensive due to the high prices of imported affinity columns. Using the VICAM system of clean-up on an affinity column then brominating and measuring fluorescence in a small fluorimeter, the aim has been to replace the affinity column with a low cost alumina-based column which can be made from locally available 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 does need validation and it is recommended that this should be carried out with a major involvement of developing countries.

This part of the project overlaps with the work of TAM50 (Tim Phillips) that is examining the use of Novosil clays for aflatoxin clean-up columns. It is recommended that the work in UWI49 by Dr. Wilson is pursued to completion but funding the experiments at Texas A&M University should is discontinued as this work is not complementary. The work carried out in UWI49 has advanced the furthest to date.

The project at the University of Georgia has also worked on introducing a silica-based material (Protect-It) for use during storage of peanuts to reduce insect damage. 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.

(2) Concerning the part of the project undertaken at the University of Wisconsin, the Principal Investigator is working at molecular level examining the genes controlling aflatoxin synthesis and the symbiotic relationship between the fungus and the peanut plant. The project has examined factors that influence the switch-on of genes for aflatoxin production and the extent which plant/fungal interactions can be controlled. Key genes in the peanut responsible for the release of oxylipins has been identified and the role of fatty acids in these interactions are being investigated. The results of the project are helping to build a clearer picture of the complex biosynthetic pathways involved in aflatoxin production, and the interaction that occur between fungus and plant. The work ultimately could help direct construction of bioengineered plants resistant to fungal attack or not triggering aflatoxin biosynthesis or development of novel fungicides. There is no question that the work being carried out is cutting-edge science of a high quality that places it at the forefront of aflatoxin research.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

The achievements in Georgia and Botswana can be briefly summarized as follows: (1) Joao Augusto, a graduate student at University of Georgia, developed a simple screening method for determining aflatoxin contamination in peanut and corn, and (2) Sejakhosi Mohale, a graduate student at the University of Botswana, showed that there is variation in the degree of resistance to pre-harvest aflatoxin contamination in the different peanut varieties tested in Botswana. Local peanut varieties appeared to be the least susceptible to aflatoxin contamination in the field when compared to the core collection and breeding lines. Dr. Knonga, at the Botswana College of Agriculture, carried out most of the work. *Tribolium confusum* was found to be the most predominant insect attacking stored groundnuts in Botswana. Losses due to *T. confusum* and the transfer of *A. flavus* spores in groundnuts during storage can be minimized by the application of diatomaceous earth (Protect-It). This part of the work was carried out at the University of Botswana and supervised by Dr. Siame and Dr. Allotey. These collaborating scientists have benefited from these studies and have gained skills in this area.

3.2 Technical Outputs in United States

Insight into aflatoxin regulation has been made by findings 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 production. The psi factor genes have been cloned in *Aspergillus nidulans*, called ppoA, ppoB and ppoC (for psi producing oxygenases). These products are similar in structure to 13 and 9 HPODE seed molecules and support the hypothesis that the peanut seed releases oxylipins important for fungal development. These genes (ppoA, ppoB and ppoC) are involved in metabolizing fatty acids into oxygenated fatty acids. The genes required for production of fatty acids in Aspergillus have been found: odeA (published) that produce linoleic acid and sdeA and sdeB (submitted) which produce oleic acid.

3.3 United States Training and Capacity Development/Maintenance

A Ph.D. degree student (Dimitrios Tsitsigiannis) was partially funded by Peanut CRSP to work on ppo and lox genes in *Aspergillus* and peanut respectively. Dr. Richard Wilson in Keller Laboratory was partially funded by Peanut CRSP to work on genes (odeA and sdeA) encoding enzymes that produce the fatty acids that are the precursors to psi factor.

3.4 Host Country Training and Capacity Development/Maintenance

A successful partnership has developed between the University of Georgia and Botswana and in 2004 an M.S. degree student from Botswana worked on storage and insect damage to peanuts. Training has been provided for a student from Mozambique, and two graduate students from Malawi and Lesotho. There have been a number of successful workshops and training courses carried out at the University of Botswana.

Two graduate students (Yuan Jin and David Pinero) completed their M.S. degrees from the University of Wisconsin with support from USAID. A post-doctoral fellow (Dr. Richard Wilson) was partially funded by USAID. Dr. Wilson worked on the mechanism by which 23 and 19 HPODE affect sporulation and aflatoxin/sterigmatocystin production in Aspergillili.

The University of Wisconsin part of this project previously lacked a host country involvement and thus the contrived arrangement with University of Georgia which was established to provide Botswana as a common host country thus fulfilling USAID requirements. Links have recently been established with University of Durban. Dr. Bonesh Somai from Durban has spend two months at the University of Wisconsin and he is both academically qualified and motivated so it is possible this might provide a fruitful link with a host country.

Dr. Benesh Somai is now participating in the Peanut CRSP project. He has moved to the Department of Biochemistry and Microbiology at the University of Port Elizabeth and visited the Keller Laboratory in late 2003/early 2004 to get some training. Dr. Somai is collaborating with the Keller Laboratory on the importance of the pacC transcription factor for aflatoxin biosynthesis in *Aspergillus flavus*.

3.5 Technology Transfer (workshops, publications, patents)

Publications released during the review period.

McDonald T, Devi T, Shimizu K, Sim S-C, Keller NP 2004 Signaling events connecting mycotoxin biosynthesis and sporulation in Aspergillus and Fusarium spp.: New Horizon of Mycotoxicology for Assuring Food Safety, Proceedings of the International Symposium of Mycotoxicology (Editor: Takumi Yoshizawa):
Wilson R A, Chang P.-K., Dobrzyn A., Ntambi J. A., Zarnowski R., Keller N.P. 2004 Two ï „9-stearic acid desaturases are required for Aspergillus nidulans growth and development.: Fung Genet Biol :
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MOHALE, SEJAKHOSI 2004 Preharvest Aspergillus invasion and aflatoxin contamination of groundnut and control of Tribolium confusum by diatomaceous earth in stored groundnuts.: PDF fileof M.Sc. Thesis :
Mohale, Sejakhosi 2004 Preharvest Aspergillus invasion and aflatoxin contamination of groundnut and control of Tribolium confusum by diatomaceous earth in stored groundnuts.: University of Botswana, MSc Thesis :
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Wilson, David M., Wellington Mubatanhema, Zeljko Jurjevic 2002 Biology and ecology of mycotoxigenic Aspergillus species as related to economic and health concerns: Advances in Experimental Medicine and Biology:
Buntin, G. David, R. Dewey Lee, David M. Wilson, Robert M. McPherson 2001 Evaluation of YieldGard transgenic resistance for control of fall armyworm and corn earworm (Lepidoptera: Noctuidae) on corn: Florida Entomologist:
Augusto, Joao, Mamadou Coulibaly, David M. Wilson, Corley Holbrook, Neil W. Widstrom 2004 Screening method for determination of aflatoxins in peanut and corn: AOAC International Annual

Meeting, September 19-23, 2004, St. Louis, Missouri:

Jurjevic, Z., M. Tertuliano, G.C. Rains, D.M. Wilson, C.C. Holbrook, W.J. Lewis 2004 A comparison of volatile metabolites produced by aflatoxin-tolerant and aflatoxin-susceptible peanut plants: Phytopathology:

Jurjevic, Z., D.M. Wilson, J.P. Wilson, M. Coulibaly 2004 Fungi and mycotoxins associated with pearl millet from 1996 to 2002: Phytopathology:

Timper, Patricia, David M. Wilson, K. Hirano, C. Corley Holbrook 2003 Root-knot nematodes and preharvest aflatoxin contamination in peanut: Proceedings of the 3rd Fungal Genomics, 4th Fumonisin, and 16th Aflatoxin Elimination Workshops, October 13-15, 2003, Savannah, Georgia, USA:

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Wilson, J.P., C.C. Holbrook, L. Wells, B. Mandal, D. Rowland, D.M. Wilson 2004 Effect of foliar application of particle films on drought stress and aflatoxin contamination of peanut: Mycopathologia:

Holbrook, C. Corley, Baozhu Guo, David M. Wilson, C.K. Kvien, Weibo Dong, Diane L. Rowland, Meng Luo 2004 Selection of peanut breeding lines with resistance to preharvest aflatoxin contamination and improved drought tolerance: Mycopathologia:

Wilson, David M., Joao Augusto, Corley Holbrook, Neil Widstrom 2004 Using cyclodextrins in a rapid inexpensive aflatoxin screening method for field research applications: Mycopathologia:

Rains, Glen C., W. Joe Lewis, and David M. Wilson 2004 Trained wasps as chemical detectors : application for aflatoxin related issues: Mycopathologia:

Holbrook, C. Corley, Dave M. Wilson, Marshall Lamb, C.K. Kvien, Baozhu Guo, K.T. Ingram, K.T., and Diane L. Rowland 2002 Development of peanut germplasm with enhanced resistance to preharvest aflatoxin contamination: Mycopathologia:

Ingram, Keith, Corley Holbrook, Arthur Weissinger, Dave Wilson 2002 Using green fluorescent protein producing strains of Aspergillus flavus to assess aflatoxin resistance of peanut under drought: Mycopathologia:

Wilson, D.M. 2002 The need for uniform standards, methods and reporting of data from biocontrol studies using atoxigenic Aspergillus flavus and A. parasiticus: Mycopathologia:

Mubatanhema, W., Z. Jurjevic, D.M. Wilson, N.W. Widstrom, F. Meredith, B. Evans 2002 Fumonisins and aflatoxins in preharvest corn in south Georgia: a five year survey: Mycopathologia:

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Mphande, Fingani A., Bupe A. Siame, and Joanne E. Taylor 2004 Fungi, aflatoxins, and cyclopiazonic acid associated with peanut retailing in Botswana: Journal of Food Protection:

Zulu, Chipo N. 2003 Morphological and biochemical distinction among toxigenic Aspergillus flavus group: University of Botswana, undergraduate report:

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Pinero D, and Keller, NP 2002 pH signaling in Aspergillus: a role in sporulation and mycotoxin production.: Phytopathology:

4 Demonstrated/Potential Impacts

The work on new lost-cost screening for aflatoxins needs formal validation by testing in other laboratories and it is recommended that this be carried out with a major involvement of developing countries. This part of the project overlaps with the work of Dr. Tim Phillips (TAM50) who is examining the use of clays for aflatoxin clean-up columns and it is recommended that this is not pursued further as it is competitive. The work carried out in UW149 has advanced the furthest to date.

5 United States/Host Country Beneficiaries and Benefits

Aflatoxin contamination is a world wide problem. Genetic blockage of the ability of peanut to produce aflatoxin for use in cultivar improvement would be a significant contribution to consumers in both the US and HC's. Rapid tests for aflatoxin would assist monitoring agencies and researchers. Farmers would benefit from management practices to lower aflatoxin levels and enhance farmgate prices for peanuts.

6 Building Partnerships

The partnership between two U.S. universities (University of Wisconsin and the University Georgia) in one project has not worked well and should not be repeated.

The U.S. Principal Investigators have also collaborated with Dr. Peggy Ozais-Aikens at the University of Georgia-Tifton, who is transforming peanut with a soybean lipoxygenase gene (lox 1) which produces soly 13-HPODE (a putative inhibitor of aflatoxin). In related collaboration with Dr. D.V.R. Reddy from the International Center for Research in Semi-Arid Tropics (ICRISAT), the project has cloned several peanut seed lipoxygenases, some of which produce 9-HPODE (a putative inducer of aflatoxin).

7 Constraints and Recommended Solutions

The Principal Investigator at the University of Wisconsin, due to personal reasons, is not likely in the near future to travel to beneficiary countries or even travel away overnight. This is likely to be a significant problem in establishing effective links in host countries.

8 Lessons Learned

This project was unusual in being a fairly "unhappy marriage" between the University of Georgia as a sub-contractor to the University of Wisconsin. This was facilitated largely to ensure the University of Wisconsin component of the project fulfilled the CRSP requirements to work with beneficiary countries. Objectives 1, 3 and 5, being implemented by the University of Georgia does not scientifically make a cohesive package with the objectives being delivered by the University of Wisconsin. Management of funds from USAID to UW then to UGA and finally to host countries has not worked smoothly partly because of the added complication of one University being a sub-contractor to another and partly because UW do not have good management systems in place for handling finances and rely on the Principal Investigator, who does not regard this as a priority.

9 Next Steps and Future Directions

The next steps for this project need to consider the work at the University of Georgia separately from the work at the University of Wisconsin, as follows:

(1) The part of UWI49 undertaken at the University of Georgia has been successful in focusing on practical matters (robust low-cost testing and improved storage) and has been noteworthy in the extent of training and networking undertaken in Botswana. The low-cost testing method for aflatoxin needs validation and widespread promotion to be more widely accepted, it needs participation of other countries besides Botswana (Botswana imports most peanuts from South Africa). There seems little need for continuation of this part of UWI49 particularly with the retirement of Dr. Wilson who has been the main driving force although it is important that the validation work is undertaken.

(2) For the part of UWI49 undertaken at the University of Wisconsin, it comprised the most academic R&D (as opposed to be applied R&D) being a quest for knowledge rather than having any short-term practical exploitation. The project is academically prestigious and is cutting edge science that furthers the understanding of fungal/plant interactions and triggering of aflatoxin production. The linkage with University of Georgia is no longer needed and it is recommended that it is discontinued especially as the work in Botswana will be completed soon. The linkage with a host country is tenuous at present but the partnership with South Africa has the potential to be strengthened, although it is highly dependent on a particular individual post-doctoral fellow. The Principal Investigator is unwilling to travel and although continuation of this project area (as part of a balanced portfolio of projects) is recommended it is conditional on the Principal Investigator's having support at Wisconsin who can travel to the host country.

10 General Observations

This project is unusual in that the work falls into two discrete parts with no obvious connections, one part carried out by the University of Georgina with strong focus on Botswana and the main part is managed by the Principal Investigator at the University of Wisconsin. The work at University of Georgia is sub-contracted by the Principal Investigator and the work in Botswana is linked with the University of Georgia. This arrangement is difficult and does not work effectively exacerbated by lack of financial management support at the University of Wisconsin. Neither party wants this arrangement to continue.

The day-to-day management of the University of Georgia seems to have operated well, and the problems that have arisen have been caused by the need to work through the University of Wisconsin.

Dr. David Wilson does not like the Peanut CRSP mode of working entirely with a web site. While he recognized the rationale to reduce management costs, he felt that it might be a false economy. For example there was a lack of a printed Annual Report and no mechanism to give visitors a glossy hand-out showing what has been accomplished in the project.

11 Recommendations

There seems little need for continuation of the University of Georgia part of UWI49, particularly with the retirement of Dr. Wilson who has been the main driving force. Although it is important that the validation work on the rapid method for aflatoxin analysis is undertaken.

The Principal Investigator is unwilling to travel and although continuation of this part of the project (as part of a balanced portfolio of projects) is recommended, it is conditional on the Project Investigator being supported at Wisconsin by someone who can travel to the host country.

Insect damage can be a precursor to aflatoxin contamination.

1 Project Title and Investigators

TAM50: Sustainable Enterosorbent Strategies for the Protection of African Populations from Aflatoxin

U.S. Principal Investigator	Dr. Tim Phillips	Texas A&M University, -----------, Texas
H.C. Principal Investigator------	Dr. Jia-Sheng Wang	Institution of Environmental and Human Health
H.C. Principal Investigator-----	Dr. David Ofori-Adjei	Noguchi Memorial Institute for Health Research, Ghana

Host Country: Ghana

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Phase 1: Characterize and compare the sorption of aflatoxins (and aflatoxin analogs) onto the surfaces of diverse NS clays (in aqueous solution). Determine the indices of chemisorption, ligand specificity, affinity, capacity, enthalpy, and Gibbs free energy of adsorption from equilibrium analysis.	Continuing
Objective 2	Phase 2: Screen clays that possess the highest capacity, affinity, and enthalpy for the sorption of aflatoxins for toxicity and efficacy using rapid, aflatoxin-sensitive, in vitro bioassays. Test the least toxic and most acceptable clays (based on biological and chemical analysis) for safety and efficacy in pregnant Sprague-Dawley rats and their offspring. Compare findings with results from Phase 1 to verify the experimental paradigm and to select the most effective and least toxic clays human trials.	Continuing
Objective 3	Phase 3: Conduct short-term human trials in Ghana to establish the feasibility of clay addition to the diet of humans who are exposed to high levels of aflatoxin. Molecular dosimetry biomarkers for aflatoxin will be used to predict exposure and the consequences of dietary inclusions of NS clay. If successful, further research to develop delivery mechanisms and extending this practice in long-term studies would be justified.	Continuing

1.2 Budget:
The budget for 2004-2005 was $220,000

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

This project is one of the most exciting being undertaken anywhere in terms of making an impact in human health through the use of clays and, thereby, potentially reducing aflatoxin exposure. The science has been very professionally executed to exacting standards in terms of the characterization of the NovaSil clay (NS), understanding its mechanism of aflatoxin binding, and carrying out animal studies to establish safety. The science that has been undertaken is of the highest standard and the project is relatively low risk in that there is a high probability of a successful outcome for humans based on the already established use in animal feed.

The main problems to be overcome are presentational in terms of getting the use of clays accepted in this application (and associated public relations and communication issues), and ensuring an effective delivery mechanism. This project forms an effective cluster with OKS55 and UAB56, although both of these projects are supporting TAM50 and there are dependences between the three projects.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

The project initially had to focus on research in the United States to prove the safety of Novosil (NS) clays before being tested on humans in the host country (Ghana). The focus of research will be in Ghana for the remaining period of the project. The final plans for the Ghana phase of the project were made during the review meeting and the plans for this research are well designed, anticipating potential difficulties.

3.2 Technical Outputs in United States

Two key studies for establishing the safety for use of NS clay before being tested on humans in the host country were conducted.

The first study was undertaken to evaluate the potential toxicity of long-term (chronic and sub-chronic) dietary exposure to NS clay using 5-6 week old Sprague-Dawley rats (64 males and 66 females). The animals were fed rations containing up to 2.0% (w/w) levels of NS for 28 weeks. Feeding, body weight, and organ weight parameters were all evaluated. Necropsy and histopathological evaluations were conducted on 30 animals (3 rats/sex/group) at day 90, while the remaining 100 animals (10 rats/sex/group) were examined at day 196. Organs/tissues including liver, kidneys, lungs, heart, brain, spleen, tibia, skin, sections of the GI tract, uteri and ovaries were all observed for any anatomic abnormalities and used for subsequent histopathological evaluation. In addition, whole blood samples were analyzed to determine potential changes in the hematological parameters, red and white blood cell counts and morphology between NS-fed rats in comparison to the controls. Serum biochemistry, concentrations of serum and hepatic vitamins A and E, and levels of serum Fe and Zn of the treated animals were all quantified and compared to those of the controls. Statistical analysis of the results has been completed and the manuscript is in preparation for publication.

This study demonstrated that the NS clay has no adverse effects. Lifetime exposure was harmless using the rat model fed NS at five times the normal rates needed for aflatoxin protection. Results of these studies support the use of NS clay dietary interventions for human populations at high risk for aflatoxicosis. This information increased the feasibility of evaluating the safety of NS clay in short-term human trials.

The second study was undertaken to test humans for responses to exposure to NS clay without the exposure to aflatoxin. The information gained from this study, coupled with the chronic and sub-chronic toxicity studies in rats will serve as the basis for use of NS clay in long-term human intervention trials in populations at high risk for aflatoxicosis in Ghana. A randomized and double-blinded phase I clinical trial was conducted to determine the safety and tolerance of NS clay in humans and establish dosimetry protocols for long-term efficacy studies. Volunteers (20 - 45 yr in age), were clinically screened for confirmation of their health status. Fifty subjects (23 males and 27 females) were randomly divided into two groups: the low-dose group received six capsules containing 1.5 g/day, and the high-dose group received 6 capsules containing 3.0 g/day for a period of two weeks. NS clay capsules were distributed to each participant three times a day at designated sites. Blood and urine samples were collected before and after the study for laboratory analysis. Each participant completed the trial and compliance was 99.1%. All laboratory analyses, including hematology, minerals, vitamins A and E, and concentrations of selected electrolytes have been completed. Clinical and sub-clinical analyses, before and after NS clay exposure, have also been evaluated. The study examined in great detail the consequences of exposure to NS clay and found no evidence of increased risk. Thus the project can move on to the next phase which is to gain further data on human safety, and to test efficacy of NS clay in naturally exposed people in Ghana.

3.3 United States Training and Capacity Development/Maintenance

The U.S. Principal Investigator continues to gain experience and recognition in this important field of endeavor.

3.4 Host Country Training and Capacity Development/Maintenance

Evans Afriyie-Gyawu, a Ph.D. graduate student from Ghana, is working on the project with USAID funding. The project is reliant on host country participation for the intervention study and excellent relations have already been established through UAB56. This partnership will be built upon in future work.

3.5 Technology Transfer (workshops, publications, patents)

Technology transfer/acceptance issues are being anticipated through the support that this project is providing to OKS55 where the consequences of adding NS clay to foods prone to aflatoxin contamination are being evaluated. The studies of NS clay safety are also in preparation for transfer to humans since this technology is already accepted in the animal feeding industry.

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4 Demonstrated/Potential Impacts

The potential impacts of this project are enormous. Being able to economically assure that food in developing countries has a low risk of exposing people to aflatoxin will have significant health benefits.

5 United States/Host Country Beneficiaries and Benefits

The U.S. and host country benefits from this project are not yet realized but the potential is very high.

6 Building Partnerships

There is strong collaboration is with the Noguchi Memorial Institute for Medical Research, Ghana and the Ghana University, to built on in future work.

7 Constraints and Recommended Solutions

The problems identified in other projects of transfer of funds to Africa and the need to pay up-front means that Principal Investigators have to provide funding from other accounts before recovering from USAID. The relative low level of Peanut CRSP funding has meant that expensive toxicological studies and other activities are reliant on leverage of other funds, e.g., National Institute of Health (NIH) funding.

8 Lessons Learned

Research that involves clinical studies and laboratory analyses is expensive and requires leveraging of funds from several sources to finance the full set of experiments needed to complete the work.

9 Next Steps and Future Directions

In scientific terms, this was the most exciting project of those reviewed with the potential for maximum impact on human health and yet is relatively low risk in that the proof of principle is already established. Substantial funding will be required if the initial (pilot) study is successful and the project moves to a large scale intervention and begins to tackle the practical issues such as local availability of suitable clays and the most effective delivery mechanisms.

Publicity resulting from a success of this project could be enormous and brings tremendous credit to the Peanut CRSP if handled effectively. It is recommended that resources are concentrated to enable greater funding into this area for the future program as funds leveraged from other sources cannot be relied upon.

Somewhat peripheral work has been carried out on the use of clays in aflatoxin clean-up in laboratory analysis. This work overlaps with work undertaken in UW149 that has probably progressed further. Validation and exploitation of the method developed in UW149 is required and it would be wasteful to pursue two competitive methods. It is recommended that no further funding is provided for the use of Novosil clay for analytical columns and future enhanced funding should concentrate on the human intervention work.

10 General Observations

The project has been very effectively managed and flexible ways have been found to carry out the activities (e.g, analyze aflatoxin M_1 in urine samples for UAB56 without funding) just to keep the project moving.

11 Recommendations

This project area should be continued in the future because of its high scientific merit, the potential impact on human health world-wide. It is recommended that resources are concentrated to enable greater funding into this area for the future program as funds leveraged from other sources is not sustainable.

1 Project Title and Investigators

AUB30S: Production Efficiency and Market Development of Peanuts and Peanut Products for Ghana, Benin, and Bulgaria

U.S. Principal Investigators	Dr. Curtis Jolly (PI)	Auburn University, Auburn, Alabama
	Dr. Pauline Jolly (Co-PI)	University of Alabama at Birmingham, Alabama
H.C. Principal Investigator-Ghana	Dr. Richard Awuah	Kwame Nkrumah University of Science and Technology, Ghana
H.C. Principal Investigator-Bulgaria	Dr. Nelly Bencheva	Agricultural University, Plovdiv, Bulgaria
H.C. Principal Investigator-Bulgaria	Dr. Stanko Delikostadinov	Institute of Introduction and Plant Genetic Resources, Sadovo, Bulgaria
H.C. Principal Investigator-Benin	Dr. Emmanuel Prophete	*Cenre de Recherche de Documentation Agricole* (CRDA), Benin

Host Countries: Benin, Bulgaria (the economic component of NMX53) and Ghana

1.1 Project Objectives

Objective	Goals	Status
Objective 1	Evaluate the degree of awareness of the health risks of producers, market participants, and consumers of aflatoxin on humans and animals and behavioral changes in groundnut production, marketing and consumption practices employed to minimize these risks.	Completed
Objective 2	Examine the extent and financial impact of groundnut aflatoxin contamination by areas and by levels of production and consumption.	Continuing
Objective 3	Evaluate the economic effects of adoption of improved, indigenous, groundnut, storage-technologies on producers, market participants and consumers of groundnuts.	Continuing
Objective 4	Conduct a cost/benefit analysis of the adoption of new technologies, designed to reduce aflatoxin contamination in groundnut storage, in animals and humans, and in market products.	Continuing
Objective 5	Evaluate the impact of aflatoxin groundnut contamination reduction on the agricultural economies of Ghana and Benin	Continuing
Objective 6	Training of participants in appropriate techniques	Pending

1.2 Budget:
The budget for 2004-2005 was $115,000.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

Although the project is multi-faceted only two areas were described in depth during an EEP member's visit to Auburn:

(1) The questionnaire approach to establishing the extent of awareness of aflatoxin among producers, market participants, processors, consumers, and administrators involved in the peanut sector in Ghana and Benin. It was designed to assess the level of behavioral change as reflected by improved storage practices, modified consumption habits and marketing practices and examine the impact on peanut production and marketing. Although the statistical treatment of the data obtained on awareness was sophisticated, the questions themselves were simplistic and there was no evidence that adequate controls typical for this type of polling had been used. That awareness of aflatoxin was low was unsurprising, and although the three workshops held in Ghana were probably helpful in building trust (and thereby assisting other Peanut CRSP projects) the effort in itself seems to be of doubtful justification.

(2) A comparison was being undertaken of peanut production in two trial plots using different harvesting techniques and also use of a clove-based product as an insect and anti-fungal agent during storage. Although data has been collected on a number of parameters including presence of fungi, plot yields of peanuts and moisture content, the key determination of aflatoxin levels in the samples had not been carried out at the time of the visit (December 2004). No economic data analysis was presented and the impression was given that this was awaiting the aflatoxin results. It was not clear if a provision for the not insubstantial costs of the analytical work had been made using the Peanut CRSP budget nor indeed who would be doing the analysis.

Work in Bulgaria on economic and financial analysis of growing peanuts post-breakdown of collective farms had evidently been carried out in this project but the results were not presented. The project set out to establish the costs and returns to producing peanuts in the key peanut growing region of Plovdiv. The Principal Investigators in Bulgaria were to conduct a field survey of 456 producers, establish the production function, and determine the impact of changing factors of production (capital investments, fertilizers, pesticides, seeds, technology and labor) on yield per acre, and overall production in the region. Additional information on this project was obtained in a site visit to Bulgaria.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Dr. Nelly Bencheva has undertaken an economic analysis of peanut production in Bulgaria. The economic analysis, based on a questionnaire approach sent to farmers and through one-to-one interviews, has collected a lot of information (e.g., yields of peanut varieties being cultivated, size of cultivated areas, age distribution of farmers, etc). While some conclusions were self-evident, a more detailed analysis was going to be undertaken when new statistical tools were provided (including training) from collaboration with the U.S. Principal Investigator (Dr. Curtis Jolly).

The EEP member was very impressed with the amount of information that had been rigorously collected and this economic analysis will be essential in terms of feeding into development of the Business Plan (intended 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 in very small farms mainly for 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 '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 effectively '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.

3.2 Technical Outputs in United States

No technical benefits were foreseen for the U.S.

3.3 United States Training and Capacity Development/Maintenance

Drs. Jolly and Ligeon have acquired new knowledge concerning peanut production in Bulgaria, accumulated useful resource documents on production practices, gained increased understanding of farming systems practices through the visit to the host country, and held extensive discussions with Bulgarian scientists and other key individuals in the country.

3.4 Host Country Training and Capacity Development/Maintenance

Drs. N. Bencheva and S.G. Delikostadinov (from Bulgaria) visited Auburn University and received practical training in data collection, preparation, and analysis. The host country principal investigators also visited peanut growing areas in Alabama and received 10 days training on data coding and interpreting results. They also benefited from the training provided by Drs. Jolly and Ligeon during their visit to Bulgaria.

When the recently purchased software package for economic analyses is installed, it will enhance the capabilities of the Bulgarian Principal Investigators in economic analyses.

3.5 Technology Transfer (workshops, publications, patents)

Knowledge and skills of methods used in conducting economic analysis was gained through the use of the new software and interactive exchange visits to Alabama and Bulgaria by the Principal Investigators. Plans for preparing joint publications were developed. The Principal Investigators jointly arrived at the realization that analytical tools necessary for this project would have to be rebuilt based on assumptions appropriate for a non-centrally controlled economy. Also, assumptions relative to farm unit size and managerial capabilities of the new farm owners would need to be retooled. Hence, technology transfer and technology transformation would result from the Peanut CRSP endeavor.

4 Demonstrated/Potential Impacts

There has been an increase in the understanding of the importance of peanut production in Bulgaria and of the potential market constraints introduced when aflatoxin contamination is prevalent (in Benin, Bulgaria, and Ghana). The U.S. and host country Principal Investigators have jointly established the importance of conducting market studies at the country level and in the context of regional trade within the European Union. Bulgaria is now establishing goals for becoming the premier producer and exporter of quality peanuts within the European Union and possibly elsewhere.

5 United States/Host Country Beneficiaries and Benefits

The project has been working in Benin, Ghana, and Bulgaria where collaboration has been successful. The linkages with this work and UAB56 are strong and efforts from both projects to develop rapport with local researchers in Ghana have been notably successful. There were three workshops in Ghana involving large numbers of people (about 300 in each case) that followed up on the apparent lack of awareness among professionals of the health problem associated with aflatoxin. These workshops have been successful in developing rapport at a local level, and while the direct benefit to AUB30S is not obviously apparent, there is no doubt that this activity has facilitated work in UAB56 and will be vital if TAM50 is to be successfully undertaken in terms of intervention studies.

Producers, consumers, and processors (male and female) will have increased knowledge of the prevalence and health impact 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 stages, along the custody 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 local and export 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.

6 Building Partnerships

Host country (Benin, Bulgaria, and Ghana) and U.S. scientists have formed useful partnerships which will lead to developing appropriate tools for conducting market analysis, impact assessments, and documenting behavioral changes producers, consumers, and market participants. The partnerships should also lead to increased understanding of the potential dangers of aflatoxin and ways to reduce health risks. The partnerships should also lead to the development and flow of scientific and marketing information relevant to the U.S. and the host country policy makers.

7 Constraints and Recommended Solutions

The processing of food samples, peanut products, and other samples for aflatoxin analysis has been slow due to the lack of agreement on who will do the chemical analysis and a lack of clarification as to who will pay for this. It seems that the economic analysis of plot trial data has, therefore, been constrained by the pending analysis of aflatoxin in other samples. There is a lack of capacity for conducting laboratory analyses of food samples and other samples in the host country facilities; hence, all analysis is done in the U.S.

8 Lessons Learned

The transfer of analytical tools and concepts from the U.S. (a competitive market-driven economy in terms markets and production units) to Bulgaria (a recently decentralized economy) is not a simple process. Assumptions underlying the production processes must be retooled and expectations regarding coefficients of production must be adjusted, and indeed the basic input/output and product cost and return budget formulas must be developed for the Bulgarian situation (reflecting conditions in an open and atomistically competitive economy).

9 Next Steps and Future Directions

In Ghana and Benin,, the analysis of samples for aflatoxin should be moved off dead center and the level of awareness of health risks should be established. Forward steps should be taken to establish the linkage between aflatoxin and the possible abatement of the HIV Aids pandemic, as a basis for opening the flow of health funding toward agro./health (CRSP) research and outreach.

In Bulgaria, the framework, theoretical basis, and tools (computer software package) for farm level analysis and market analysis should be put in place. The U.S. and host country Principal Investigators should utilize the strong partnership to guide the development and transformation of these analytical tools and approaches appropriate for Bulgaria and those techniques deemed applicable for a non-centrally controlled economy. These would prove to be valuable models and analytical tools not only for Bulgaria, but also for other countries of the Eastern European region. This outcome would be valuable as projections and conjectures are made relative to expanded export/import marketing opportunities. They would also be essential to efforts to conduct economic impact analyses.

10 General Observations

There were no issues raised regarding management or transfer of funds to beneficiary countries, and from the discussion with the administrators it was evident that there was good support provided to the Principal Investigators.

Partnerships between the host country and U.S. Principal Investigators will be an important part of the foundation for future Peanut CRSP efforts in Africa and Bulgaria. Economic analysis of potential market income and health gains should guide the scope and levels of all other research initiatives pertaining to peanuts.

11 Recommendations

Accelerate analytical work on aflatoxin to complete during the last year the work underway to establish the awareness of health risks in Ghana and Benin. In Bulgaria, complete the installation and training on the economic analysis software, and use the strong partnership to guide the development of information related to the conversion of the economy for centralized to free market.

1. Project Name and Participants

UGA01A: Extrusion Cooking of Peanut Meal in the Presence of Lysine to Deactivate Aflatoxin and Improve Nutritional Quality.

US PI	R. Phillips	University of Georgia, Dept. of Food Science
Co-PI	Samuel Sefa-Dedeh	University of Ghana
Co-PI	Larry Beuchat	University of Georgia,
Co-PI	Esther Sakyi-Dawson	University of Ghana, Dept of Food Science

Host Countries: Ghana

1.1 Objectives

Objective	Objectives	Status
Objective 1	To develop technologies for reducing aflatoxin contamination of peanut meal by extrusion in presence of sodium calcium aluminosilicates (HSCAS) clays, food-grade nucleophiles, and other agents. To investigate use of electrolyzed (EO) water for removing aflatoxin from intact peanut kernels.	Active
Objective 2	To determine the effect of extrusion of peanut meals, singly and in combination with other food ingredients on allergenic potential of peanut proteins.	Active
Objective 3	To develop peanut-based food products with improved toxicological and allergenic safety.	Active
Objective 4	To investigate the presence of bioactive peptide sequences in peanut protein by simulated gastric-intestinal (pepsin-pancreatin) and alkalase digestion.	Active

1.2 Budget:
The budget for 2004-2005 was $60,000

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

Notwithstanding the project title (which is quite focused) this is in fact a multi-faceted project examining detoxification during extrusion cooking incorporating clays and other agents, and examining ways of inactivating the allergenic potential of peanut proteins. Progress has been made on all fronts but the objectives in three areas are ambitious and will be difficult to meet them all with the limited resources. The apparent protection of aflatoxin by lysine when co-extruded rather than destruction was unexpected, and binding from clay during extrusion was less than in solution. The more interesting findings have been in relation to bioactive proteins in peanut meal and attempts to prepare hypoallergenic peanut butter from extruded peanut flour.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

The emphasis on extrusion cooking may not be very relevant in Ghana nor is allergenicty a developing country problem - the technical focus is more towards U.S. interests than of the host country.

3.3 Technical Outputs in United States

Most work is being undertaken in the U.S. with the links being provision of training in the Food Science Department at the University of Georgia. Dr. F.K. Saalia is conducting aflatoxin research at the university with the U.S. Project Investigator (Dr. Phillips). There is potential for creating desirable foods with reduced aflatoxin content and reduced potential for allergenicity such as "hypo-allergenic peanut butter" made from extruded peanut flour and peanut oil. Although the texture and color were not too different from the control, the sensory quality was not acceptable due to "overcooking". Another product that has been extensively tested is peanut extruded puffed snacks from blend of rice (up to 50%) and defatted peanut flour.

The major focus of this project has been the destruction of aflatoxin in contaminated peanut meal by extrusion in the presence of either food-grade nucleophiles or HSCAS. This approach was chosen because of the unique high temperature, high shear environment created by extrusion and the present state of knowledge of aflatoxin chemistry. These efforts have been moderately successful, although results have been complex and difficult to interpret. As expected, processing at elevated pH enhances destruction, but lysine seems to actually protect the toxin. Further, proteolysis released toxin bound to protein, reducing the apparent efficacy of this approach. Co-extrusion with clay reduced toxin content by about 60% in contrast to complete binding from solution.

Thus far only in vitro studies on reduction of peanut allergy by extrusion have been possible. Based on the results, the ability of peanut protein to bind to soluble IgE following extrusion is drastically reduced, even when most of the protein is solubilized by SDS. This implies reduced allergenicity. However, only clinical tests can confirm this, and attempts to acquire additional funding have not been successful.

Peanut butter with similar physical characteristics to the control could be made from extruded peanut flour and oil. However, sensory quality was not good due to overcooking in the extruder. This remains a promising method for making reduced allergy peanut products if optimal combinations of processing can be identified. In related work, extruded snack products containing significant levels of peanut flour have been developed and extensively evaluated.

Proteolysis of peanut flour protein generates peptides that inhibit angiotensin-converting enzyme (a controller of blood pressure). Three promising groups of peptides have been identified and are being characterized. Peanut protein hydrolysates also have antibacterial activity against *listeria* and *E. coli*.

3.3 United States Training and Capacity Development/Maintenance

Three graduate students completed their degrees (2 with Ph.D. and 1 with M.S.), with research on physico-chemical characteristics of fortified peanut spreads, reduction of allergenicity by extrusion, and sensory characteristics of puffed snacks.

3.4 Host Country Training and Capacity Development/Maintenance

Two researchers from Ghana completed their advanced degrees at UGA: (1) Firibu Saalia completed Ph.D. in 2001 and is currently doing post-doctoral fellowship, and (2) Enyonam Quist completed M.S. in 2005 and is continuing his Ph.D. program at Michigan State University. The involvement for host country has to date only included the training component at UGA/Griffin.

3.5 Technology Transfer (workshops, publications, patents)

Technology transfer will be difficult as extrusion cooking will not be a developing country priority.

Publications:

- 4 thesis and dissertations (2001-2002)
- 4 journal articles (2002-2004)
- 7 manuscripts in review
- 18 abstracts and presentations

Chen, L.: 2001 Reduction of Peanut Allergenicity by Extrusion Cooking
PhD Dissertation, UGA [Publication type: THESIS]

Chen, L., Phillips, R.D., Nordlee, J.A., Taylor, S.L., Hefle, S.L., and Doyle, M.P.: 2001 Reduction of peanut allergens by extrusion cooking.
Abstracts, 11th World Congress of Food Science and Technology, Seoul, Korea [Publication type: ABSTRACT.]

Choi, I. and Phillips, R.D.: 2001 Physical properties of peanut based extrudate snacks Abstracts, 11th World Congress of Food Science and Technology, Seoul, Korea [Publication type: ABSTRACT, ABSTRACT]

Choi, I.-D, Phillips, R.D., Jeong, H.-S.: 2004 Cellular structure of peanut-based extruded snack products using scanning electron microscopy J. Text. Stud. 35: 353-370. [Publication type: JOURNAL]

Choi, I.-D.: 2002 Development, Physical, and Sensory Characteristics of Extruded, Indirectly Puffed Peanut-Based Snack Products.
PhD Dissertation, UGA [Publication type: THESIS]

Choi, I.D., Resurreccion, A.V.A. and Phillips, R.D. : 2002 Optimization of sensory characteristics and consumer acceptability for peanut-based extruded snack products using response surface methodology. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K.: 2001 Degradation of Aflatoxins in Peanut Meal by Extrusion Cooking in the Presence of Nucleophiles PhD Dissertation, UGA [Publication type: THESIS]

Saalia, F.K. and Phillips, R.D.: 2001 Optimization of extrusion conditions to degrade aflatoxins in peanut meal. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D.: 2001 Degradation of aflatoxins in the presence of nucleophiles.
Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D. : 2002 Reduction of aflatoxins in contaminated corn by extrusion cooking Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D.: 2002 Examining the influence of screw paddles on the severity of extrusion of corn meal Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D. : 2002 Reduction of aflatoxins in contaminated corn by extrusion cooking Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K., and Phillips, R.D.: 2000 Decontamination of aflatoxins in peanut meal by extrusion cooking in the presence of nucleophiles and starch Technical Program, Annual Meeting, IFT [Publication type: ABSTRACT]

Yeh, J.Y. Phillips, R.D., and Hung, Y.-C. : 2001 Physical stability and textural attributes of nutritional modified peanut spreads. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Yeh, J.-Y., Phillips, R.D., and Hung, Y.-C. : 2003 Optimizing protein-and vitamin-fortified peanut spreads containing soybean or milk powder. J. Food Qual. 26: 243-256 [Publication type: JOURNAL]

Yeh, J.-Y., Phillips, R.D., Resurreccion, A.V.A., and Hung, Y.-C. : 2002 Physicochemical and sensory characteristic changes in fortified peanut spreads after 3 months of storage at different temperatures. J. Agric. Food Chem 50: 2377-2384.[Publication type: JOURNAL]

Yeh, J-Y., Phillips, R.D., and Hung, Y.-H: 2002 Overall acceptability and sensory profiles of peanut spreads fortified with protein, vitamins, and minerals. J. Food Sci. 67(5): 1979-1985 [Publication type: JOURNAL]

Duplicate
Yeh, Y.-Y.: 2001 Effect of Storage Temperature on Physicochemical and Sensory Characteristics of Fortified Peanut Spreads MS Thesis, UGA [Publication type: THESIS]

Quist, E.E. 2005. Peanut (Arachis hypogaea) as a source of antihypertensive and antimicrobial peptides MS Thesis, UGA [Publication type: THESIS]
Quist, E.E., Saalia, F.D., and Phillips, R.D. 2005. Angiotensin converting enzyme inhibitory activity of proteolytic peanut digests. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Quist, E.E., Phillips, R.D., and Chen, J. 2005. Antimicrobial activity of proteolytic peanut hydrolysates against Escherichia coli O157:H7 and Listeria Monocytogenes. Book of Abstracts, Annual IFT Meeting. [Publication type: ABSTRACT]

4. Demonstrated/Potential Impacts

There is considerable interest in peanut allergens and development of non-allergenic peanut butter may have significant impact as will a better understanding of the proteins involved in allergenicity.

5. United States/Host Country Beneficiaries and Benefits

The purpose of this project is to discover mechanisms by which peanut can be transformed into safer, more nutritious, and more desirable foods, and to investigate specific non-nutritional effects of peanut protein. Achieving these goals will increase demand for peanuts and peanut-based foods in the U.S. and other countries, including developing countries, and will assure that those foods will make a positive contribution to health.

6. Building Partnerships

UGA has worked with some U.S. research laboratories to carry out complementary studies: (1) toxicology study with the USDA Russell Laboratory in Athens (Dr. Ken Voss), and (2) breakdown products study with USDA, Tifton (Dr. Tom Potter).

Other related peanut projects were funded by the Georgia FoodPAC Program, the Georgia Peanut Commission, and the Southeastern Peanut Research Initiative.

These partnerships in the U.S. have enabled a broader range of related research to be conducted on peanut-based snacks and peanut allergy.

7. Constraints and Recommended Solutions

There have been some Visa problems for Dr Saalia who has had to return to Ghana but will be able to return to Griffin at the end of the project. There appeared also to have been problems over submitting work for publication where referees have requested either supporting analytical data (on degradation products) or supporting toxicological studies. The supporting analytical data and toxicological studies were not foreseen. Arrangements to address some of these problems were made through collaborative research.

Most recently, the necessity for Dr. F.K. Saalia to return to Ghana when his visa expired has seriously impeded progress. His expertise in aflatoxin chemistry, analysis, and the processing techniques able to destroy the toxin cannot be replaced quickly. Fortunately, it appears that he will be able to return to the US on another J-1 visa to the end of the project.

The refractory nature of aflatoxin in foods is also a challenge. While great care must be taken to prevent accidental loss of the toxin during analysis, it is very difficult to destroy >95% of the toxin by processing. Likewise, difficulties in moving from in vitro studies to allergy clinical trials for extruded peanut protein mean that there is more work to be done.

8. Lessons Learned

Working with excellent young scholars from the host country has been an ongoing source of gratification by U.S. Project Investigators. They have shown an excellent degree of preparation and diligence in the pursuit of their training and research goals. But they have to be encouraged to return to their host country research institution to ensure that their expertise could be utilized to strengthen the host country's peanut research program.

There have been problems over submitting work on detoxification for publication where referees have requested either supporting analytical data (on degradation products) or supporting toxicological studies neither of which were foreseen. This work is expensive to undertake.

9. Next Steps and Future Directions

Detoxification of aflatoxin in peanut meal *per se* is unlikely to be acceptable other than a beneficial consequence of a processing operation undertaken for other technological reasons. Extrusion cooking while of interest in terms of new peanut based products for the U.S. market has the disadvantage for developing countries that investment would need to be made in processing plant.

The incorporation of clays into the diet in Ghana would thus need not only to overcome the additional hurdle of marketing a new food product. To some extent the work on extrusion of clay with peanut meal duplicates project OKS55, but the later has the advantage of working with local foods rather than introducing new technology.

10. General Observations

The project has adequately managed although the U.S. Project Investigator was pleading for additional administrative support to handle financial matters.

11. Recommendations

The work on allergenicity is novel and tackles a significant U.S. and developed country problem and should be continued. The work on extrusion cooking, other detoxification techniques and incorporation of clays into extrusion cooked products adds little to other work on clays and it is recommended the limited resources would be better focused on allergenicity.

Peanuts are versatile ingredients in many cuisines.

1. Project Title and Investigators

UGA04U: Development of Peanut Post-harvest Handling and Processing Technologies for the Food Industry

This project is one of the most prolific projects in the Peanut CRSP portfolio. An impact study carried out in collaboration with NCSU Investigators (NCS07) and host country collaborating institutions, showed significant benefits to consumers of Vitamin A-fortified peanut butter and safe aflatoxin-free peanut-based products. Industry innovators that were originally involved in processing these products increased their share of the local and export markets (to U.S.). The UGA Principal Investigator is commended for developing the successful Industry Incubator Model for technology transfer involving the private food industry and other key stakeholders. This model could be used, with appropriate modifications, in other countries.

U.S. Principal Investigator	Dr. Anna Resurreccion	University of Georgia, Griffin, Georgia
Co-PI	Dr. Manjeet Chinnan	University of Georgia, Griffin, Georgia
Co-PI	Dr. Larry Beuchat	University of Georgia, Griffin, Georgia
HC Principal Investigator	Dr. Alicia Lustre	Food Development Center/National Food Authority, Manila, Philippines
Co-PI	Dr. Flor Galvez and Prof. Leonora Francisco	University of the Philippines at Diliman, Quezon City, Philippines
Co-PI	Dr. Lutgarda Palomar and Prof. Lucy Palomar (2003)	Leyte State University, Baybay, Leyte, Philippines

Host Country: Philippines

1.1 Project Objectives and Budget

Phase 2 Objectives	Objectives	% Completed
1	Identify new market opportunities for peanuts and peanut products in the Philippines.	75
2	Conduct research on peanuts and peanut products to understand physical, chemical, nutritional, functional and sensory properties.	80
3	Develop processing technologies for fortified peanut products for Philippine markets.	90
4	Transfer to the Philippine food industry post-harvest, processing and packaging technologies.	75
5	Enhance research capabilities of Philippine collaborators/partners in the government and private sector.	90
6	Conduct regional and national workshops and training on peanut processing and utilization in Thailand (moved to UGA37).	

1.2 Annual Budget: In 2003-2004, the budget for this project was US$105,000, of which US$18,678 (18%) was transferred to the Philippine partner institution (FDC/NFA). Considerable leveraging of funds occurred within UGA beyond the 25% counterpart funding required. Other sources of funds included: The Georgia Peanut Commission, the Peanut Foundation, the Southeast Peanut Commission, etc. The Philippine collaborating institutions also provided funding on a cost-sharing arrangement. Representatives of private food companies who participated in seminars and workshops paid their own cost.

The Budget for this project In 2004-2005 was $105,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches

A nationwide survey was carried out in the Philippines in 2001, participated by 387 households, to determine Filipino consumers' preferences for peanuts and peanut-based products.

UGA04 partnered with the Philippine Food Industries and Grass-roots business organizations to develop and optimize new/improved peanut-based products considering preferences of Filipino consumers: Natural and stabilized (new for Philippines) peanut butter, Vitamin A-fortified peanut butter (new), chocolate peanut spread (new), Peanut-based sauces such as "satay" sauce, "kare-kare" sauce, and curry sauce (improved and aflatoxin-free), Peanut praline (improved), choco-peanut bar (improved), garlic-flavored roasted peanuts (improved), and peanut polvoron (new). Optimized new/improved peanut-based products were also developed considering preferences of U.S. consumers, including cracker-coated peanuts (new with 7-layered coatings), chocolate peanut spread (new), and roasted peanuts (improved).

The project standardized the processing and packaging of these peanut-based products appropriate for the medium-scale food industry and micro-, small- and medium-scale enterprises, farmers' cooperatives and grassroots village business organization in the Philippines.

In the U.S., a method for post-harvest induction of resveratrol synthesis in peanut kernels (new, patent by May 2005) and the processing technology for production of Resveratrol Enhanced Peanuts (REP) and Peanut Butters containing REP, were developed.

Before the peanut products were introduced, the Investigators conducted systematic and extensive research on peanuts and peanut products to test and understand the physical, chemical, nutritional, functional, and sensory properties, using different techniques, sometimes developing improved techniques.

3. Outputs/Achievements

3.1 Technical Outputs in Host Country

The 2001 survey on consumers' preferences in the Philippines showed that peanut butter was the best-liked product; 66% of the families preferred stabilized peanut butter; and over 90% of respondents were willing to pay more (about PhP1) 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 (new) peanut butter, (2) Vitamin A-fortified peanut butter (commercialized), (3) chocolate peanut spread (to be commercialized); (4) peanut based sauces such as "satay" sauce, "kare-kare" sauce, and "satay" sauce, (5) peanut praline (commercialized), (6) chocolate peanut bar (commercial 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 were standardized with assistance from the U.S. Project 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.

A successful effort was carried out to transfer to the Philippine food industry and to Cooperatives and Grassroots Business Organizations (micro-and small-scale enterprises) the improved post-harvest processing and packaging technologies. This included the Peanut CRSP developed manual sorting technology that significantly reduced aflatoxin content of peanut-based products. The Philippine food industry groups, including factory workers and managers, have been trained on the application of the technology. An EEP member visited the manufacturing facilities of the partner food companies to discuss with the managers their experiences in collaborating with Peanut CRSP, which they indicated as very positive.

3.2 Technical Outputs in the United States

Five new/improved peanut-based products were developed; and some are being considered for commercial production 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,(4) chocolate peanut spread, and- (5) roasted peanuts.

A peanut product (chocolate peanut spread) was introduced in the U.S. from the Peanut CRSP work in Philippines and tested with private food company. A corresponding product was developed and optimized considering the preferences of American consumers. A consumer Home-use test on two flavored cracker coated peanuts was conducted to determine their effect on quality and taste.

3.3 United States Training and Capacity Development/Maintenance

There had been a significant contribution of the project to U.S. capacity building on peanut research, as follows:

1. An M.S. graduate student at UGA, Glencia Walker (American, woman), completed research on cracker-coated peanuts;
2. An M.S. graduate student at UGA, Christine Chu (American, woman), completed research on chocolate peanut spread;
3. An M.S. graduate student at UGA, Jamie Rudolf (American, woman), completed research on resveratrol enhanced peanut;
4. Four Post-doctoral Associates completed their work in Georgia or collaborated with UGA scientists. Dr. Nelson Grosso (Argentinian, man), Dr. Kayanush Aryana (American, man), Dr. Marlene Bulgarelli (American, woman) and Dr. Isam Hashim (African, man) - a collaborator on honey-peanut spreads; and
5. U.S. Graduate students received awards for their work on peanut processing and post-harvest in graduate paper competitions during the IFT annual meetings, and other graduate competitions (i.e., Phi Tau Sigma).

3.4 Host Country Training and Capacity Development/Maintenance

Degree training: There were no Filipino researchers were supported for degree training by Peanut CRSP. However, as part of Peanut CRSP project implementation in the Philippines, several B.S. and M.S. students completing their thesis on peanut research, as follows:

1. B.S. student at LSU/ Philippines, L, J. Oclarit (Filipino, man), completed his thesis on garlic oven-roasted peanuts
2. B.S. student at LSU/ Philippines, L.C.Honor (Filipino, woman), completed her special problem peanut butter
3. M.S. student at LSU/Philippines, Imma A. Licayan (Filipino, woman), completed her thesis on peanut praline

Non-degree training and awards: Many Filipino collaborating scientists and researchers benefited from non-degree training. Some researchers were recognized by their institutions for their work on peanut research. The following benefited from short-term training:

1. two women researchers from Philippines trained at UGA in 2002 on peanut processing and sensory and consumer evaluation; both participated in IFT meeting, the Georgia Peanut Tour, and a PCRSP processing workshop at UGA;
2. three women scientists and investigators trained for six months at UGA on peanut processing methods and peanut quality measurements;
3. two women scientists participated in International course on processing of aflatoxin-free peanut products in Thailand in 2003;
4. six women scientists will attend the PCRSP-sponsored International Peanut Conference in Thailand in January 2005 (planned); five scientists will present papers in said conference;
5. In recognition for their significant contributions and quality of their research on peanut processing and post-harvest topics, three LSU/ Philippines collaborating scientists received awards: Dr. Lutgarda Palomar, Dr. Lemuel Diamante, and Dr. Roberta Lauzon; and
6. An FDC scientist received an award for 3rd Best Paper in the 2003 NFA Project Review; two papers from UP received awards as 2nd place Best Undergraduate Research Paper (Nutrition Category), FNRI-DOST and FNRI Research Foundation Inc, 29th Seminar Series on Food and Nutrition Researches ("Assessment of the Vitamin A fortification of peanut butter on middle-income and low-income Filipino families and consumers in Metro Manila.") and 2003 International Publication Award (Manual sorting to eliminate aflatoxin from peanuts, J. of Food Protection, 66(10):1979-1884").

3.5 Technology Transfer (workshops, publications, patents)

Workshops: The project carried out 18 workshops and seminars in 2001-2004, a significant number, participated by a total of 487 farmers, entrepreneurs, factory employees, and managers. An estimated 57% of the participants were women (some gender disaggregated data are missing). The private sector representatives paid for their own cost of participation. The list of workshops and seminars, including the topics and number of participants are in **Appendix Table 1**.

Publications: One of the main outputs of this project are 69 publications and presentations, with eight scientific papers - in refereed journals (2002-2004), which are significant; an additional three in press and 16 are in review or have been prepared as part of Students' theses/dissertations and will be submitted; and six are in preparation by host country investigators. These types of publications are the traditional outputs of researchers. The two training manuals, especially the Pilipino and Visayan versions are significant. The EEP noted the many publication outputs of the project during the meeting with the Project Investigator.

Six monographs were prepared, and 3 have been published. Five training manuals were prepared. An extension-type media material (laminated poster containing pictures of damaged peanut kernels) was prepared to facilitate dissemination of aflatoxin-contaminated peanut kernels to various clients.

The different types of publications produced by the U.S. and Philippine Project Investigators are summarized in **Appendix Table 2**. As expected, most of the publications were prepared or published within the past two years. Philippine collaborators are also preparing four manuscripts for publication.

Patents: One (1) U.S. patent for resveratrol-enhanced peanut is provisional and will be final in May 2005. No other patents were approved for any peanut-based products developed by Peanut CRSP scientists and the host country partners. In the U.S., a new peanut-based product, Chocolate Peanut Spread, had potential for patenting but it was not eligible because the data were presented at an IFT meeting before the patent application was submitted. However, a food company in Georgia (Bell Plantations, Inc.) is interested in commercializing the product in the U.S.

4. Demonstrated/Potential Impacts

Commercialization of Vitamin A-fortified peanut butter was one of the most significant impact of the work of Peanut CRSP in the Philippines, as shown by the Impact Study carried out by Moxley et al. 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 Philippines now produces only Vitamin A-fortified peanut butter. Prior to 1999, there was no fortified peanut butter produced or marketed in the Philippines. 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 tested.

The availability of Vitamin A-fortified peanut butter has implication to children's health in the Philippines. The Impact Study carried out by NCS07 in 2004 showed that older children ages 7-12 years showed highest consumption, followed by children ages 2-6, which is the most vulnerable age group.

An increase in the production of peanut-based products by the food industry in the Philippines showed that: (1) slight decrease in shelf life due to vitamin fortification did not decrease product returns because of fast turnover; and (2) a 10% increase in production cost did not increase the price of peanut butter because the company was willing to absorb any added cost due to expansion of the market.

The use of sorting technology improved the quality of peanut-based products with longer shelf-stability (from six months to 1-2 years); about 30% increase in the volume of domestic and sales; about 39% increase in the export market share of sales of the collaborating company (Marigold Commodities Inc.) and introduction of one more peanut-based product (Java sauce) as cited by Moxley et al (2004).

There is potential employment generation impact of the introduction of new peanut-based products or the application of new peanut processing and post-harvest technologies. Moxley et al. (2004) showed that an increase in the market of peanut-based products also resulted to hiring of 4-8 employees, two production personnel, and five-month seasonal employees at Newborn Foods, Inc., the collaborating food industry company. Both industrial partners moved to larger manufacturing facilities after the collaboration. There is also a potential for developing micro- industry association such as the Wright Peanut Processors Association (WPPA) to have sustainability in the production and marketing of high quality peanut products due to strong support and coordination from stakeholders.

5. United States/Host Country Beneficiaries and Benefits

Philippines: Filipino consumers (both here and abroad) are benefiting from greater availability in the market of healthy and safe (aflatoxin-free) peanut-based products. With the application of manual sorting technology by the Philippine food industry, aflatoxin-free products are now commercially available in local and export markets. In addition, Filipino consumers, especially children, are benefiting from the increased availability of Vitamin A-fortified peanut butter in local stores and supermarkets. Based on the consumers' survey, families were willing to pay extra for this product (about PhP1). As a spill-over, the food company that has the largest share of the peanut butter market, is now producing Vitamin A-fortified peanut butter under its own brand.

Filipino entrepreneurs that own village-level, micro- and small-scale food enterprises are benefiting from the improved/optimized aflatoxin-free peanut-based products with improved packaging and product quality and longer shelf-life and lower production cost. The owners of these rural enterprises are mainly women.

The Philippine food industry (medium- to large-scale businesses), would benefit from the application of improved processing and post-harvest technologies, such as manual sorting technology and new standardized and optimized peanut-based processing methods, resulting in safer products, better packaged, and have longer shelf-life. This was shown to be successful by collaborating medium sized food companies such as Newborn Food, Inc., (Lily's brand), and Marigold Commodities, Inc. (Mama Sita's brand).

United States: In the U.S, the peanut processing industry would benefit from the availability of new value-added products, optimized for consumer acceptability, for manufacture. Peanut processors, globally, will benefit from the introduction of Resveratrol-enhanced peanuts for use in many peanut products. Consumers will benefit from the nutraceutical properties of resveratrol, having anti-cancer and anti-cardiovascular disease properties.

Potential beneficiaries are Peanut CRSP Project Investigators and collaborating research institutions in other countries would benefit from the successfully developed Industry Incubator Model in the Philippines as a strategy to enhance transfer of food technologies to the private food industry and facilitate commercialization of these products. Peanut CRSP Project Investigators and collaborating institutions would also benefit from a grassroots business organization model used in villages in rural areas in the Philippines as a strategy to enhance commercialization of peanut products. Host country researchers and institutions have benefited from capacity building and training programs funded by Peanut CRSP.

6. Building Partnerships

Philippines: One of the most significant achievements of this project has been the establishment of strong linkages with the private food industry in the Philippines, which made it possible for the development of an Industry Incubator Model to transfer PCRSP technologies. Even in Phase I of the project, PCRSP had already linked with the food industry to test and later commercialize peanut-based products developed in the Philippines and the U.S., through UGA. This initial linkage is with medium-sized companies (Newborn Foods, Inc. and Marigold Commodities Inc.). The availability of improved and safe peanut products in stores and supermarkets in Metro Manila, generated by the Vitamin A-fortified peanut butter, increased local consumption. An increase in peanut export, because of aflatoxin-free peanut-based products (i.e., Mama Sita,s "Kare-kare" Mix), also contributed to this achievement.

PCRSP has established linkages with strong Philippine research institutions including: (1) the Food Development Center of the National Food Authority, Manila, (2) the University of the Philippines at Diliman, Quezon City, (3) the Leyte State University, Baybay Leyte. Additional linkages were forged, with the following agencies: (i) the Bureau of Post-harvest Research and Development of the Department of Agriculture, Quezon City, (ii) Department of Agriculture (Region VIII), (iii) Department of Labor and Employment (RegionVIII), (iv) Department of Trade and Industry (Region VIII), (v) TESDA, and (vii) Local Government Units (Region VIII).

Another initiative introduced by PCRSP is to link up with micro- and small-scale business enterprises in the Visayas. Through LSU/Philippine researchers, PCRSP technologies were transferred to Wright Peanut Processors Assocation (formerly St. John's Farmers Producers Cooperative in Paranas, Samar) to the Bucarez Food Processing Cooperatives in Bohol, and to the Small Industry Association of Eastern Visayas in Samar. FDC/NFA started to work with the Chamber of Agriculture, Fisheries and Food Industries of Northern Mindanao (CAFFINORMIN) and the Northern Mindanao Peanut Industry Associations (NMPIA) of Cagayan de Oro to transfer production, processing, and post-harvest technologies.

United States: In the U.S., strong linkages have been established with the Georgia Peanut Commission, the Georgia Peanut Foundation, the Southeast Peanut Commission, etc. which leveraged PCRSP funding for UGA researchers. As in the Philippines, the role of the food industry was critical in the use of the Industry Incubation Model to initiate commercialization of peanut-based products developed by PCRSP scientists. For example, negotiations are underway for Bell Plantations Inc., a producer of peanut flour, is interested to commercialize at least five peanut-based products from PCRSP.

7. Constraints and Recommended Solutions

Inadequate supply of raw peanuts. The volume of peanut produced in the Philippines is not sufficient for the needs of processors. Poor communication between producers and processors had magnified the problem. The Peanut CRSP project and the Growth and Equity Project (GEM), an initiative funded by USAID, are assisting farmers in securing funds to establish a Peanut Service Station in Mindanao. This is a proposed collecting point for peanut produced locally so food processors can procure the volume of peanuts in the form they need for their factory, and free from aflatoxin.

Few publications by host country researchers: Although the Philippine researchers were highly qualified and were very active in peanut research, and in developing and testing new and improved peanut-based products, writing papers for publication in refereed journals is not given high priority. Up to 2004, only one paper was published, two are in review, and five are in preparation. In FDC, performance of researchers is not measured by publications. Philippine institutions need to provide adequate incentives and training for their scientists to publish papers. It was noted that after some researchers trained at UGA, they became more aware of the need to publish.

IPR provisions: When testing new products or methods with the private sector, project policy requires them to hold on to the successfully tested product or method for a period one to two years) before sharing with other companies. Knowledge of provision of Intellectual Property Right laws should be considered early and to tap the opportunities for patenting of new products/processes.

Fund management: Transfer of funds from UGA to host country research institutions continues to be a problem, as already noted by the last EEP. The problem had caused delays in research and technology transfer activities in the Philippines. The Management Entity needs to come up with improve fund transfer mechanism for the next phase.

8. Lessons Learned

To ensure success and sustainability of Peanut CRSP processing and post-harvest technologies in the Philippines, the selection of the right collaborating institutions, including private food enterprises, was critical in building trust and working relationship; training of collaborating researchers in the US (at UGA) and establishing a strong network between the US researchers and the host country partners, were equally important.

Experience in the Philippines showed that early and continued partnering with the private food industry ensured an understanding of consumers' needs by researchers, facilitated product development and testing of Peanut CRSP products at the commercial scale, and assured that safe and preferred products quickly get to the market place. A key actor in the Industry Incubator Model in the Philippines is the private food industry.

9. Next Steps and Future Directions

Philippines: The collaborating research institutions should provide assistance and to periodically monitor the changes in the uptake of safer (aflatoxin-free) and fortified peanut-based products by private food companies, including the micro- and small-scale business enterprises at village level.

Philippine collaborating research institutions should work closely with the extension service to ensure sustainability of the provision of technical services, especially to small peanut producers, micro- and small-scale enterprises, and other field level clients. The collaborating researchers should continue to provide technical advice and relevant training. The Philippines can learn from successful experiences in Thailand where extension workers are trained and work closely with researchers at the community level. Appropriate extension-type media materials should be prepared. Regional/ provincial government offices will have to be tapped to assist in the implementation of the projects to ensure multiplier effects, especially for micro- and small-scale enterprises at the village level.

United States: UGA scientists continue to work with the US food industry to facilitate commercialization of safer (aflatoxin-free) and high quality peanut-based products developed by PCRSP to ensure that they reach the marketplace at a reasonable timeframe. Future directions of a food technology project should be based on the requirements of the market and products preferred by consumers in the U.S. or the host country, and this may differ. Hence, any intervention by the project should suit specific local situations.

Developing Countries: The Industry Incubator Model that was developed by the PCRSP in the Philippines can be introduced in other countries where PCRSP is working, with appropriate modifications. Priority should be given to countries where increased peanut production has occurred due to the introduction of new peanut varieties and improved production technologies. Examples are in Bolivia and Guyana where peanut production has increased 2-3 times in the past two years and had caused problems in marketing and reduced prices. The use of manual sorting technology to produce aflatoxin-free peanut products would be a significant improvement towards safer peanut-based products for consumers where aflatoxin contamination is currently at very high levels.

10. General Observations

Strengths: It was noted that very significant synchrony resulted from the work of three different experts (Food Scientist, Microbiologist, and Food engineer) in the Food Science and Technology Department of UGA. The close working arrangement facilitated that expert backstopping needed for product development, testing, and other analytical work. The UGA team worked well together in a complementary manner.

Weakness: The impact study involving social scientists and economists from NCSU enabled the evaluation of the impact of the food technology PCRSP initiatives in the Philippines. This experience showed the need for more multi-disciplinary inputs, especially in the socio-economic aspects, and should be available as early as the planning and design stage, to ensure that benchmark information is collected using the agreed key performance indicators. Because of this weakness, the impact study could only use post-scenario analysis.

Strengths: The scientific expertise, experiences, and dedication of both the US and Philippine partners are commendable and have been critical in the success of PCRSP initiatives in the Philippines. The institutional arrangements for research backstopping, and strong linkages with the private food industry, contributed to the significant achievements of the project. A stronger linkage with extension service providers (from both public and private sectors) at all levels could further enhance the linkage of traders and food processors to peanut producers and their organizations.

11. Recommendations

Specific: Peanut CRSP to maintain initiatives in the Philippines. In the next program phase, the successful initiatives in the Philippines have to be maintained, especially those involving the private sector food industry and the emerging work involving micro- and small-scale food enterprises in the rural areas. The focus should be on monitoring and evaluation of changes as the food industry builds on the significant achievements to push for an increased share in the peanut-based products market. Strengthen linkages with extension service providers for wider public dissemination of information and to strengthen linkage of markets (traders/processors) with peanut producers (farmers). U.S. scientists should continue to provide technical guidance to Philippine research institutions on new technologies and research methodologies. The strong research network that was established with UGA scientists, through the project, needs to be maintained.

General: Peanut CRSP to promote the Industry Incubator Model to transfer processing and post-harvest technologies to other regions where Peanut CRSP has intensively worked (i.e., West Africa, Latin America, Eastern Europe). This would necessitate a strong technology transfer component of the ongoing/new projects that should include training of key stakeholders. In some cases, a new institutional arrangement would be needed with new partners besides the current collaborating research institution to enlist support from a food science group. Facilitate active involvement of the private food industry (focusing on small- to medium-scale businesses), public (government), and private (non-government organizations, civil society groups, etc.) extension providers, health workers, traders, and other stakeholders (i.e., donors).

Appendix Table 1. List of Workshops and Seminars Conducted by Peanut CRSP (UGA04).

Title of Trainings Conducted	Date of Training	Venue	Source of Support	No of Participants		
				Male*	Female*	Total
1. Consultative Meeting with Industry on Feasibility of Establishing a Peanut Sheller Industry	March 16, 2001	Food Dev. Center	FDC and PCRSP	12	8	20
2. Workshop on Control of Aflatoxin in Raw Peanuts through Sorting	April 2, 2001	Food Dev.	FDC Philfoodex members	1	6	7
3. Seminar on Post-Harvest Technologies for Upgrading Peanut Quality and Expanding Peanut Production and Markets	April 3, 2001	Food Dev. Center	FDC, PCRSP and Industry	19	30	49
3. Post harvest Handling of Peanuts to Meet Marketing Standards and Needs and Peanut Processing	August 22, 2001	Cagayan de Oro City	FDC and Dept. of Agriculture	18	8	26
4. Seminar on Impact Assessment of Technology for Vitamin A Fortification of Peanut Butter and Sorting of Peanuts for Aflatoxin	December 18, 2002	Food Dev. Center	FDC, PCRSP and Industry	13	36	49
5. Workshop Food Product Development for Industry Managers	June 24, 2003	Griffin, Georgia USA	Food PIC	No Data	No Data	25
6. Developing New Products for a Changing Market place	July 11-12, 2003	Chicago, Illinois USA	Institute of Food Tech. and Food PIC	27	23	50
7. Record keeping transactions, producer costing, Incomes and Expense	July 5, 2003	Buray, Samar	PCRSP, LSU	5	19	24
8. Basic Plant Sanitation and Hygiene for Food Plant Workers	August 21, 2003	Cagayan de Oro City	FDC and PCRSP	3	7	10
9. Basic Plant Sanitation and Hygiene for Plant Workers	August 22, 2003	Bukidnon	FDC and PCRSP	11	9	20
10. Developing Value-added Products for a Changing Marketplace	September 5-6, 2003	Griffin, Georgia, USA	PCRSP and FoodPIC	No Data	No Data	No Data
11.Training Workshop on Processing of Roasted Peanuts and Peanut Sauces	October 15 –16, 2003	Food Dev. Center	FDC and Industry	7	21	28
12.Peanut Quality and Safety, Hazards on Foods	October 29, 2003	CSCST, Cebu City	Academe	16	39	55**
13. Peanut Quality and Safety Hazards on Foods and Aflatoxin Kit	October 27, 2003	Buray, Samar	PCRSP, LSU	4	18	22

14. Food Quality and Safety. Unoptimized peanut products (oil roasted and oven roasted peanuts)	November 15, 2003	Buray, Samar	WPPA members	4	17	21
15. Seminar on Good Manufacturing Practices and Development of HACCP Plans for Product Development	November 6-7, 2003	Cagayan de Oro City	FDC, PCRSP and Industry	9	15	24
16. Business, Expense, Saving Training (BEST) Game,	February 13, 2004	Buray , Samar	PCRSP, LSU	4	17	21
17. Current and Future Status of Consumer Testing In Product Development	February 17-20, 2004	Chiang Mai, Thailand	Chiang Mai University	No Data	No Data	22
18. Food Product Development Process for the Georgia Food Industry	February 23-24, 2004	Atlanta Georgia USA	FoodPIC	6	8	14
TOTAL				159	281	487

*columns do not equal 487 due to missing gender disaggregated data.
**Staff and students of Cebu State College of Science & Technology, Cebu City.

Appendix Table 2. List of Publications Prepared by U.S. and Host Country Project Investigators, 2001-2004.

Type	2001-2002	2003	2004	Total
Monographs	-1 Monograph1: Tech. and policy issues in strengthening peanut markets -1 Monograph2: Peanut butter consumption patterns of Filipinos		-1 Monograph3: Control of Aflatoxin through manual sorting of peanuts -1 Monograph4: Techno-economic Feasibility of Peanut Sheller Industry (In Press.) -1 Monopgraph5: Peanut butters and spreads (In Press.) -1 Monograph6: Impact of Vitamin A-fortified peanut butter (In Press)	-3 monographs published -3 monographs in press.
Manuals		-1 Standard Sanitation Operating Procedure Manual for food industry	-2 Training Manual on Sorting for Aflatoxin contaminated kernels (2 versions) -1 Training Manual translated into Pilipino and Visayan (same) -1 Training manual on Processing of Roasted Peanuts	-5 manuals
Papers (Refereed Journal Articles)	-3 manuscripts on peanut butter and spreads (published) -1 manuscript on cracker coated peanuts (published)	-1 manuscript on manual sorting (published) - 1 manuscript on peanut butter (published)	-1 Dev. And optimization of chocolate peanut spread (Chu and Resurreccion, published) -1 manuscript on Resveratrol enhanced peanut (Rudolf et al., published) -1 paper on roasted peanuts (in press/accepted) -2 manuscripts on peanut polvoron and chocolate peanut bar by FDC/NFA researchers (in-press) -1 manuscript on products containing honey (in review) -1 manuscript on chocolate peanut bar (in review). -4 manuscripts prep. on chocolate peanut spread (to be submitted) -3- manuscripts prep. on resveratrol enhanced peanut (to be submitted) -4 manuscripts on cracker coated peanuts (to be submitted) -3 manuscripts on roasted peanut (to be submitted) -2 manuscripts on chocolate peanut spread by UP Diliman researchers (in prep.) - 2 manuscripts on stabilizers and vitamin A fortification of peanut butter (in preparation) -1 manuscript on roasted peanuts (in prep) -1 manuscript on peanut brittle (in prep).	-8 publications in refereed journals -3 manuscripts in press -16 manuscripts (in review or to be submitted) -6 manuscripts in preparation
Presentations	-7 IFT presentations on peanut butter. -1 IFT presentation on	-1 presentation at IFT on roasted peanuts -1 presentation at IFT on postharvest	-1 presentation at PTS on chocolate peanut spread (Philippines). -1 presentation at IFT on roasted peanuts	-24 presentations

	cracker coated and roasted peanuts. -2 IFT presentations on choc-peanut spread -1 IFT presentation on shelf stability of peanuts -1 IFT presentation on peanut snacks -1 IFT presentation on resveratrol	handling of peanuts -1 IFT presentation on peanut processing.	- 6 presentations at International Peanut Conference	
Proposal			-1 Establishment of Peanut Service Station in Mindanao	1 proposal
TOTAL	19	6	44	69

1. Project Title and Investigators

NCA32U: Development of Value-added Products from Peanuts and Aflatoxin Detoxification

U.S. Principal Investigator	Dr. Mohamed Ahmedna	North Carolina A&T State University, Greenesboro, North Carolina
Co-PI	Dr. Ipek Goktepe (Aflatoxin)	NC A&T at Greensboro, North Carolina
Co-PI	Dr. Jianmei Yu (Antioxidants)	NC A&T at Greensboro, North Carolina
H.C. Principal Investigator	Dr. Amadou Kane	*Institut de Technologie Alimentaire*, Dakar, Senegal

Host Countries: Senegal

2.1 Project Objectives and Budget

Objective	Objectives	% Complete
Objective 1	Produce functional ingredients from peanut and peanut processing by-products.	90
Objective 2	Develop value-added products from peanut alone or in combination with fish mince.	100
Objective 3	Optimize physical, chemical, and sensory properties of the peanut-based products for consumers in the US and Senegal.	90
Objective 4	Select inexpensive treatments and/or additives that eliminate aflatoxin in the end products.	90

1.2 Annual Budget: In 2003-2004, the budget for this project was US$70,000, of which US$10,683 (15%) was transferred to the Senegalese collaborating institution (ITA). Significant leveraging of funds from NCA&T management occurred with the university providing over US$200,000 to procure critical pieces of laboratory equipment, beyond the 25% const-sharing required. The Principal Investigator has also received a USDA grant of US$300,000 for another food science project. The salary of a team member working on antioxidant is paid through another source but she works full time on Peanut CRSP activities.

This evaluation covers the period from 1 August 2001 to the present.
Selected general recommendations for Peanut CRSP stated in the 1996-2001 External Review Panel Report were (1) Utilization research is of great importance in that peanuts are an important source of value-added products for small businesses and women-based companies; and (2) Both food safety and utilization research are necessary to ensure markets for peanuts. The potential importance of exploiting the clay-adsorption technologies as a means to impart human health and child survival worldwide is an exciting prospect, and both the Peanut CRSP and USAID should work to prove that this technology works for human use and are safe. The significant impact in the U.S. resulting from the research on human health responses to peanut diets justifies continued efforts in this area. The objectives of this project NCA32U were set in place to develop and advance technologies for quality and safe peanut products.

2. Research Approaches

This study was designed to sustain the market competitiveness of peanuts in the US and Senegal by addressing aflatoxin contamination (Senegal) and by reducing the level of fat calories (US) to meet the new threshold fat calories level (33%)set by the National Institutes of Health (NIH). By reducing the fat level in daily diets, it expected that the risk level for coronary heart disease in the general population would be lowered. The 50-55% fat level established in peanuts made it imperative that ways be found to bring it down - in line with the new NIH guidelines- so that the consumption of peanuts would not suffer a significant decline. Maintaining market share and reducing the levels of health risk from fat and aflatoxin became the core of the project. Successfully designed new products and new uses would essentially permit an expansion in market share.

Defatted peanut flour was prepared from peanut factory processing by-products. Heat treatment and fungal (Rhizopus sp.) fermentation were used to modify defatted peanut flour, which was used successfully in developing new products such as meat analogs, peanut-based fish nuggets using tilapia and catfish mince, and high protein snacks. Extensive testing was done in the laboratory to identify physical, functional, and chemical properties of these products and consumers' acceptability tests were carried out using U.S. and West African sensory panels.

Antioxidants or nutraceuticals were extracted from peanut skins, another by-product from peanut processing. Phenolic extracts were separated and identified using HPLC and LC/MS. Antioxidant and radical scavenging capacity of crude and purified peanut skin extracts were determined and compared with Trolox and Vitamin C. Effect of skin removal methods and extraction solvent used on relative TAAs were determined. Shell fragments from the shelling process were separated from kernels as feedstocks for making value-added products. Shell fragments were processed as activated carbon and chemically activated absorbents.

Inexpensive treatments to detoxify aflatoxin in peanut products were tested using ozone, ultraviolet light, biological agents, and mild heat treatment in the U.S. Attapulgite clay was tested in Senegal for detoxification of aflatoxin in peanut products, such as peanut paste.

Transfer of the new/improved technologies to cottage- small-scale processors (many are women) in Senegal and to interested food industry partners in the U.S. have been initiated through intellectual property contact with stakeholders. This is currently being pursued. An assessment was carried out in Senegal to establish the level of aflatoxin contamination of peanuts and peanut products through sampling. The baseline information is being used as basis for providing guidance on the best methods to reduce aflatoxin by cottage- and small-scale processors in the country. Socioeconomic improvements are related to the availability of aflatoxin-free value-added peanut products and co-products in the marketplace. Safe, quality products contribute to healthier people.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

Use of technologies adaptable/appropriate to Senegal include local clays, UV light for aflatoxin detoxification by cottage level peanut processors, peanut milk and protein isolates for protein deficient children, and fish by-products used to produce high protein peanut-based snacks. Peanut-based fish nuggets could enable recovery of fish by-products in Senegal and the U.S., where fishing industries are strong, and add value thereby enhancing both the fish and peanut industries.

Product development: Two high-protein baked snacks from defatted peanut flour were developed and tested in the U.S. and Senegal: (1) cookies, and (2) chin-chin (a West African snack). Substitution of up to 40% roasted defatted peanut flour yielded snacks that was most acceptable to consumers. U.S. and West African sensory panels tested both snacks; the West African panel gave higher acceptability ratings to peanut-based snacks especially chin-chin compared to the U.S. panel. Shelf-life of chin-chin was determined to be good. The high protein-low fat products have health implications. Peanut milk from defatted peanut flour is being developed in Senegal by collaborating researchers for testing for acceptance 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 on health risks to consumers and provide guidance on ways to reduce aflatoxin especially at the village/small-scale processor level.

Aflatoxin detoxification: B1 and G1 Aflatoxin detoxification of peanut products using Senegalese Attapulgite clay was tested in Senegal in collaboration with NCA&T researchers. Addition of clay as low as 0.5% level resulted to non-detectable levels of aflatoxin in all samples. Samples of all peanut products in local markets in Senegal showed aflatoxin contamination; the products showing high levels of over 30% were: crude peanut oil (92%), peanut cake (90%), and peanut paste (55%), and kernels in local market (30%). Sorting and removal of skins proved effective in lowering aflatoxin for some uses, and the utilization of the Senegalese attapulgite clay reduced aflatoxin to none detectable levels in other uses of peanut.

3.4 Technical Outputs in United States

Significant outputs were achieved in the U.S. by the NCA&T Project Team in the past four years, including: (1) developing peanut-based products developed from peanut processing plant by-products acceptable to consumers, (2) identification of antioxidant components of peanut skin by-products (phenolics), and (3) successful testing of inexpensive methods to detoxify aflatoxin in peanut-based products, such as use of ozone and mild heat treatment of peanut flour and kernels.

Product development: Two sets of new peanut-based products were developed and tested: (1) Meat analogs as substitute for ground beef in taquitos, tamales, and chili, and (2) peanut-based fish nuggets. Both products used defatted peanut flour made of peanut processing plant by-products. Fermentation enhanced the functional properties of heat-treated peanut flour.

(1) Peanut-based meat analogs were highly acceptable as ground beef substitutes in three Hispanic snacks (taquitos, tamales, and chili). These meat analogs are also potential candidates for incorporation into other meat-based formulations. Extrusion was used to produce high quality texturized meat substitute from fermented and unfermented peanut flour.
(2) High consumer acceptance of peanut-based fish nuggets incorporating up to 15% defat peanut flour. Addition of peanut flour masked the muddy taste of catfish and fishy taste of tilapia. Consumers' test showed that the product has potential for commercialization. The sensory characteristics of the best fish nuggets were further optimized via enhanced formulation and optimized extrusion technologies. Overall, the extrusion process produced a better texture, improved flavor product compared to the non-extruded fish nuggets.

NCA&T researchers showed that peanut skins (a by-product of peanut processing) are a good source of antioxidants. Peanut skin contains phenolic compounds (90-130mg/gm) with very high antioxidant properties. Peanut skin has more antioxidant power than green tea (standard), vitamin C, Trolox, and grape seed extracts. Phenolics are made up of procyanidins monomers, A-type and B-type procynidin dimmers, trimers, and tetramers, as well as phenolic acid and resvertrol. This extract is a potential source of inexpensive source health promoting nutraceuticals. Peanut skin makes up 3.0-3.5% of the whole seed; one gram of dry skins contains 90-130 mg of total phenolics. Currently, peanut skins by-products are used for animal feeds. Peanut skins could be used as functional ingredients in dietary supplements as value added products for local industry.

Peanut protein concentrate using defatted peanut flour is being developed at NCA&T for the U.S. market. Protein solubility, functional properties, and other characteristics of the concentrate have been established through extensive testing. Additionally, these peanut protein products are being tested in peanut milk in Senegal, a product that would add nutritional value to the diets of children.

Aflatoxin detoxification: Two inexpensive treatments and/or additives to eliminate/detoxify aflatoxin in peanut-based products were tested by NCA&T researchers: (1) use of ozone, and (2) mild heat treatment of peanut flour and peanut kernel. Gaseous ozonation could destroy about 80% of AFB1 and AFG1; 60% of AFB2 and AFG2. The process was more effective in peanut seed than peanut flour; and longer treatment at low temperature was as effective as shorter time at high temperature. Degradation by as much as 80% was achieved within 15 min. of exposure. Ozonation at room temperature for 10-15 min. would be the most economical since heat generation typically adds to the processing cost.

3.3 United States Training and Capacity Development/Maintenance

Exchange visits in Senegal: NCA&T Principal- and Co-Investigator visited in 2001 to initiate project activities and to attend a regional Peanut Workshop in Senegal; in 2003 the Project Investigator carried out a second visit to provide training for researchers at ITA, review progress of collaborative activities, and finalize work plans for the remaining period.

The Principal Investigators received Achievement Awards(a strong recognition program implemented by NCATSU administrators to recognize excellent work by their faculty). The PI received the 2002 Outstanding Young Investigator, and 2001 Gamma Sigma Delta Award of Excellence in Research. The Co-PI received the Outstanding Young Investigator Award in 2005. Graduate students received nine awards in 2001-2004 in recognition for their excellent research papers through graduate student paper competition.

Five M.S. students completed their degrees at NCA&T and have presented their research findings at national meetings; theses topics were: development of meat analogs (2), fish mince (1), high protein snacks (1), and detoxification of aflatoxins (1). Technology transfer will be stimulated from new products developed during the training of the students and researchers. Techniques used and knowledge gained in the laboratory experiences are valuable indicators of the kind of tech transfer that can take place.

A contribution to the program was the development of a scientifically equipped laboratory with University funding ($200K) and refinement of analytical procedures. A USDA, CREES Capacity Building grant ($300K) was awarded to the PI, further strengthening support of research programs, including leveraging the Peanut CRSP program at NCATSU.

Because of strong administrative support and grants, major instrument and equipment buys were made to support the research program. They are FTIR, HPLC, Texture Analyzer, Color Analyzer, Nitrogen-Carbon Analyzer, Autotitration System, Spray Dryer (for protein concentrates, isolates), Twin Screw Extruder, Elisa System (allergens) and a UV light instrument. Note, the Twin Screw Extruder, contributing strongly to food product development in the program was purchased with Peanut CRSP funds.

3.6 Host Country Training and Capacity Development/Maintenance

Degree: M.S. candidate from Senegal (Nimsate Kane, female) has passed English proficiency test after completing language training in the U.S.; she is now pursuing her M.S. degree program in NCA&T; the EEP members met her in NCA&T to discuss about her program.

Funding for language communication capabilities proved to be a primary constraint. High out of state tuition charges presented a problem for Senegalese and other students that attend NCA&T. The small size of the grant funding made it difficult to underwrite the cost of a larger number of graduate students from the HC. The PI was innovative in setting aside Peanut CRSP funds for two years to allow support of the M.S. student from Senegal to participate in the Peanut CRSP program at NCATSU.

Non-degree: ITA Director (Dr. Amadou Guiro, male) attended the FDA Mycotoxin Workshop in Maryland in July 2002; he again visited U.S. in June 2004 to discuss additional collaborative activities with NCA&T Principal Investigators. Dr. Amadou Kane (Senegalese Principal Investigator) will attend the 2005 APRES meeting and present two papers on his peanut research in Senegal. These travels were/are being funded by Peanut CRSP. A Ph.D. graduate student is working with Dr. Kane in Senegal.

3.5 Technology Transfer (workshops, publications, patents)

Workshops: No workshop was held involving cottage-level, small-scale processors in Senegal because activities to transfer new/improved food products or food processing technology have not been initiated. However, training workshops for ITA researchers and technicians were timed with the visit of the U.S. Project Investigators to Senegal. Also, technical assistance is provided in product development and testing, quality control and characterization of peanut-based products for local markets.

Publications: The following publications were prepared by the scientists and researchers involved in the project:

(1) Three publications in refereed journals in 2004 on: (1) Peanut skin procyanidins: Composition and antioxidant activity as affected by processing (J. Yu, M. Amedna, I. Goktepe, and J. Dai); (2) Detoxification of aflatoxins in peanut kernels/flour gaseous oxonation and mild heat treatment (A. Proctor, A. Ahmendna, and J. Kramer); and (3) Effects of processing methods and extraction solvents on concentration and antioxidant activity of peanut skin phenolics (J.Yu, M. Ahmendna, and I. Goktepe).

(2) Five M.S. thesis reports by: (1) Carlyn Ray (2001) on Meat analogs from modified peanut flour, functional properties and potential food applications; (2) Vivian Ray (2001) on Modified defatted Peanut flour: functional properties and sensory acceptability as meat analogs and fish additive; (3) Kendra Mathews (2003) on Optimization of extrusion parameters and formulation of value-added snacks; (4) Alexandria Proctor (2004) on Detoxifixation of aflatoxin using ozone and mild heat treatment; and (5) Pauline Ireh (2004) on Development, sensory acceptability, and physiochemical properties of high protein peanut-based snacks.

(3) Nine papers and 7 abstracts presented at national meetings (Dr. Kane will present 2 research papers at the 2005 APRES meeting).

(4) 12 articles in local media: SAES Newsletter and News Releases, Aggie Report, SAES Website, and Greensboro Newspaper.

Patents: One invention disclosure has been submitted for potential patent consideration in the U.S.

4. Demonstrated/Potential Impacts

Production of new high-protein food products and nutraceuticals from under-utilized peanut processing by-products has potential to add value to the peanut industry in the U.S., Senegal, and other countries. It could also meet the fast growing demand for meat substitutes in vegetarian diets. The U.S. meat analog industry is growing rapidly and is expected to exceed US$2.6 billion of annual sales within the next five years, an opportunity to promote peanut-based products. Peanut-derived nutraceuticals will also tap into the large and growing nutraceuticals and functional food market, currently estimated at US$17 billion per year.

5. United States/Host Country Beneficiaries and Benefits

The main beneficiaries so far are five graduate students who have completed their M.S. degrees at NCA&T; two M.S. students from Senegal (Nimsate Kane) and Algeria (Djaafar Rehrah) who are undertaking their studies. Host Country scientists and researchers have visited the U.S. and NCA&T, and attended conferences, an addition to the capacity building effort.

In Senegal, the potential beneficiaries are consumers who will have access to new/improved, safe and aflatoxin-free peanut-based products to become available in the market. Village-level, small-scale processors and/or private food industry partners in the host country are expected to benefit from high potential commercialized new/improved peanut-based products.

In the U.S., potential beneficiaries are U.S. peanut processing industry which could have useful commercial uses of their peanut processing factory by-products. By-product use would reduce the potential environmental risk implications of the present disposition of the wastes. Food industry companies that would commercialize these new/improved peanut-based products would also benefit directly. Based on low-fat products, they also have a mechanism or route for addressing the fat/health challenge to the market head on. Collaborations are being discussed with the Peanut CRSP project PUR10U PI working on the effects of peanut consumption on hunger, ingestive behavior, energy expenditure and coronary heart disease risk.

6. Building Partnerships

The main partner institution in Senegal is the Institut de Technologie Alimentaire (ITA) in Dakar. The U.S. Project Investigator had visited ITA twice to train scientists and researchers on various methodologies and laboratory techniques and to exchange ideas. Three ITA scientists carried out short-term technical visits in the U.S. and NCA&T and to attend conferences.

Partnering outcomes were less than desirable leading to inability to transfer the knowledge and new technologies to the village level processors in Senegal. New partnerships will need to be cultivated with private sector entities, agricultural extension and research providers, NGOs, village level marketers and other stakeholders if appropriate technology transfer is to occur. Similarly, partnerships should grow in the U.S. to foster technology transfer.

7. Constraints and Recommended Solutions

A Senegalese candidate for graduate studies at NCA&T had problem for two years in complying with English proficiency requirement. To solve the problem, the graduate student was invited to the U.S. to undergo intensive language training. In the future, ITA needs to recruit researchers who are already proficient in English or start English language training for potential candidates so as not to delay the start of their graduate program.

High out-of-state tuition fees continue to disadvantage foreign graduate students at NCA&T because of compliance to a North Carolina state law. NCA&T management encourages Project Investigators to include this fee into the grant request. Since Peanut CRSP grants are medium-sized, only limited number of graduate students could be provided with fully funded graduate assistantships, without sacrificing the direct support to research activities. The NCSU Project Investigator (NCS07) also cited a similar problem.

Presently, the limited partnership opportunities in Senegal need to be addressed to continue program growth and insure technology transfer. This project would benefit from the experiences in partnership development in Philippines (UGA04) and Thailand (UGA37). The PI and Co-PI of NCA32 want to learn from these experiences and apply them in Senegal. A training plan should be developed and funded by Peanut CRSP.

8. Lessons Learned

The selection of a high caliber scientist (Principal Investigator), who is also a good leader was critical in maintaining significant progress in this project. Additionally, the selection of a capable Co-PI, provided a team has been able to turn around this project and achieved significant outputs in the past four years. The Project Team is fully supported by the NCA&T management. Principal investigators can be successful when provided with appropriate support from the university administration. Higher levels of scientific output and productivity can occur when the Principal Investigators are strong and the team is built on mutual respect and trust. Science continues to be a source of solutions to vexing problems affecting the food chain and markets.

Significant leveraging of funds had occurred in this project through the efforts of the Principal Investigator, with support from the NCA&T management. In this case, the Principal Investigator has to ensure that the activities are complementary so conflict in time allocation of researchers does not occur.

9. Next Steps and Future Directions

Product development and testing should be continued, and prepare to transfer to Senegal the technologies (peanut-based food products and nutraceuticals and processes) developed by Peanut CRSP scientists at NCA&T. Focus of the next phase should be technology transfer and training activities involving village-level processors, traders in Senegal, and private food industry partners in Senegal and U.S. Technology transfer activities would require new institutional arrangements, involving the private sector, NGOs, agricultural extension providers, and other stakeholders.

A plan has been prepared to introduce a Peanut Food/Processing Industry Incubator at ITA in Senegal. The industry incubator model developed in the Philippines (UGA04) would facilitate technology transfer to the local food industry and provide solutions to local peanut processing and safety problems.

Continue to strengthen the institutional and human capacity of ITA-Senegal and other partners through more intensive training at different levels involving as many stakeholders as possible.
Future plans include possible expansion of the project to two additional countries in the region.

10. General Observations

Strength: NCA32 Project Team consists of young professionals and technical experts who work well together. They have achieved significant outputs, and turned around a low-performing project in the past four years. Selection of a good and dedicated Principal Investigator was a key action taken by the NCA&T management, as well as sustained financial support for the project team, and providing solutions for their problems. For example, data obtained from the Peanut CRSP project was critical in securing USDA, CSREES funding for research on other aspects of value-added use of peanut and peanut by-products. Hence, Peanut CRSP was key in bringing together a peanut research program with funding from various sources at NCA&T

Strength: EEP met with three members of NCA&T management (Associate Dean, Department Head, and Peanut CRSP TC). They fully support the Principal Investigator and scientists working in the project, and were quite pleased with the significant outputs that they have accomplished. The project is used by NCA&T as a successful example in the briefing of visitors. NCA&T procured about US$200,000 worth of equipment to complete the laboratories needed by the project team. The management solved the problem of transfer of funds to Host Country collaborating institution by changing from reimbursement of expenditures scheme to advanced fund release scheme.

Strength: The result of the work in aflatoxin detoxification could provide a bridge between agricultural and health issues. Expansion of Peanut CRSP initiative to public health aspects of peanut research (i.e., aflatoxin, peanut allergies, HIV AIDS) would allow joint research by agriculture and health scientists. In Senegal, other funding sources from Belgium, Canada and France are supporting research programs in these areas and leveraging Peanut CRSP.

11. Recommendations

Specific: Peanut CRSP to continue product development in the next phase. Further development of value added peanut products and improvement and fine-tuning of the processes are needed to bring them to pilot production stage. Integrating a strong technology transfer component, especially in the host country would facilitate the transfer of Peanut-CRSP technologies (new food products and processes) to the region through Senegal. Refocus the efforts in the U.S. and Senegal towards more commercialization of these technologies and intensive training of key stakeholders, in the U.S. and Senegal. This would necessitate new partnerships involving the private food industry (focusing on small- to medium-scale businesses), the public (government entities), and public (or NGOs) extension providers, health workers, traders, and other stakeholders, including donors. ITA should continue to provide research support and coordination to ensure sustainability and quality of the products produced in Senegal.

The Peanut CRSP project at NCATSU includes emphasis on development of aflatoxin-free value-added peanut foods, feeds and nutraceuticals from peanut products and co-products suitable for the Senegal and U.S. markets. Work is examining the use of aluminosilicate clays (Attapulgite) to reduce levels of aflatoxins in cottage industry peanut paste. The results are very promising. It is recommended that this work be expanded to include that of Peanut CRSP project OKS55. The combined effort could focus on the aflatoxin problem throughout countries in West Africa. Proper funding would be required to assure success of the program.

The Peanut Collaborative Research Support Program

External Evaluation Panel 2005 Report

Annex 3

Valencia Peanuts

Peanut Trials

Production Efficiency Sector Summary Report

1. Relevance and Research Approaches:

Production efficiency projects are based on scientific research approaches designed to increase production especially under conditions of low or minimized input use. In lesser-developed countries, technologies that exploit genetic resistances or avoidance mechanisms are most likely to impact on peanut production by resource-poor farmers.

These same approaches are the ones most likely to provide benefits to the U.S., where chemical inputs are a major cost and where lowering costs of production is an important requirement for the farmers to remain competitive.

Increased efficiency of labor resource utilization will become a paramount issue as the ravages of the HIV epidemic impact labor resources in developing countries, and reduced use of pesticides will impact positively on environment preservation.

In East/Southern Africa, collaboration with ICRISAT has guided the approach. ICRISAT has been developing varieties with early maturity and resistance to Groundnut Rosette Virus disease (GRV) and the Peanut CRSP has worked both upstream (evaluating variability) and downstream enabling the national programs to test and release adapted varieties.

In this cluster a number of projects are utilizing or developing biotechnology tools to allow for improved efficiency of crop improvement (gene-probes/markers and genetic manipulation) to access and evaluate novel genes that have the potential to provide solutions to otherwise intractable problems.

2. Outputs/Achievements:

Dr. Geoff Hildebrand of Seed Co Ltd, Zimbabwe was the primary reviewer of this cluster of projects. He was assisted by Ron Gibbons.

Handy Williamson participated also in the review of projects in Ghana and Guyana.

Dely Gapasin participated in the review of the project in Bolivia.

2.1. Technical

In many cases, projects have led to the development of improved technologies. These include improved germplasm and varieties, improved production practices, new techniques and interventions, and improvement of institutional and human resource capacity.

2.1.1 Genetic Improvement

Improved varieties and useful germplasm have been released, developed or identified in a number of projects (UFL 16, TAM17, UGA28, NMX53):

Disease resistant varieties in experimental plots in Ghana.

Bolivian germplasm collected and evaluated (UFL16) has led to the identification of useful resistances to TSWV, leaf spot and invasion by *A. flavus*. These have been used in crosses and two derivatives have been included in UPPT tests. One could be released in the U.S. in 2006, and a release can soon be expected in Bolivia as well.

The TAM17 project has identified and used sources of resistance to *Sclerotinia*, TSWV, seed dormancy, improved quality (high Oleic), and to abiotic (water and heat) stresses. Nematode resistance in the variety NemaTam was introgressed from wild species, and the release of a second wild species derivative is pending.

The NCS19 project has facilitated screening trials for thrips, potato leafhopper, Southern corn rootworm and TSWV resistance, and a number of germplasm lines showed useful levels of resistance.

Improved production practices, including site and seed selection, agronomic practices, pest and disease control, and harvest practices have led to yield increases in most host countries. Disease control practices include the use of local soaps in Ghana.

2.1.2 Management Options

A number of projects have investigated management options and interventions:

NCS19 and UFL13 have successfully demonstrated yield increases possible with integrated management. UFL13 has used growth simulation to characterize yield gaps, and NCS19 has shown the benefits of integrated pest management. Both are developing the predictive capabilities of modeling and GIS procedures for pest, disease, and aflatoxin risk management. Models developed could have use in other countries such as Bolivia and Guyana.

2.2. Training and Capacity Development

Notwithstanding some difficulties experienced by host country scientists when traveling to the US since September 2001, commendable progress has been made in higher degree training. In particular, the TAM 17, UFL13, FAM51 and NCS19 projects have trained a large number of students.

Institutions and scientists in the US and host countries have benefited from training in new procedures and techniques. Expertise in data collection, software development and modeling has been gained in UFL13 and NCS19. UGA28 has contributed to improved transformation techniques resulting in greater recovery of transgenic plants with better fertility.

TAM17 has refined the introgression of useful traits from wild species, the identification of markers for useful traits, fatty acid and oil quality assay capabilities, and molecular biological techniques.

FAM 51 has characterized biochemical responses to drought and has identified drought-resistant genotypes. Screening techniques have been improved, and markers for identification of drought tolerant genotypes have been identified. Proteins are being evaluated for their antimicrobial activity against *A. flavus*.

Scientists, students and technical staff have been trained in molecular biology techniques, and laboratory capacity in biochemical and molecular techniques and peptide analysis has been enhanced, resulting in impressive laboratory facilities at Tallahassee.

Items of equipment have been made available to a number of host countries and include digital cameras and GPS's (UFL13 and NCS19). In addition, labor saving devices for planting, harvesting, shelling have been supplied to collaborators in Senegal, Ghana, Guyana and Bolivia.

In the USA a number of projects have had their capacity to undertake research enhanced by the presence of CRSP supported graduate students and post doctoral visitors. In Florida UFL13 has partially supported a program that has been involved in modernizing the PEANUTGRO model, while in UFL16 a US student is using the project as the basis for her research in plant pathology.

2.3 Technology Transfer

A pleasing improvement in technology transfer has been apparent during this second phase of the funding period. In general, the first phase embraced the development of technologies or interventions, but the second phase has seen major effort directed toward technology transfer.

2.3.1 In Host Countries

Notable achievements are the adoption of improved production practices through field days, workshops and farmer training activities in countries such as Ghana (UFL13 and NCS19) and Bolivia (UFL16) where yields have been increased two-fold, and in Guyana (UFL52) where area planted has increased dramatically. The use of labor-saving devices in Guyana has been emphasized and is well accepted (UFL52).

Effort has been directed toward farmer training in a number of countries and the use of farmers as trainers is a very positive development, notably in Ghana (UFL13 and NCS19), Bolivia (UFL16) and in Guyana (UFL52).

Improved varieties have been identified in a number of countries, often through farmer participatory evaluation, and these are currently undergoing multiplication and deployment: Two short-duration, rosette-resistant varieties have been released in Uganda and one is scheduled for release in Malawi in 2005; improved varieties have been identified in Guyana; a rosette-resistant variety has been released in Ghana; and leaf spot-resistant varieties are scheduled for release in Senegal and Burkina Faso. The adoption of rosette-resistant varieties in Uganda and Malawi are expected to result in yield savings amounting to more than USD 40 million.

Improved harvest and post-harvest practices have been demonstrated in a number of countries, and yield losses and labor requirement have been reduced in Ghana, and food safety awareness is becoming more apparent. However, this is one area that requires increased effort.

2.3.2 In the U.S.A.

In North Carolina, the adoption of tomato spotted wilt virus and Southern Corn Rootworm advisory indices has resulted in 50% reductions in the incidence of each of these pests. In Georgia/Florida the production technologies being developed under these projects are advancing towards the stage where they can be transferred. This will be done by the State/University extension systems.

3. Demonstrated/Potential Impacts :

Very significant impacts have been realized by this cluster of projects, particularly those that have an early application. The program has contributed to significant alleviation of poverty in Guyana where production by the native people of the Rupununi has increased 5 fold during the period of the project.

In Ghana the use of IPM based largely on the use of locally produced soaps with fungicidal properties is providing farmers with yield increases of 200-300 % relative to their former production. Similar gains in productivity are being achieved in Uganda through the adoption of Rosette Resistant lines released by the National Program in a collaborative effort with ICRISAT. The impacts of these technologies are being extended through all the means available to the participants of the CRSP. Where possible the program has assisted in the seed multiplication process, but the resources available determine that the CRSP and its participants can only catalyze the process.

In the USA combination of multiple disease resistance and modified agronomic management allow for farmers to save 80% of their present fungicide application costs through the beneficial effects of resistance interacting with the benefits of mulch and zero tillage (UFL16).

A very major impact of the CRSP in this area has been the enhanced capacity of the CRSP partner in Bolivia. This organization of progressive farmers has established a seed multiplication role for peanuts, and has been designated as the national reference point for peanut technologies in Bolivia, expanding the role of ANAPO to cover the whole country with its expertise, and allowing the organization to successfully compete for funds from other sources (USAID Mission and GTZ Bolivia).

The benefits of the systems/modeling research has been to demonstrate to the Research Management of Ghana that the major opportunities for increased productivity can be discovered without expensive empirical research.

4. United States/Host Country Beneficiaries and Benefits;

A wide range of Beneficiaries can be identified from this cluster of projects. The beneficiaries of the Peanut CRSP in the Production Efficiency cluster are the farmers of Guyana, Bolivia, Ghana, Uganda, and Malawi, and also the farmers in the USA. There are also beneficiaries in the peanut consuming sectors of these countries where the lower prices that occur when production increases enable consumers to afford more nutritious foods.

Another clear beneficiary of projects in this sector are the processors. The release of varieties with high oleic acid peanuts by TAM17 in the USA and their impending release in Africa will improve shelf-life of peanut products allowing them to produce peanut products for sale in markets presently not accessible with their present packaging technologies. Consumers will also benefit from this technology in that lipid chemistry of their blood will be manipulated favorably, so diminishing their risk of heart and cardio-vascular diseases.

5. Building Partnerships:

A wide range of partnerships were developed within this sector. The long-standing partnership with ICRISAT was important to the success of activities by UGA28 in Uganda and Malawi; other intra-CRSP partnerships have developed between the Peanut CRSP and the IPM CRSP, and between projects in this CRSP (NCS19 and UFL 13).

However, the majority of the partnerships that were developed by Peanut CRSP participants to promote their CRSP activities were not supported by the CRSP, rather they leveraged the CRSP project.

Examples of this leveraging are:

The partnerships developed by ANAPO with the 'Valleys Foundation' and the 'Chacos Foundation' for the extension of peanut technologies into those regions.

Partnerships were developed with Compatible Technology International to increase utilization of peanuts in Guyana through the provision of peanut butter milling technologies funded by the Canadian Government.

6. Constraints and Recommended Solutions:

See Section 8 "Next Steps and Directions"

7. Lessons Learned:

The solutions to high production efficiency were variable; in some cases they were achieved by only genetic intervention (for example rosette disease-resistant early maturing varieties in Uganda (UGA28)), in others it was a key input (fungicidal local soaps). In some cases the efficiency change was achieved by a combination of genetic and input technologies (variety tillage/spray combinations in the USA; and sowing date x variety combinations in Ghana).

7.1 Market Pull/Production Push.

A major lesson learned in this area of CRSP activities is that technology change that depends only on improved production techniques can rapidly lead to decreased profitability for the farmer. It is important that there is a balanced research and development program between the production efficiency options and market development. In both Bolivia and Guyana successful transfer of technologies increased production more than the local market could absorb and prices declined significantly and thus discouraged producers. Ensuring market demand is just as important as solving constraints to production.

7.2 Systems Approaches.

The locations where the Peanut CRSP was able to make significant production advances were where understanding of the local constraints to production were established. In Ghana the research on the limitations to yield undertaken in the first 5 years of this phase of the CRSP were applied to solve the most critical constraint to yield.

8. Next Steps and Future Directions:

A logical time in the life of many of the Production Efficiency projects has been reached, and perhaps some fairly major changes need to be made in the 'Request for Proposals' for any future Peanut CRSP.

It is clear that the program has made significant advances in the area of production efficiency, and it is also clear from the experiences in Guyana, Ghana and Bolivia that systematic application of crop science can make rapid changes in production. However, sustaining and transferring these to the broad farming population is more challenging. Careful choice of the priority constraints for the next phase is needed. Quality traits are likely to be as important as productivity.

8.1 Upstream Research

The program should continue to invest in a blend of upstream and applied research. Some of the upstream research needs to be continued. Some of this work is rather long-term, and usable applications are still to be realized; included in this area is the need to expand research in the area of genomic characterization of peanuts. This basic research will greatly increase the efficiency of crop improvement by scientists and breeders in developing countries in the next ten years.

However, we believe the transformation work done in UGA28 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. The work on molecular biology, molecular markers, introgression of useful genes from wild species that is being done in TAM17 is similarly a long-term investment that will be of considerable future benefit. Similarly the research on biochemical and molecular responses to drought being investigated in FAM51 could have long-term benefits, and techniques developed will be of use to improve the efficiency of breeding for difficult traits by other scientists.

8.2 Applied Research

A number of projects have directed effort toward identifying production constraints (yield gaps) and have applied interventions. Production constraints have been identified in the UFL13, UFL16, UFL52, NCS19 and NMX53 projects. The main constraints have been well documented and potential interventions have been applied. These have led to marked increases in yield, particularly as shown in the UFL13, UFL16, UFL52 and NCS19 projects. All of these have gone a step further to deploy these technologies to farmers with spectacular results in some cases.

The UFL13 and NCS19 have made major advances in characterizing the environment and using this information to quantify yield losses. The models developed and refined will form a solid base for predicting productivity limits and the development of risk management mechanisms.

Other projects, notably UFL16, TAM17 and NMX53 have used conventional breeding to transfer useful sources of resistance to agronomically suitable genotypes. These could have wide applicability in many countries.

Our feeling is that there are three areas which merit particular effort in this field:

- greater effort should be directed at the utilization of resistance sources (conventional or novel) developed by the upstream activities.
- variety evaluation should be restricted to the identification of genotypes suitable for release, but once these are identified the CRSP effort must be directed toward seed production, rather than the *ad infinitum* continuation of variety testing. This has paid good dividends in Uganda and needs to be undertaken in Senegal.
- modelling activities should continue with particular reference to risk management (diseases, pests and aflatoxin), but closer collaboration between projects involved in modelling cannot be over-emphasized, particularly in the collection and sharing of data. The models developed could be widely used, particularly by the UFL16, UFL52, TAM17 and NMX53 projects.

9. General Observations:

The Production Efficiency projects appear to have made good progress and project objectives have been largely met. The Farmer Field School model has been very successful in transferring technology to growers and other stakeholders in the industry.

We believe these activities are worthy of sharing in the region, and Ghana may be well placed to be the focus of groundnut technology in the region.

10. Recommendations:

We recommend the holding of a regional workshop as a means to developing a network that would facilitate the transfer of ideas and technologies across the region, for example:

- IPM and Technology Transfer experiences in Ghana
- Community Seed Production Systems in Mali, Niger, Nigeria and Senegal (CFC/ICRISAT Groundnut Seed Project).
- Aflatoxin risk interventions (CFC/ICRISAT Groundnut Seed Project).
- Aflatoxin awareness (CFC/ICRISAT Groundnut Seed Project).
- Producer/ Trader/ Industry/ Consumer partnerships (CFC/ICRISAT Groundnut Seed Project).

Also, we think the Uganda and Malawi variety testing activities could be scaled down, and maybe phased out in the case of Malawi. Initially, the Malawi work was really worthwhile, but since they have identified a suitable variety, we think a change of tack to focus on the extension of this technology through the development of a seed multiplication mechanism is in order, but perhaps outside the bounds of Peanut CRSP.

Peanut breeders in their fields

Peanut CRSP started work in Bangladesh

Peanut hybridisation in Bolivia

1 Project Title and Investigators

UFL13P: Simulation of Peanut Cropping Systems to Improve Production Efficiency and Enhance Natural Resource Management

US Principal Investigator	Dr. Ken Boote	University of Florida
Host Country Principal Investigator- Ghana	Dr. Jesse Naab	Savanna Agricultural Research Institute, Ghana
Host Country Principal Investigator- -Benin	Mr. Adomou Moustapha (until 2004)	*Institut National Des Recherches Agricoles Du Benin (INRAB), Cotonou, Benin*

Host Countries: Ghana and Benin

1.1 Project Objectives

2001-2005 Phase II Project Objectives

Objective	Goals	Status
1	Conduct research experiments specifically focused on critical data needs for peanut model testing in African countries, identify yield gaps, and recommend additional experimentation.	Active
2	Integrate research outcomes of component scientists into the peanut model to expand its predictive capabilities.	Active
3	Apply the PNUTGRO model to current production systems, identify production constraints, and recommend improved production practices.	Active
4	Aggregate regional databases on historic weather and soils, couple with current climate forecasts, to apply the peanut model for purposes of predicting risks of leafspot disease development, aflatoxin contamination, and drought-induced yield losses in West Africa.	Active

1.2 Budget.

The Budget for this project in 2004-2005 was $75,000.00.

This evaluation covers the period from 1 August 2001 to the present.

3 Research Approaches

The main objective of this Project is to use systems modeling to improve resource use efficiency in peanut production.

The approach is 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 minimizing negative environmental impact.

The project has good relevance, although more emphasis should be directed at post-harvest aspects.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

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 disease and lack of fertilizer, have been relatively accurately predicted with the PNUTGRO model. Losses due to pests and diseases can be as high as 50-80%.

The need for additional emphasis on harvesting and drying is recognized.

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.

The recommendation made during the last review to strengthen inter-Peanut CRSP project collaboration amongst those working on GIS and aflatoxin issues has been heeded but could be strengthened further.

3.2 Technical Outputs in United States

3.3 United States Training and Capacity Development/Maintenance

Human resource development amongst government and non-government agencies and institutions, in both HC and U.S., will benefit from capacity building in software development, data collection and modeling skills. Training of scientists and support staff has already had major impact on technology deployment in HC's.

3.4 Host Country Training and Capacity Development/Maintenance

HC scientists have been well trained in data collection, input, and modeling techniques. HC scientists have traveled to the US for training and exposure to scientific methods and techniques. This is felt to be more cost-effective than PI's traveling to the host country. However, recent visa restrictions on visitors to the U.S. may impinge negatively on future HC scientist training.

3.5 Technology Transfer (workshops, publications, patents)

Modeling workshops have been held, and a number of publications have resulted from this work.

A number of farmer field days and workshops have been conducted in Ghana and Benin, and farmers appear to be very receptive to improved technologies. Extension aids have been developed and distributed. Field days have received national television coverage. Recommendations arising from the results of the yield-gap experiments will be transferred to farmers via the field schools and field days that have been shown to be very effective in the Ejura area. A number of field days/workshops have been held to which banks and other NGO's have been invited.

The Project is also collaborating with an NGO (PLAN Ghana) who are working with women's groups. An additional NGO is working on oil extraction from soybean. The company requiring the oil provides inputs, the costs of which are deducted at delivery. It is hoped that groundnut oil extraction may be included in this scheme.

Publications include:

Naab, J. B., P. Singh, K. J. Boote, J. W. Jones, and K. O. Marfo. : 2004 Using the CROPGRO-Peanut model to quantify yield gaps of peanut in the Guinean Savanna zone of Ghana. Agron. J. [Publication type: Journal]

Prasad, P. V. V., K. J. Boote, L. H. Allen, Jr., and J. M. G. Thomas: 2003 Supra-optimal temperatures are detrimental to peanut (Arachis hypogaea L.) reproductive processes and yield at ambient and elevated carbon dioxide. Global Change Biology [Publication type: Journal]

4 Demonstrated/Potential Impacts

Risk management strategies will have very strong applicability for many countries in Africa and worldwide, as well as the U.S. There are good opportunities for the development of regional risk management strategies for site-similar recommendations. Demonstrated impacts include improved yields, and identification and better understanding of physiological constraints to improved production. This will lead to the development of modeling tools to improve crop management. Improved models for growth, yield and aflatoxin risk will identify conditions, and areas, of highest risk for aflatoxin.

Development of improved technology and management packages will have impact on a wide range of stakeholders, including farmers, particularly women farmers in Africa, extension agencies, traders and consumers.

Information will be available on yield/quality trade-off, and consumers will benefit from improved storage/marketing information and strategies. Other difficulties such as harvesting and drying problems have been identified and have prompted the introduction of interventions that will improve yield and quality.

5 United States/Host Country Beneficiaries and Benefits

The project has been able to demonstrate to researchers through the yield gap analysis that the potential for peanut yields is considerable and to direct research policy away from the drive to have short seasoned varieties at the expense of yield. Sowing date simulations indicate that providing the crop is sown at an appropriate date that moisture stress is not a major limiting factor. Disease simulations show that the major opportunity is the management of foliar diseases which justify moderate inputs and emphasize the need to focus the breeding on the provision of foliar disease resistant varieties.

6 Building Partnerships

There appears to be very good collaboration among HC scientists and U.S. institutions, and administrative support from the University of Florida was good, although, once again, there seemed to be a serious delay in fund distribution. Implementation of a new personnel/accounting software package seems to be the cause of this delay, so this may be a temporary situation.

Linkages with agencies involved in food science aspects would be beneficial. There are high expectations for improving local production and ensuring food safety in HC and U.S. industries.

The links with NGOs in Ghana is indicative of the development of partnerships for the transfer of technology and should be encouraged.

7. Constraints and Recommended Solutions

Lack of better integration with related Peanut CRSP projects in the Region has probably restricted accomplishment. Modeling of production constraints can help identify country and regional constraints to production of peanuts and suggest interventions.

8. Next Steps

The project is progressing well and achieving pleasing results. A broad-based and very experienced team should ensure maximum success. There is good collaboration with NGO's and government departments.

Uptake of ideas and technology has been disappointingly slow in Benin, but very good in Ghana. Therefore the project should continue in Ghana, but because of slow adoption, and difficult collaboration, it is recommended that consideration be given to removing the Benin component.

The following adjustments for a future project are suggested:

1. Increase collaboration among other Peanut CRSP projects, especially NCS 19.

2. Emphasis be directed at development of products and uses.

3. Impact assessment and assessment of economics of new technologies such as the feasibility of fungicide application should be looked into.

4. Closer linkage with organizations involved in meteorological data collection and storage to improve quantity and quality of datasets, eg. AGRHYMET in Niamey, Niger.

9. General Observations:

The project was well planned to meet its objectives, but could still be more closely linked to other projects involving modeling, e.g. NCS19P (Brandenburg). Sharing of collected weather data and utilization of weather-related pest and disease distribution information would benefit all parties. Models developed could have use in other countries such as Bolivia (UFL 16) and Guyana (UFL 52).

Rate of progress is good and early recommendation of management strategies will have major impact on yield and quality of groundnuts in Ghana and other African countries.

Peanut experiments in Bangladesh

Segregating peanut lines at ANAPO's peanut breeding center

1 Project Title and Investigators

UFL16. Development and Use of Multiple-Pest Resistance to Improve Production Efficiency of Peanut

U.S. Principal Investigators	Dr. Dan Gorbet (PI) Dr. Jim Todd Dr. Albert Culbreath	University of Florida, Quincy, Florida University of Georgia, Tifton, Georgia
	Mr. Roy Pittman	USDA/ARS Plant Introduction Station, Griffin, Georgia
HC Principal Investigators	Mr. Jaime Hernandez (PI) Mr. Marin Condori (Breeder)	*Asociacion de Productores de Oleaginosas y Trigo* (ANAPO), Santa Cruz, Bolivia

Host Country: Bolivia

1.1 Project Objectives

Phase 2 Objectives	Objective	% Completed
1	Continue to test disease and pest resistance of selected peanut breeding lines, crosses, and germplasm initiated in Years 1 - 5 of the project with multiple-pest resistance.	Completed
2	Assist breeding/agronomic programs in Bolivia to develop multiple-pest and disease resistant cultivars to improve pod yield and quality.	Continuing
3	Assist ANAPO and CIAT to develop a peanut seed program.	Continuing
4	Recommend management practices and techniques to overcome the non-agronomic constraints (e.g. labor), to increase production efficiency that were identified during the first five years of the project.	Continuing
5	Evaluate demand or product use possibilities to determine the domestic market limits to increasing production.	To be carried out in 2005
6	Train a graduate student from Bolivia in plant breeding, plant pathology, and entomology in the U.S.	Not attained

1.2 Annual Budget and Fund Leveraging:

Budget provided by Peanut CRSP in 2004/05 was $80,000. ANAPO has leveraged this project to obtain $100,000 in 2004/05 from the Valleys Foundation and Chacos Fundation in Bolivia to extend and test peanut technologies.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

Researchers used greenhouse experiments and field trials of newly introduced genotypes, local crosses, and traditional Bolivians peanut varieties, and field surveys to determine yield gaps, and level of resistance to diseases, as a basis for recommend interventions.

The project is well planned to meet the objectives as listed above and has a sound scientific, yet practical approach. The broad-based and well-balanced nature of the project is impressive. The U.S. institutions component includes a multi-disciplinary team of scientists and the Bolivian collaborating researchers are drawn from a mix of government and private sector research institutions.

There is very active participation of men and women peanut growers in Bolivia. Technology transfer activities carried out by the *Asociacion de Productores de Oleaginosas y Trigo* (ANAPO) and its partners are through well-organized farmers' associations and farmers' foundations.

No major negative environmental impact is envisaged, but market and utilization considerations need to be kept in mind if major increases in peanut production and productivity are achieved through productivity enhancing interventions. Socio-economic analyses, including gender analysis, would be necessary in the future.

3 Outputs and Achievements

3.1 Technical Outputs in Host Country

Breeding and Variety Selection: One peanut variety was released by ANAPO in 2004. A good range of germplasm has been developed through crossing, both in the U.S. and Bolivia, and some derivatives show considerable potential for resistance to tomato spotted wilt virus (TSWV), leaf spot diseases, and *Aspergillus flavus* (producer of aflatoxin) fungal invasion.

ANAPO released a new variety (Mairana, a white-seeded variety) in 2004, a selection from the earlier introduced U.S. genotypes. It is now under seed production by ANAPO for wider distribution in peanut growing areas in the Mairana valley and other zones. Three potential lines (Accession 32, 72, and 75) are being tested in advanced trials in three zones (in Mairana, 26 Agustos, and Saavedra). A new variety from these three lines could be released in Bolivia in 2005.

Some ANAPO promising lines (including genotypes from U.S.) are being tested by the Promocion de Investigacion de Productos Andianos (PROINPA) for adaptability for the altiplano (mountain zone). Crosses with local wild peanut species is also planned. Programa Investigaciones de Mani (PIROMANI), a private institution that maintains a peanut germplasm bank, including wild relatives, in Cochabamba has given access to its collection to ANAPO's breeders through a formal agreement. ANAPO has also received germplasm from Argentina and Brazil that is included in the ongoing trials.

Production, harvesting, and processing technologies. 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 intensity and weed species; (3) one or two fungicide sprayings based on disease and intensity of inoculum; and (4) zero tillage technology for sustainable peanut production.

Farm machineries. Prototypes of small-scale machinery for digging, threshing, and sorting peanut have been developed with support from Peanut CRSP. The use of these machineries was demonstrated to farmers during field days.

Peanut programs. A National Peanut Program and a Peanut Seed Production Program are in place due to the support of the Peanut CRSP to Bolivia. The government has recognized ANAPO as the national reference institution for peanut research and development. It has developed a private Peanut Seed System that is patterned after its Seed Production System for soybeans, wheat, sunflower, and wheat of ANAPO. Seed, other agrochemical inputs, and technical advice are provided by ANAPO to producers at planting time and paid for during harvest at cost plus a minimal fee.

Consumers' survey. A consumers' survey was carried out in 2002, which showed that the processing industry is not developed, with only 2-3 processors in Santa Cruz and Cochabamba. Peanut soup, preferred by 70% of the respondents, is generally produced in the home using traditional recipes. Other products are roasted and salted peanuts. Consumption is seasonal taking place during the first six months after harvest. The result of this survey is critical in understanding the local market potential and initiating activities in processing and utilization for domestic and export markets. Information on consumers' preferences in the target exporting countries would also be useful.

3.2 Technical Outputs in United States

Crosses between the dominant Bolivian variety, Bayo Grande (BG), and U.S. varieties, and genotypes are showing good benefits. BG x CR99 crosses is showing particular promise. Bayo Grande is susceptible to TSWV, but its progenies being tested in the U.S. are showing good resistance. Bayo Grande has good leaf spot tolerance. Two derivatives have been in U.S. Regional UPPT tests and one could be released in the U.S. in 2006.

3.3 United States Training and Capacity Development/Maintenance

There is limited training and capacity building benefit to the U.S. except that graduate students have been involved, and have traveled to Bolivia to assist with conduct of trials and with data collection. A Ph.D. student (Sarah Gremillion) from the University of Georgia has set-up plant pathology experiments in three locations in Bolivia in collaboration with the ANAPO plant pathologist. Her proficiency in Spanish has been valuable to the U.S./Bolivia collaboration.

3.4 Host Country Training and Capacity Development/Maintenance

Human capacity development. ANAPO has about 45 staff, 50% of whom are working on research and technology transfer. Ten staff is involved in Peanut CRSP research and technology transfer activities Technical training and capacity building in the Host Country have been major benefits. Technical support staff have benefited from interaction with the U.S. Principal Investigators over the years. An ANAPO breeder (Marin Condori) underwent short-term training in the U.S. (UFL and UGA) in 2001 and 2002 on breeding techniques. An agronomist (Ruben Mostacedo), and ANAPO General Manager and later Minister of Agriculture (Diego Montenegro) visited the U.S. in 2003. Rene Escobar, a plant pathologist, is scheduled to undergo short-term training in the U.S. in 2005.

ANAPO staff benefited from exposure to the U.S. peanut industry, have interacted with U.S. Project Investigator, and attended the American Peanut Research and Education Society (APRES) meetings held in the U.S. The staff who received training in the U.S. or who have interacted with U.S. scientists on site visits cited three areas of training that has proven beneficial to their work: (1) improved methodology in establishing field trials; (2) learned how to make crosses between lines of peanut; and (3) UGA and UFL collaborating scientists visited Bolivia at critical times to observe and help rate the trials for characteristics (i.e., disease resistance) and have taught these techniques to their Bolivian counterparts.

In 2001-2005, ANAPO have hosted 15 agriculture student interns (25% women) from the State University of Gabriel Rene Moreno. They have benefited from a season-long internship program with ANAPO while they carry out their thesis on peanut. ANAPO had employed at least four of the interns as researchers and technicians.

Facilities Development. One major addition to the facilities of ANAPO that allows researchers to maintain its breeding program is a modern greenhouse facility with support from Peanut CRSP (about US$40,000).

The reviewers commend the capability of the researchers and their practice of good science.

Degree Training. The objective of supporting a Bolivian researcher to complete an M.S. degree was not attained. ANAPO researchers and U.S. Principoal Investigators needed to set up a mechanism that in the future, Bolivia will benefit from long-term degree training to ensure the sustainability of the National Peanut Program. The English language problem could be solved partly by sending the graduate students to Latin American countries (i.e., Argentina and Brazil). Also, ANAPO can consider the "sandwich" program, being practiced by some African host countries, where the student takes graduate courses in the U.S. and conducts thesis in Bolivia.

Publications. There is a need to increase the number of publications in this project for sharing the significant results and experiences with U.S. and Bolivian scientists as well as those from the Latin American region. The U.S. Principal Investigators have prepared a total of six publications while ANAPO researchers have prepared seven publications (see table below). These include four annual technical reports describing the results of their experiments, several farmers' brochures (agronomic practices, varieties), and Peanut Production Manual that is being finalized. The Bolivian collaborating researchers should be encouraged to publish their results in Latin American journals for increased exposure to the regional peanut network.

List of Publications by U.S. and Bolivian Project Investigators.

Publication Type	U.S.	Bolivia
Journal	1	
Book	1	
Reports	2	4
Abstracts	2	
Farmers Brochures		2
Training Manual		1
Presentations		
Total	6	7

3.5 Technology Transfer (workshops, publications, patents)

In Boliva: There are two factors that contributed to the significant progress in the peanut program in Bolivia. ANAPO plays a key role in technology transfer and seed production. The first factor is ANAPO's strong linkages to technology transfer agencies such as the development foundations (FDTA) funded by a group of donors and farmers' associations. The foundations receive funding from a multi-donor group called SIBTA (System for Bolivian Agricultural Technology) implemented by the Ministry of Agriculture. ANAPO has been contracted by the government through the development foundations to provide technologies and advisory services to small-scale producers.

ANAPO and its partners have conducted numerous meetings and farmer training sessions in Bolivia. Men and women farmers have benefited from field days (i.e., recent Peanut Summit/Tour held in February 2005 and attended by over 100 farmers in the FDTA-Valles region), extension publications and growers' training manuals, and demonstration of simple equipment for harvesting, threshing, and grading. Scientists and technical support staff have benefited from workshops.

Presently, FDTA-Valles/ANAPO is in three areas of the Valles Region, but they plan expand activities into the Chaco Region in 2005. Improved varieties introduced by ANAPO occupy about one-half of the production in the Valles Region.

The second factor is the development of a Peanut Seed Production Program. Seed multiplication activities are implemented by ANAPO, a private association of farmers with seed multiplication responsibilities) have particularly good potential for technology transfer (quality seed and new cultivars). ANAPO sells certified seeds of improved varieties to farmers, facilitating the diffusion of new varieties quickly, one of the bottlenecks in many developing countries. Eight varieties are being multiplied, and counter-season production will speed up the process.

In the United States. In the U.S., the Georgia Peanut Commission has shown keen interest in the collaborative project in Bolivia. Commission members have participated in field days. The Chairperson of the GPC Research Committee has shown particular interest and has been very supportive of the Peanut CRSP activities in Bolivia.

4 Demonstrated/Potential Impacts

In Bolivia: There have been significant outputs that are showing initial impact on peanut research and production in Bolivia. In four years, ANAPO led the development of a National Peanut Program and a Peanut Seed Production Program. The Bolivian Government has recognized ANAPO as the national reference institution for peanut research and development.

This project has already resulted in increased peanut production, which is expected to stimulate the development of a local peanut industry. The area planted to peanut has increased from 2,000 ha in 2001 to 11,000 ha in 2004. Productivity of peanut has increased from less than 1.0 t/ha to 2.0-2.5 t/ha. Most farmers are small-scale producers with 1-5 hectare per farm.
There has been increase in the capacity of ANAPO researchers and technicians resulting from short-term training in the U.S. collaborating universities and from the sustained interaction of U.S. PIs during their visits to Bolivia. The new greenhouse funded by Peanut CRSP has improved the capacity of ANAPO to produce their own local crosses and maintain parent materials.

In the United States: Improved germplasm and the potential to develop TSWV-resistant genotypes will have very strong applicability for the U.S. and other countries. Bolivia, in the region of the geographic origin of peanut, could provide wild relatives to be used by U.S. breeders in producing genotypes with specific characteristics such as disease resistance. This project will generate a wider range of improved germplasm, leading to new varieties with high yield and disease resistance. Already the project has generated interest with the U,S., and the Georgia Peanut Commission has been very supportive of the project. Two varieties from this project have already been entered in UPPT tests in the US for two years, and may result in variety release in 2006.

5 United States/Host Country Beneficiaries and Benefits

Benefits to the Host Country include improved technologies, particularly new varieties and support production technologies. New cultivars, particularly with improved yield and quality, and multiple disease resistance, such as TSWV and leaf spot resistance, will be of considerable benefit.
Improved production will result in increased farmer's income, especially the small-scale producers in poorer areas. Processors and consumers will benefit from better quality, nutritionally superior, and safe foods (aflatoxin-free), especially for children. Increased production will stimulate alternative uses in the domestic market or for export.
Improved pest and disease resistance will reduce the use of pesticides and risk of environmental degradation and is good for the health of farmers.

6 Building Partnerships

This multidisciplinary approach, embracing government, private sector institutions, and farmers' associations, including seed production program in Bolivia, is making rapid progress and should ensure maximum success. ANAPO has several current and potential research and development partners, including: (1) *Promocion de Investigacion de Productos Andianos* (PROPINPA) that is testing some of ANAPO's peanut genotypes in the highlands (including those from the U.S. through Peanut CRSP), with supervision of ANAPO's peanut breeder since ANAPO is not working directly in the Antiplano Region; (2) the University of Cochabamba (Ingr. Bambrana) on testing of appropriated machinery for small-scale farmers, complementary to ANAPO's farm machinery project; (3) *Programa Investigaciones de Mani* (PIROMANI), a private entity that collects and conserves peanut germplasm (including wild species) located in Cochabamba; and (4) the Foundations (FDTA) under SIBTA.

Good relationships have been fostered between small-scale peanut producers, ANAPO, development foundations, and the local food industry. Interest by a Japanese company to export peanut to Japan and some Latin American countries (Peru, Colombia) has also been stimulated. Linkages with agencies involved in food science aspects would be beneficial.
Good relationships have been fostered between the University of Florida, The University of Georgia, ANAPO and its development partners, and the local private industry. Active support by producer organizations in the U.S. is a very positive development.

7 Constraints and Recommended Solutions

Administrative support from the University of Florida was good, but funding delays were again raised as a serious constraint. Electronic transfer of funds from U.S. to Bolivia should be considered in the future.

There are no Bolivian researchers who completed advanced degrees, hence, this project objective was not realized. ANAPO staff said low English proficiency created some difficulty in undergoing training in the United States. In the future, Peanut CRSP can consider sending Bolivian researchers to universities in the region (i.e., Brazil and Argentina).

8 Lessons Learned

The successful experience in Bolivia indicates that for peanut technologies to be adopted by farmers, research has to be complemented by a strong technology transfer effort and a seed production program. Participation of technology transfer/extension institutions and farmers' associations has facilitated the access of farmers to new peanut varieties, management practices, and information. It also generated the interest of the Bolivian government to increase the priority of peanut in agricultural research and development.

A holistic approach, considering the full value chain, is needed in future Peanut CRSP work. Peanut production increased very quickly in Bolivia. A more balanced program of production efficiency to post-harvest, processing, and marketing could be introduced early to allow value addition as well as prevent price fluctuations when production increases occur. It will also diversify the stakeholders of peanut research and would benefit more people eventually.

9 Next Steps and Future Directions

More short-term training is needed as the Bolivian Peanut Program shifts to processing, utilization, and marketing. Expertise is available in the collaborating U.S. universities to allow quick response, even within the remaining program period. For the next phase, long-term degree training should be considered, as is the case in most of the collaborating countries. Intensive English training of ANAPO staff is needed to tap the opportunities for U.S. training. This scheme will ensure the sustainability of the National Peanut Program in Bolivia, and specifically to sustain the capacity within ANAPO. The ANAPO plant pathologist is scheduled to go to U.S. in 2005 to be trained on plant pathology research methods.

ANAPO is very interested to start collaboration on the food technology aspects, especially to identify peanut products that have export potential to Colombia and Peru for processing in Bolivia. In 2005-2006, ANAPO would like to request food science expertise from U.S. (especially UGA), to carry out rapid assessment of the food industry of Bolivia, specifically Santa Cruz where ANAPO has concentrated activities) to determine potential peanut-based products, willingness of the private sector food industry to participate, and assess the in-country capacity for food technology research and product development.

10 General Observations

Strength: Rate of progress on the achievement of the project objectives has been very satisfactory and can be attributed to a broad-based and very experienced U.S. and ANAPO teams, which should ensure maximum success. Technology transfer through the program has resulted in production above present consumption, which may cause glut in the market. Purchase by the Japanese company has adsorbed some of the over production. In order for farmers to continue to expand production and reap the economic benefits, research in food technology needs to be implemented to develop an expanded choice of peanut products to expand domestic consumption. Peanut soup and roasted peanuts are the primary uses at present with a peanut beverage served in restaurants.

A valuable linkage with the Philippine and Thailand projects could be made to introduce the Industry Incubator concept to transfer food processing technologies from research to the processor. Peanut CRSP has strong food technology projects and the U.S. Project Investigators can provide the technical expertise to Bolivia for this purpose.

Strength: The exchange of germplasm to U.S. from Bolivia, one of the countries of origin of peanut, through the Peanut CRSP, is providing U.S. with valuable source of Bolivian peanut varieties (i.e., Bayo Grande) for its breeding program for resistance to diseases. It will also provide sources of wild peanut species that could further enhance the U.S. peanut breeding program in UFL and UGA.

Weakness: Language has been seen as a drawback, both for U.S. scientists visiting Bolivia, and for ANAPO researchers and staff visiting the U.S. However, a U.S. graduate student now working actively on the project has had training in Spanish and has eased the situation.

Weakness: Funding delays are seen as a major constraint. 2004 funds had still not been released by December. All Project Investigators in the UFL-based projects have raised this problem. Implementation of new fiscal software package seems to be the major cause. Direct funding of ANAPO by P-CRSP, if possible, would be a major advantage. UFL and ANAPO administrators should discuss the option of electronic transfer of funds.

11 Recommendations

Project Specific. The progress achieved is highly commendable. Continuation of the project is recommended into the next phase with due consideration of the following aspects:

- The peanut breeding program in Bolivia should continue into the next phase with variety/technology development and deployment.
- In the next phase, emphasis should be given to marketing, food utilization, and new product development; linkage to the Philippine and Thailand projects could facilitate implementation of the incubator model to transfer technology from research to the processor.
- Continue promotion of the use of small equipment and machinery, particularly for harvesting and drying to ensure quality raw products.
- Pest surveys and pest management interventions could be useful, especially integrated pest management with continuing focus of pest resistance and less reliance on pesticides.
- Linkage with the project in Guyana (UFL 52) may be beneficial; also to the food technology project in the Philippines (UGA04) and the training project in Thailand (UGA37).
- Continue strengthening seed production systems and new technologies such as deployment of new varieties as quickly as possible to farmers.

General: Drs. Gorbet and Todd are due to retire soon, but are keen to continue their involvement in the Peanut CRSP projects after retirement, but only in these (Peanut CRSP) projects. This should be encouraged. The Peanut CRSP Management entity should consider the retirement of some U.S. Principal Investigators since this will affect future sustainability of collaborative activities in the Host Countries. The Management Entity should develop a mechanism or strategy to replace the senior Project Investigators by mentorship of younger professors while they are in place (up to end of project in 2006) and for accessing the expertise of the retired Principal Investigators (i.e., UFL16) in some mutually beneficial arrangement.

1 Project Details and Researchers

TAM17P: Breeding Peanut for Better Productivity and Quality.

US Principal Investigator	Dr. Mark Burrow	Texas A&M University, Lubbock TX
HC Principal Investigator - Senegal	Dr. Osmane Ndoye	*l 'Institut Sénégalais de Recherches Agricoles (ISRA),* Bambey, Senegal
HC Principal Investigator – Burkina Faso	Dr. Philippe Sankara Dr. Zagre Bertin	Universite de Ouagadougou Institut de l'environnement et des recherches agricoles (INERA)

1.1 Project Objectives

Objective	Goals	Status
1	Develop peanut lines and varieties with early maturity.	Active
2	Develop peanut lines and varieties which have leafspot resistance, and incorporate this resistance into lines with other resistances.	Active
3	Develop peanut lines which have better yield capability and improved quality.	Active
4	Develop erect type varieties of peanut which have fresh seed dormancy.	Active
5	Preserve, evaluate, and utilize wild *Arachis* species from South America.	Active
6	Training: Graduate and undergraduate students.	Active

1.2 Budget

The Budget for this project in 2004-2005 was $115,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

Minor changes to the objectives have come about as a result of the moving of peanut production, and project scientists, to West Texas. Also, discontinuation of Project TAM 14 has resulted in some of the objectives of that project being combined into TAM 17.

The project is sound, technologically advanced, and somewhat upstream in nature, but is probably necessary to develop strategies to achieve the desired introgression of resistances that are available in the genus.

There is great potential for use, in the development of new varieties, of disease resistance, nematode resistance, earliness and quality traits that exist in the wild species.

Progress has been made in evaluating genotypes for reaction to foliar diseases and identifying early maturing lines with improved agronomic and quality traits.

Sources of resistance to *Sclerotinia*, TSWV, and to abiotic (water and heat) stresses have been identified. Nematode resistance in the variety NemaTam was introgressed from wild species. The release of a second wild species derivative is pending.

Deployment of disease- and pest-resistant varieties will reduce the need for pesticides and result in more eco-friendly agriculture. In the HCs, there is potential for development of early maturing, large-seeded varieties with seed dormancy and improved quality.

3. Outputs/Achievements

3.1 Technical in Host Countries

3.2 Technical Outputs in US:

The development of genetic markers for improvement in breeding for resistance to diseases, insects, and biotic stresses has been important to Texas/US.

The release of the nematode resistant variety "Nematam" will be important to Southwest US peanut production.

The success in the development of high oleic/low linoleic acid germplasm/varieties is important to the US industry.

Continued exploitation of genes from wild species is important for traits not normally found in the cultivated species.

3.3 US Training and Capacity Development/Maintenance:

Capacity development has been primarily in the improvement of genetic techniques, such as marker development and use of wild germplasm.

Undergraduate students employed in the program have benefited in knowledge gained and could later go into graduate training and research.

3.4 HC Training and Capacity Development/Maintenance:

Advances in molecular biology, particularly with the development, through backcrossing, of near-isogenic lines, will be of use in the introgression of useful traits from wild species, and the development of new varieties. Progress has been made in the identification of markers for useful traits.

Equipment, and technical capacity is being improved. Recent additions include fatty acid and oil quality assay capabilities.

Students are being trained in molecular biological techniques.

3.5 Tech Transfer:

Germplasm: Nematode resistant lines, F2s for high Oleic, and BCF3 backcrosses have been sent to Ghana. Crosses and BCF3 backcrosses have been sent to Burkina Faso, and nematode resistant lines (including Nematam), early lines and high oleic lines to Mozambique.

Workshops, field days, demonstrations and trials have been conducted in Senegal.

Publications:

Ndoye, O. et P. Sankara. (in press). Synthèse des travaux sur les cercosporioses de l'arachide au Sénégal. Revue Sénégalaise de Recherche Agricole et Agro-alimentaire.

López Y., Nadaf H.L., Smith O.D., Simpson C.E., and Fritz A.K. 2002. Expressed variants of _[12] Fatty acid desaturase for the high oleate trait in Spanish market-type peanut lines. Mol. Breeding: new strategies in plant improvement. 9 (3):183-190.

López Y., Smith O.D., Senseman S.A., and Rooney W.L. 2001. Genetic Factors Influencing High Oleic Acid Content in Spanish-type Peanut Cultivars. Crop Sci. 41(1):51-56.

4. Demonstrated/Potential Impacts:

New cultivars with disease resistance, seed dormancy and oil quality that increases shelf-life are near release in Senegal and Burkina Faso.

A new cultivar was released in Texas with properties that reduce rancidity, which has been a major benefit by industry/ processors toy extending the shelf-life of products. A nematode resistant cultivar was released in Texas and transferred to farmers in nematode-prone areas.

5. US/HC Beneficiaries and Benefits:

In the HCs, there is potential for development of early maturing, large-seeded varieties with seed dormancy and improved quality (O/L ratio) for Senegal, and the release of varieties with improved levels of leaf spot resistance and seed dormancy for use in Burkina Faso is imminent.

Development and deployment of enhanced germplasm will have a significant impact on farmers, traders and consumers by improving local production and ensuring food quality and safety. Reduced use of pesticides will have a positive impact on environmental issues. Short-duration varieties will have wide applicability in many African Countries. These will be able to better avoid droughts, and terminal moisture stress that may predispose the crop to invasion by Aspergillus sp.

Superior varieties with improved oil quality are required in LDCs, as well as in the U.S.

Graduate training and capacity building will benefit human resources development in HC agencies. Graduate students, including females, and currently students from Ghana and Mozambique, are being trained in molecular biological techniques. The student from Mozambique is funded by the USAID Mission in Mozambique.

In Ghana, benefits have included the supply of equipment (digital camera, balances, threshers), and project funding has been enhanced.

In Burkina Faso, training and the supply of some equipment have been of benefit. Addition of funding for the project has enabled some work to be done that would not otherwise have been possible.

Development and refinement of molecular biology techniques to aid in the introgression of resistances from wild species will make a significant contribution to peanut (and other crop) improvement in the U.S.

6. Building Partnerships:

Good collaboration has been developed between the TAM17 project and Texas Tech University and New Mexico State University. The wild species work being continued by Dr Charles Simpson is still of considerable benefit to the project, and could also be useful to the New Mexico project.

The student from Mozambique is funded by the USAID Mission in Mozambique.

7. Constraints and Recommended Solutions: \

The closure of TAM14 and integrating priority objectives into this project, and the new Texas A&M PI being at a different location has been a moderate constraint to overcome. Equipment and vehicle maintenance are needed in the host countries.

8. Lessons Learned:

Germplasm important to the US, ie the high oleic oil lines and leafspot disease resistant line have application to the host countries, emphasizing the benefits of CRSP research (benefits to both US and host countries).

9. Next Steps and Future Directions:

The project is progressing well. Some of the "up-stream" research is, of necessity, long-term, but will, in time, have marked benefits. Continuation is recommended, particularly in the following aspects: Lubbock: 1. breeding for earliness and quality 2. breeding for leaf spot resistance 3. breeding for drought and heat stress tolerance 4. development of markers" SSR" and "SNP" 5. assistance to the breeder in New Mexico

Stephenville: 1. wild species research, particularly on Arachis praecox, 2. recombinant inbred mapping, and 3. assistance to the breeder in New Mexico

Senegal: 1. training of a new breeder, 2. molecular biology training, 3. combine earliness with seed dormancy, and 4. assistance with technology and economic assessment of seed production systems.

Burkina Faso: 1. variety releases with leaf spot resistance and seed dormancy, 2. support for MS student at Univ of Ouedrago, 3. facilities and vehicle necessary for the breeder, and 4. assistance with technology and economic assessment of seed production systems.

Mozambique: 1. training for student Amade, 2. earliness and high O/L material, 3. nematode resistance, and 4. assistance with technology and economic assessment of seed production systems.

Ghana: 1. support for student Nicholas Denwar, 2. leaf spot resistance breeding and seed dormancy, and 3. assistance with technology and economic assessment of seed production systems.

ICRISAT: 1. to investigate IPR in order to facilitate better germplasm exchange

10. General Observations:

The potential for success is excellent. Improved germplasm will have a major impact on yield and quality of groundnuts.

Closing of the TAM 14 project was a constraint, but TAES are active in finding a replacement for Dr Simpson. Although retired, Dr Simpson wishes to continue to be involved in TAM 17 and is actively involved in wild species preservation, population maintenance and crossing. This work is still of considerable benefit to the project, and has potential to be of use to the New Mexico project. There is good collaboration between the TAM17 project and Texas Tech University and New Mexico State University.

There are still constraints in host country project funding, for example, the need for threshers and vehicle maintenance is a constraint. There has been a delay in oil quality measurement in the host countries through lack of locally available capacity. Also, delays in funding have been experienced - changes of fiscal year date, or revision of annual breakdown for end-of-year funds may help.

US visa restrictions may impact negatively on training in US. Training in the host country may be necessary, but recent improved coordination with the TraiNet system may help.

PIs are concerned about a perceived constraint in the use of ICRISAT germplasm, as MTA agreement conditions do not allow for plant patenting. ICRISAT material is not available through USDA.

Seed multiplication of new releases in the host countries was likely to be slow and development of linkages with seed programs was likely to be necessary.

It was felt that there was a need to do marker work in Ghana. There would be a need to have facilities in Ghana, but it may be necessary to convert from RFLPs to PCR-based markers to make this easier.

Peanuts in the Valley Region of Bolivia

A Peanut Tour Stop showcases the industry in Georgia

1 Project and Researchers

NCS19P: Improved Production Efficiency Through Standardized, Integrated, and Enhanced Research and Technology.

USA Principal Investigator	Dr. Rick Brandenburg	North Carolina State University, Raleigh NC
HC Principal Investigator	Dr. Mike Owusu-Akyaw	Crops Research Institute, Kumasi, Ghana
USA Co-Principal Investigator	Dr. David Jordan	North Carolina State University, Raleigh NC

1.1 Project Objectives

Objective	Goals	Status
1	Increase production efficiency through the development and deployment of IPM practices with emphasis on diseases and insects.	Active
2	Document the impact of weeds as pests	Active
3	Integrate aflatoxin risk into the disease and insect management strategies and determine influence of production and pest management practices on aflatoxin incidence.	Active
4	Train one host country scientist as a Ph.D. in Entomology or Plant Pathology.	Active

1.2 Annual Budget:

The Budget for this project in 2004-2005 was $105,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

The main objectives of this Project are 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.

This project has a good practical approach, is well planned and embraces a broad multidisciplinary effort. This involved: pest and disease incidence surveys to quantify crop losses and to prioritize the research; evaluation of germplasm for resistance to the identified constraints; use of GIS for processing pest and disease distribution data; and implementation of IPM management strategies

The anticipated reduction in use of pesticides, and use of local soaps, will have implications for environmentally-friendly agriculture. These interventions could have wide application regionally.

In North Carolina, the focus has been on the development of management strategies for tomato spotted wilt virus which is vectored by thrips, development of management strategies for control of Southern Corn Rootworm, evaluation of insect resistant germplasm, evaluation of insect control strategies, developing an improved understanding of insect pest biology and ecology (thrips), and pest forecasting.

In Ghana the research teams at both Crops Research Institute and the Savanna Agricultural Research Institute have been productive and on-track for solving the pest management issues associated with groundnut production in Ghana and West Africa.

3. Outputs/Achievements

3.1 Technical Outputs in HC:

The research has focused on developing good survey data on the major pest problems, conducting crop loss assessment studies, evaluating more than 30 lines of groundnuts, conducting trials on control methodologies including local soaps for leafspot suppression, and actively involving participant farmers in 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 *A.flavus*. 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 yield 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.

Collection of meteorological data from Ghana has assisted in improving datasets for modeling. Mutual benefit could be achieved by sharing of data between NCS19 and UFL13.

It appears that activity in modeling for aflatoxin risk management has been limited, but collaboration and data sharing with UFL 13 would be highly beneficial.

3.2 Technical Outputs in US:

Screening trials and evaluations have been completed for thrips, potato leafhopper, Southern corn rootworm and TSWV 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.

More than a dozen publications have resulted from Peanut CRSP funded research.

These programs have been successful from both the scientific perspective in that they have they have resulted in numerous refereed publications(more than a dozen publications have resulted from Peanut CRSP funded research), and from the aspect of helping North Carolina and US peanut farmers through new technologies that reduce the impact of insect pests through cost effective programs. The development of the tomato spotted wilt virus index and its adoption by farmers has been a classic example of this progress and impact.

3.3 US Training and Capacity Development/Maintenance

The funding has been a major driving force in what we have been able to study in North Carolina. This Peanut CRSP funding has been a part of all of our research programs and it critical. Current peanut research in North Carolina would only be a small percentage of its current level without PCRSP funding. Observations of cultural practices and production schemes in Ghana have provided insight into tomato spotted wilt virus research in the US.

In the U.S., progress in identification of resistance, and provision of advisories to growers regarding TSWV risk, has been a major benefit to the NC peanut industry. There has been a change of emphasis to weed control since the untimely death of Jack Bailey, and the problem of weeds in Ghana has been recognized. This project has assisted in graduate student training, and allowed for impact assessment studies (NCS07).

Institutional development is resulting from accumulation of research data and developing modeling tools.

3.4 Host Country Training and Capacity Development/Maintenance

Human resource and institutional capacity building in the HC has been achieved, particularly in terms of training and provision of equipment. Pest survey and environmental data has been collected and scientists have been exposed to modeling techniques. The host country has also benefited from: 1) Student training, 2) improved capacity in conducting trials, data collection, and modeling, 3) provision of necessary items of equipment (harvesting equipment, digital camera, GPS)

Ghana has benefited greatly from the introduction of interventions to improve production. The development of Farmer Field Schools has been particularly effective in technology transfer to farmers, and field days (one was televised widely in Ghana) have been well received. Training videos and DVDs have been produced. Interaction with farmers in one village (including about 50% women) was ample evidence of the rapid adoption of improved practices. The farmers were very enthusiastic and were eager to learn more about improving their yields and incomes. They were equally eager to impart knowledge to other farmers. Farmers in the Ejura region claim they have doubled their yields since participating in this program.

Extension workers are extremely enthusiastic about the advances made and have written letters of appreciation to the PI's and shared photographs of their activities.

Some of the better farmers have been singled out as extension examples to lead the community in the adoption of new technology.

Only two publications have resulted to date from this effort, but many more are in preparation, including an IPM Manual.

3.5 Technology Transfer (workshops, publications, patents)

Publications:

C Hurt, R Brandenburg, D Jordan, B Shew, T Isleib, M Linker, A Herbert, P Phipps, C Swann, W Mozingo: 2003 Managing Tomato Spotted Wilt Virus in Peanuts in North Carolina and Virginia North Carolina Extension Service AG-638 [Publication type: OTHER]

D Jordan, J Bailey, R Brandenburg, S Marlow, M Linker, M Rayburn, J Spears, G Naderman, D Teer, and JBeam: 2000 Knowing Your Field A Guide to On-Farm Testong for Peanut Growers North Carolina Cooperative Extension Service AG-615 [Publication type: OTHER]

D L Jordan, C W Swann, J F Spears, R L Brandenburg, J E Bailey, and M R Tucker: 2001 Comparison of Virginia and Runner Market-Type Peanut (Archis hypogaea) Grown in the Virginia-Carolina Production Region Peanut Science [Publication type: JOURNAL]

D L Jordan, P D Johnson, A S Culpepper, J S Barnes, C R Bogle, G C Naderman, G T Roberson,J E Bailey, and R L Brandenburg: 2002 Research in North Carolina with Reduced Tillage Systems fro Peanut (1997-2001) E. van Santen (ed.) 2002. Making Conservation Tillage Conventional: Building a Future on 25 Years of Research. Proc. of 25th Annual Southern Conservation Society [Publication type: PROCEEDINGS]

David L Jordan, Gail G Wilkerson, and David W Krueger: 2003 Evaluation Of Scouting Method in Peanut (Arachis hypogaea) Using Theoretical Net Returns from HADSS
Weed Technology [Publication type: JOURNAL]

DL Jordan, J F Spears, R L Brandenburg, A B Brown, B Shew, and G T Roberson: 2003 Peanut Information North Carolina Cooperative Extension Service AG-331 [Publication type: OTHER]

Garcia, L E, Brandenburg, R L, Kennedy, G G, Bailey, J E, and Bradley, J R: 2003 Winter occurrence and spring migration of Frankliniella fusca (Hinds) (Thysanoptera: Thripidae) in North Carolina peanut (Arachis hypogaea L.) fields.
Peanut Science [Publication type: JOURNAL]

Herbert, Jr, D A, A S Malone, R L Brandenburg: 2003 Evaluation of the Southern Corn Rootworm Advisory for Peanut. Peanut Science [Publication type: JOURNAL]

Herbert, Jr., D. A., S. Malone, R. L. Brandenburg.: Evaluation of the Southern Corn Rootworm Advisory for Peanut Peanut Science [Publication type: JOURNAL]

Hurt, C. A., R. L. Brandenburg, D. L. Jordan, G. G. Kennedy, and J. E. Bailey.: 2004 Management of Tomato Spotted Wilt Virus Vector Frankliniella fusca (Thysanoptera:Thripidae) in Virginia Market Type Peanut
J. Econ. Entomol. [Publication type: JOURNAL]

Jordan, D L, J S Barnes, C R Bogle, R L Brandenburg, J E Bailey, P D Johnson, and A S Culpepper: 2003 Peanut Response to Cultivar Selection, Digging Date, and Tillage Intensity. Agronomy Journal [Publication type: JOURNAL]

Lanier, J. E., D. L. Jordan, J. F. Spears, R. Wells, P. D. Johnson, J. S. Barnes, C. A. Hurt, R. L. Brandenburg, and J. E.. Bailey.: 2004 Peanut Response to Planting Pattern, Row spacing, and Irrigation. Agron. J. [Publication type: JOURNAL]

Lanier, J. E., S. R. Hans, D. L. Jordan, P. D. Johnson, J. S. Spears, R. Wells, C. A. Hurt, R. L. Brandenburg.: Sicklepod Control in Peanut Seeded in Single and Twin Row Planting Patterns. Peanut Science [Publication type: JOURNAL]

Lemay, Andrea, J E Bailey: Peanut resistance to and the efficacy of acibenzolar-s-methyl and fluzinam on sclerotinia blight. Plant Disease [Publication type:]

Linker, H M, DA Herbert, Jr, and R L Brandenburg: 2003 The Southern Corn Rootworm Peanut Advisory Virginia Cooperative Extension Publ. No. 444-351 [Publication type: OTHER]

Mary Ann Rood: Disease Advisories: The Peanut Farmer [Publication type: OTHER]

Naab, J. B., F. K. Tsigbey, P. V. V. Prasah, K. J. Boote, J. E. Bailey, and R. L. Brandenburg: 2004 Effect of Sowing Date and Fungicide Application of Yield of Early and Late Maturing Peanut Cultives Grown Under Rainfed Condtions in Ghana.
Crop Protection [Publication type: JOURNAL]

Scott, J H, R L Brandenburg, and G G Kennedy: 2003 Laboratory bioassay evaluating peanut seedlings for resistance to the southern corn rootworm, Diabrotica undecimpuntata howardi Barber (Coleoptera: Chrysomelidae). Peanut Science [Publication type: JOURNAL]

Tsigbey, F. K., R. L. Brandenburg, and V. A. Clottey: 2004 Peanut Production Methods in Northern Ghana and Some Disease Perspectives. World Geography of the Peanut Knowledge Base website [Publication type: PROCEEDINGS]

4. Demonstrated/Potential Impacts:

In Ghana, farmers that have adopted IPM technologies have increased yields two-fold and there is still room for improvement. The 2X increase in yield by farmers in Ejura has been impressive after just two years of working with farmers. The surveys and documentation of yield loss to various pests and the development of appropriate technology to manage these pests has been well targeted and will continue pay numerous dividends.

In North Carolina, 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 southern corn rootworm treatment of preventive applications with insecticides on a vast portion of our acreage has been reduced to only those acres that are "high risk" This has been made possible through an advisory program that is supported by Peanut CRPS supported research.

5. US/HC Benefits:

In Ghana:

Adoption of improved production practices such as careful site selection, minimum tillage (using herbicides), seed selection, planting in rows, and integrated pest management practices have led to reduced labor requirement and marked increases in yield and profitability of groundnuts. Prices paid for groundnuts (C 700,000 per bag) appeared quite attractive compared to C 350,000 per bag for maize.

Farmers, although less than 30% are women, will benefit from higher yields, improved food security and higher income through adoption of new technologies. Consumers will benefit from better quality and safer foods, particularly for children.

Human resources development in both the government and non-government agencies will benefit from capacity building, however more training opportunities are recommended.

In the U.S.

A wider range of germplasm will become available to US breeders, and there is great potential for the development of improved varieties with good resistance to TSWV.

The development of resource-efficient, pest management packages would have impact on farmers and extension agencies in both the U.S. and Ghana. Regional opportunities for development of risk management strategies for site-similar recommendations are good. The projects modeling cropping systems and aflatoxin contamination should also benefit from the data accumulated.

Research and survey data being incorporated into GIS databases will enhance pest distribution and occurrence maps in the U.S. and many other countries.

Increased inter-project collaboration is essential to strengthen this program.

6. Partnerships:

Good relationships have been developed with counterparts in the host country. A multidisciplinary approach to groundnut improvement has been developed, and scientists and extension staff are working well together to improve production.

The development of linkages with other disciplines is highly recommended. There could be major benefit from pooling resources, particularly data collected and advances in modeling.

7. Constraints:

The untimely death of the CO-PI at North Carolina State University necessitated the shift in emphasis from diseases to weeds, the expertise of the new CO-PI, even though weeds are important in Ghana and Benin.

8. Lessons Learned:

The team approach to an IPM based program has been successful in relieving constraints and increasing peanut yields in Ghana.

9. Next Step:

Progress, especially the enthusiastic transfer, and adoption, of technology is pleasing and the team's efforts are to be commended.

This broad-based and very experienced team should ensure maximum success. The project should continue, but suggestions for closer linkages and greater involvement of other disciplines should not be overlooked. There could be major benefit from pooling resources, particularly data collected and advances in modeling. Areas of concern, and potential benefit, include:

1. Health and food safety considerations.

2. Closer collaboration with UFL 13 on adaptation and adoption of the aflatoxin sub-model since the association of insect damage and aflatoxin is well established.

3. Consideration should be given to the PIs suggestion of using Ghana as a lead institution in the West African region.

4. Closer collaboration amongst the projects being conducted in Ghana is highly recommended.

5. There is great potential for reducing crop losses through improved post-harvest operations and storage. Relating pest management, especially soil arthropod management to aflatoxin levels

in groundnuts is important. In the next phase, moving forward with technology transfer of current research findings to groundnut farmers and documentation of impacts.

6. Publishing the volumes of research findings to help scientists in the rest of Africa.

Some other areas that may benefit from strengthening are:

1. The evaluation of new varieties and participatory variety selection. The involvement of breeders and agronomists together with farmers, traders and consumers is recommended to ensure that variety improvement is market-driven rather than technology-driven.

2. Seed multiplication of newly adopted varieties is also an area requiring attention.

3. Research in US will continue to focus on plant resistance, pest ecology, and tomato spotted wilt virus resistance.

10. General Observations:

Rate of progress is good. The approach has been sound and systematic. The development of the team in Ghana is encouraging and lays the foundation for future success. Management strategies could have major impact on yield and quality of groundnuts. With impressive increases in yield and production, the possibility of production surpluses must not be ruled out, and options for storage and alternative uses must be borne in mind. Linkages with agencies involved in food science and food safety aspects would be beneficial.

Wild relatives of peanut have been used to provide normally unavailable genes for the cultivated variety.

Prof. Samuel Sefa-Dedeh, a Ghanaian food scientist who participates in the Peanut CRSP.

1. Project Name and Participants

UGA28P: Control Strategies for Peanut Viruses: Transgenic Resistance, Natural Resistance, and Virus Variability.

US Principal Investigator	Dr. C. Deom	University of Georgia
Host Country Principal Investigator -Uganda	Dr. Charles Busolo-Bulafu	Serere Agricultural and Animal Protection Research Institute (SAARI), Uganda
Host Country Principal Investigator -Malawi	Dr. Charles Mataya	Dept. of Rural Development, Chitedzi. Malawi

1.1 Project Objectives

Objective	Goals	Status
1	To develop transgenic groundnut lines with pathogen-derived resistance to groundnut rosette disease and spotted wilt disease.	Active
2	To breed naturally occurring resistance to groundnut rosette disease into agronomically important early maturing and/or drought resistant cultivars of *Arachis hypogaea*.	Active
3	To increase the quantity of seed of high-yielding, groundnut rosette disease resistant groundnut and evaluate the resistant germplasm in Uganda.	Active

This evaluation covers the period from 1 August 2001 to the present.

1.2 Annual Budget:

The Budget for this project in 2004-2005 was $95,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

This project has a sound scientific base, and although necessarily longer-term, could provide useful additional sources of resistance to the natural resistance already successfully used for rosette virus and TSWV resistance.

Economic and social benefits are enormous, particularly since much of the groundnut crop in Africa is grown by women farmers for whom it is their sole source of income.

Increased production of better quality groundnuts will have important benefits to health and safety, particularly for children.

The reduced use of pesticides in some areas could have important beneficial impact on the environment.

3. Outputs/Achievements

3.1 Technical in HC:

Adoption of rosette-resistant varieties has already had major impact in Malawi and Uganda.

The long-season rosette-resistant variety Nsinjiro (ICGV-SM 90704) has already been released for use in Malawi. ICG 12991 has been released in Malawi as Baka. ICG 12991 is a short duration (90-110 days to maturation), drought tolerant spanish-type groundnut earmarked for both rainfed and residual moisture groundnut production. Over 3 tons of Baka has been multiplied and made available for commercial production both under rainfed and residual moisture peanut production.

In Malawi in four years of testing, ICGV-SM 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 12991 was released in 2002 as Serenut 4T (tan-seeded), and ICGV-SM 93530 has been released as Serenut 3R (red-seeded). Seed is currently being multiplied.

3.2 Technical in US:

The transformation work done in UGA28 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 with the result being the generation of a number of trangenic plants carrying the viral sequences for resistance induction being obtained. Transgenic plant verification has been by PCR, showing the presence of the transgene in genomic DNA. Northern and Southern blot analyses are being conducted. Fifteen transgenic lines are going through a seed increase in the greenhouse. This seed will be used for a seed multiplication in the field in 2005. Subsequent seed will be tested for field resistance in the future. Up until 2004 we were introducing the coat protein gene of GRAV into AT120 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 we have begun transforming AT120 and Georgia Green 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 should to be highly effective in the laboratory and will be equally effective in applied situations. With the RNAi approach less trangenic plants need to be generated because the percentage of transgenic plants showing resistance using RNAi are high (generally >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 US farmers. Future possibilities include the development of transgenics with resistance to foliar fungal diseases, particularly leafspot.

3.3 US Training and Capacity Development:

A US student was supported through the 2003 budget cycle.

3.4 HC Training and Capacity Development:

HC scientists and technical support staff have benefited from training and capacity building.

Since 2001, nearly 1,000 farmers attended farmers field days conducted during both the summer and winter periods. During this time, new varieties and production technologies were demonstrated.

Nearly 1,000 farmers attended farmers field days conducted during both the summer and winter periods. During this time, new varieties and production technologies were demonstrated.

Training and exposure of HC scientists to transformation technologies used in US will assist in capacity building. Bringing HC scientists to the US has been a more cost-effective way of exposure than PI travel to HC. Improvement of transformation techniques, and training of technical support staff is of scientific benefit to the U.S., and the addition of coat-protein resistance to the arsenal of virus resistance will be of great benefit.

There is also the possibility of transformation for resistance to foliar fungal diseases.

3.5 Tech Transfer:

Major impact has already been realized through on-farm testing of rosette-resistant varieties in Malawi and Uganda. The rapid adoption of these technologies has resulted in the saving of millions of dollars in lost production in Uganda. Similar potential savings have been estimated for Malawi. Other countries in the region could reduce similar losses. Field days have been held in Malawi and Uganda, and seed production has been speeded up. The project is collaborating with the ICRISAT Malawi program, which has USAID funding for seed multiplication. This activity is designed to provide funding to establish a revolving fund to enable multiplication of these and future releases. This will greatly facilitate rapid deployment of these cultivars in Malawi, Uganda, and other countries, notably Mozambique, Tanzania and Zambia. There have been numerous publications on transformation techniques.

Publications:

C.M. Deom*, R.A. Naidu, A.J. Chiyembekeza, T. Kapewa, C.M. Busolo-Bulafu, P. Subrahmanyam, P.J.A. van der Merwe.: 2005 Registration of ICG 12991 Peanut Germplasm Line. Crop Science [Publication type: JOURNAL]

Chiyembekeza, AJ, Subrahmanyam P, van der Merwe, PJA, and Kapewa, T: 2000 A Proposal to Release ICGV-SM 90704, Rosette-Resistant Groundnut Variety for Production in Malawi. Report for Cultivar Release; Malawi: Department of Agricultural Research and Technical Services, Ministry of Agrioculture and Irrigation [Publication type: REPORT]

Chiyembekeza, AJ, van der Merwe, PJA, and Subrahmanyam, P: 2000 A Proposal to Release JL 24, a High-Yielding Short-Duration Groundnut Variety Adapted to Marginal Areas of Malawi. Report for Cultivar Release; Malawi:Department of Agricultural Research and Technical Services, Ministry of Agriculture and Irrigation. [Publication type: REPORT]

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Naidu, R.A., Ingle, C.J., Deom, C.M. and Sherwood, J.L. : 2004 The two envelope membrane glycoproteins of Tomato spotted wilt virus show differences in lectin-binding properties and sensitivities to glycosidases. Virology [Publication type: JOURNAL]

Naidu, R.A., Sawyer, S., Deom, C.M. : 2003 Molecular diversity in the RNA2 genome segments of Pecluviruses causing peanut clump disease in West Africa and India. Archives of Virology [Publication type: JOURNAL]

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Subrahmanyam, P, Van der Merwe, PJA, Reddy, LJ, Chiyembekeza, AJ, Kimmins, FM, and Naidu, RA: 2000 Identification of Elite Short-Duration, Rosette Resistant Lines in World Germplasm Collections International Arachis Newsletter [Publication type: JOURNAL]

Van der Merwe, PJA, Subrahmanyam, P, Hildebrand, GL, Reddy, LJ, Nigam, SN, Chiyembekeza, AJ, Busolo-Bulafu, CM, and Kapewa, T: Registration of groundnut Cultivar ICGV-SM 90704 with Resistance to Groundnut Rosette International Arachis Newsletter [Publication type: JOURNAL]

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Wangai, AW, Pappu, SS, Pappu, HR, Deom, CM, Naidu, RA: 2001 Distribution and characteristics of groundnut rosette disease in Kenya. Plant Disease [Publication type: JOURNAL]

4. Demonstrated/Potential Impacts:

University of Georgia:

1. 15 transgenic plants are going through seed increases for future field studies.
2. Numerous other transgenic plants testing positive by PCR for the presence of the transgene. Future seed increases in order.

Malawi:

1. Released ICG 12991 (designated 'Baka' in Malawi) in 2001. ICG 12991 is a short duration (90-110 days to maturation), drought tolerant spanish-type groundnut earmarked for both rainfed and residual moisture groundnut production. Over 3 tons of Baka has been multiplied and made available for commercial production both under rainfed and residual moisture peanut production. However, many farmers expressed reservation to grow Baka because its small-seeds renders it difficult to hand-shell.

Uganda:

1. Released ICG 12991 (designated 'Serenut 4T' in Uganda) in 2002. Rosette-resistant varieties are desperately needed for many countries in sub-Saharan Africa. Potential savings are estimated to exceed $ 40 million in Malawi and Uganda.

5. US/HC Benefits:

The project has good relevance as short-duration rosette-resistant varieties will have wide applicability in many African countries. In addition, improved varieties with TSWV resistance are required in the U.S. and in South America.

The development of enhanced germplasm would have impact on farmers, traders and consumers in many countries. The increased stability of peanut production will have great impact on peanut production and food/income stability in sub-Saharan Africa.

Transformation protocols and experience developed will be of value in future peanut transformation.

Improved varieties will result in improved yield and quality, increased farmer income (most groundnut growers in Africa are women), and improved quality, food security, and safety for children.

6. Partnerships:

Valuable partnerships have been developed in Malawi: ICRISAT is providing breeders seed of new varieties; Seed Co Malawi is undertaking the next stage of multiplication through production by contracted growers; and the final stage of seed production, and commercial production for export is being coordinated by the National Smallholder Farmers Association of Malawi (NASFAM).

In Uganda, there is a demand for red-skinned varieties in the local trade. The recent release of a red-skinned rosette resistant variety is likely to result in increased production and stimulate local, and possibly export, trade of this type of product.

7. Constraints:

There have been no major constraints to the execution of this project, although quality of vehicles for transport in Malawi has been problematical. Attempts to improve the situation have been somewhat unsuccessful. Earlier delays in transferring funds have, to an extent, been resolved.

8. Lessons Learned:

The germplasm developed in Malawi for rosette resistance was adopted and released in Uganda. This suggests these hard to develop resistant cultivars could be used Africa wide. Rosette is a Regional problem.

9. Next Step:

Excellent progress is being made.

The research work to improve on transformation techniques has been a worthwhile investment of resources. Continuation of the work on transformation is recommended in order to supply a wider range of germplasm.

Emphasis should be placed on the following areas:

1. Collaboration with projects involving market opportunities, new product development, and use should be encouraged to avoid any negative effects of increased, or over-production.

2. Screening of developed material for other resistances should be done as soon as possible.

3. Consolidation of efforts towards seed production should be encouraged, and expanded to include other countries.

4. Transgenics incorporating GRV and/or TSWV resistance should be made available as soon as possible, and conventional breeding, using resistance available in transformed varieties, is to be encouraged.

5. Development of biochemical screening and marker technologies to allow the earlier testing of lines for resistance will provide a major saving of time and costs.

10. General Observations:

The progress being made is very pleasing. The adoption of rosette-resistant varieties is already having major impact on yield stability and quality of groundnuts in a number of countries.

1 Project and Researchers

UFL52: Development of Sustainable Peanut Production Technologies For Amerindian Villages in the Rupununi Region of Guyana.

US Principal Investigator	Dr. Greg McDonald	University of Florida, Gainesville FL
US Co-Principal Investigators	Dr. Bob Kermerait Dr. E. Jay Williams Dr. S. Brown Dr. Glen Harris	University of Georgia, Tifton GA
Host Country Principal Investigators	Mr. Clairemont Lye Mr. Jerry LaGra	Beacon Foundation, Georgetown Guyana

1.1 2004-2005 Phase II Project Objectives

Objective	Goals	Status
1	Improve the standard of living and protect the environment in the Rupununi by improving per unit and total peanut production in a sustainable manner. This objective is essentially the umbrella one for the project, with remaining ones being subsets.	Active
2	Conduct field trials to determine peanut varieties most adapted to the Rupununi, targeting management of leaf spots and peanut rust disease.	Replaced by #8
3	Develop correct seeding rates as influenced by climate, soils and production techniques used by farmers.	Replaced by #8
4	Determine nutrient needs for peanut production in the diverse soils of the Rupununi.	Replaced by #8
5	Survey for key weed, nematode, plant disease and insect pests; produce a pest management guide.	Active
6	Obtain and demonstrate small-scale labor-saving devices and machinery as well as appropriate technologies, e.g. alternative forms of irrigation, for use by growers.	Active
7	Train Guyanese professionals to teach others all aspects of peanut production and postharvest technology. Develop internet information links and digital diagnostics.	Active
8	Field research plots at specified locations in the Rupununi to determine appropriate pest control measures and fertility requirements in each region. These will also serve to as demonstration sites to educate growers on improving production efficiency.	Active
9	Determine the most favorable economic and social applications for technologies developed in the project.	Active

1.2 Budget

The budget in 2004/05 was $ 65,000.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

The project is sound, well executed, and is well accepted by the farmers. They are eager to learn, and already increases in production are evident.

The U.S. institutions component includes a multidisciplinary array of scientists and the HC collaborators are drawn from a mix of government and non-government agencies.

Marketing and end-use considerations need to be addressed urgently as a result of increases in production.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

New technologies (increased plant density, in particular) have resulted in increased yield. The adoption of simple harvesting, shelling and drying equipment, has led to a dramatic increase in production. Increases (from 300 farmers producing 400,000 lbs in 2001 to 700 farmers producing an estimated 1,500,000 lbs in 2004) have resulted in over-production. This has largely been from increases in area planted rather than yields and is often due to more bush-clearing and environmental destruction which is not sustainable. Although the project has undoubted social and economic benefits, the environmentally impact has been somewhat negative. Production has exceeded demand and prices have declined, causing discouragement among growers. In Guyana women are generally not very involved in farming, although a few of the larger growers (who produce about 30 ha) are women. Individual farmers generally cultivate in the order of 1-3 ha.

Evaluation of new varieties will identify more adapted varieties with better quality and acceptability to the consumer. Already improved varieties have been identified, but retailers in .

Peanut production has increased three fold over the recent production seasons and stands to increase even further due to use of soil amendments, better cultivation practices and improved varieties. These technical factors would be spurred on by the peanut CRSP. But just as important as the technical factors of production are several other considerations. There exists an unusual level of enthusiasm and willingness to participate on the part of the local farmers. There exists a high degree of trust between the project participants and the people of the Rupununi and a mutual, yet cautious expectation for success. The American Principal Investigators demonstrated a dedication to the project and this type of work and a genuine commitment not to be found among other projects. Finally, there was a high level of participation by women and they virtually dominated (in number) the workshops.

3.5 Technical Outputs in United States

This project operates using the adaptive research/demonstration model used by Land-grant University Extension Services. All research and development activities were in the Host Country.

3.3 United States Training and Capacity Development/Maintenance

Direct benefits to the U.S. are minimal at this stage, although a U.S. graduate student will be visiting Guyana in late 2004 to assist with planting trials and data collection. Capacity development was in terms of U.S. scientists learning peanut production and use in a different culture and environment. They were able to translate U.S. experiences into training and guiding HC individuals.

3.7 Host Country Training and Capacity Development/Maintenance

Training and capacity building have been of major benefit to the HC. Technical staff at the Beacon Foundation have been trained in research methods and maintenance of equipment. Field trials, surveys and workshops were conducted in 2002 and 2003. Field trials and workshops were held in 5 villages in 2004. The better farmers are being trained as trainers to impart knowledge to their peers. There has been a rapid shift in training emphasis as the production has expanded. Leveraging this project the Beacon Foundation has initiated training of women's groups to process these peanuts and add value. Five village factories have been established.

The technologies being promoted for production, processing, roasting and making peanut butter are labor intensive and will absorb the available labor in the region. While roasting, shelling and peanut butter making devices are available, they are undergoing continuous improvements, often with input from the locals. Processing technologies for new products yet to be selected will need to be developed and fitted to local circumstances and the peanut CRSP will be on hand to offer help in those transitions.

Women have played a major role in the status of the project and will be a major force behind future success. They organized and led many of the workshops that we visited and were key players in generating questions and stimulating discussions. The demonstration exercise where we were introduced to the use of the shelling, roasting, de-skinning and peanut butter grinding technologies were run mainly by women. The making of the cassava bread which will also be sold in the school feeding program was demonstrated by women. Involvement of the youth participants appears to have been orchestrated by the women participants.

3.5 Technology Transfer (workshops, publications, patents)

Farmers are being exposed to new technologies through field days and technical workshops. Field trials, surveys and workshops were conducted in 2002 and 2003, and trials and workshops were held in 5 villages in 2004. Advisory publications have been developed and distributed. The better farmers are being trained as trainers and are being used for training their peers. Labor saving devices (planters, diggers, shellers etc.) have been acquired and demonstrated, and training in use, repair and maintenance of equipment has been carried out.

Publications:

LaGra, J.: 2004 Developing The Peanut Industry In Guyana: Production Potential And Market Opportunities. Peanut CRSP [Publication type: REPORT] Record 2138
Rich JR: Sustainable Peanut Production Technology For Amerindian Villages in the Rupununi Region of Guyana . [Publication type: OTHER] Record 1921

4. Demonstrated/Potential Impacts

Marketing Force Key to the Future: Eddie Singh and Sons (ES&S) have been playing a key role in the projects survival and will feature strongly in future successes. They along with the Beacon Foundation are the other major players. The warehousing, shelling/processing, trucking, and credit functions provided by ES&S to the farmers of the Rupuneni cannot be overstated in terms of importance. When the expanded Caribbean market is opened and when the yield increases are realized, it will likely be the transport and shelling operations that will move the locally produced products into the marketing channel. It will be the production credit and informal banking system that will enable the farmers to participate fully. The new marketing arrangement in the Caribbean will be key to more significant and sustainable income generation for the people of the Rupununi. It will be essential that the desired quality standards including the absence of aflatoxin be upheld if the export expectations are to be met.

Through the actions of the Beacon Foundation, CRSP and USAID has been supporting development of aflatoxin certification capacity by the Food and Drug Authority in Georgetown, and the training of Guyanese entrepreneurs in improving their products, using best manufacturing processes and quality control.

Potential for Demand Pull from Barbados, Trinidad: Sales to these two and the other Caribbean islands and will generate the demand pull necessary for sustained success. The peanut CRSP would be in a good position as it is extended to facilitate the success. Apart fro shelled peanuts, other peanut products can potentially find their way into the market in ways that will bring value added benefits to the farmers and processors. Findings from other CRSP projects in Asia might well be of benefit to this location.

5. United States/Host Country Beneficiaries and Benefits

Benefits to the HC include improved production technology, and there is potential for introducing superior varieties, as local varieties are unknown in some areas. This will also result in improved quality, as already shown with some U.S. varieties.

There has already been a major impact in production in a very short time. Increased production has impacted negatively, as over-production has already occurred. However, there is potential for increased local consumption, and alternate uses and new products need to be investigated. There is interest, and potential benefit, from developing cottage industries, where peanut products could be used in school feeding projects. The children dislike the powdered milk currently used. The increased production already achieved has stimulated the industry, and raised interest in exports. Traders from Georgetown have shown interest, and sales into these markets have resulted in 20% increases in net returns. However, distances from the port and poor road communication operate against realizing this potential. Farmers, although few women appear to be involved, will benefit from improved food security and higher income through adoption of new technologies. Processors and consumers will benefit from better quality, nutritionally superior, and safe foods, particularly for children. Development of alternate uses may help to overcome over-production. Use in school feeding schemes will be of great benefit.

6. Building Partnerships

Upon visiting the several project sites, sitting in on the field day workshops and interacting with a range of individuals, it was determined that the project was on the verge of greater success. Apart from the involvement of the local villagers, there were other factors under girding the future prospects.

One of those factors was and is the tremendous level of collaboration among the NGOs (including the Beacon Foundation), USAID and national research institutions (NARI, MFCL). Prominent among these were: 1) USAID mission with its support of the local peanut industry cluster and aid in combating the aflatoxin challenge; 2) Canada through (CFLI) had placed its support behind efforts to enhance village capacity to produce peanut butter by local cottage industries; 3) the World Bank was on the threshold of joining the effort by enabling expanding the project to include all communities within the Rupununi; 4) women's groups were receiving strong support from the Farmer to Farmer and Partners of the Americas organizations; and 5) other entities and individuals seemed strongly vested in the success of the project and of the people of the Rupununi.

7. Constraints and Recommended Solutions

Although there has been a good working relationship between the HC and the University of Florida, considerable difficulties have been experienced regarding funding. These appear to be due to the same software difficulties experienced by other UFL projects, but the UFL administration provided assurance that the problem was now resolved. Funding of HC institutions directly from P-CRSP in Georgia, if possible, would be advantageous.

8. Lessons Learned

Before visiting Guyana, not much had been learned of the Peanut CRSP project other than the fact that an early focus on production and subsequent abundant yields caused a flooding of the local available market and a subsequent downward pressure on prices. This outcome had left the local participants with less income earnings from product for which there was no market. Subsequently, there was doubt about being able to turn the situation around in the future.

Government support through School Feeding Program had been recently decided and would be a first round solution to the initial problem of over supply. By purchasing the locally produced peanut butter for the school feeding program, the government would insure the demand and a market outlet. This would virtually stabilize expected incomes in the short run. Apart from fostering project success, this move initiated from a government dominated by the fro Guyanese sends a positive signal to the citizen of the Rupununi who are predominantly Amerindians. The government would provide strong support through the Ministries of Health, Education and Agriculture.

9. Next Steps and Future Directions

Continuation of the project is encouraged, with due consideration of the following:

1. Continuation of variety evaluation and deployment;

2. continued promotion of the use of small equipment and machinery, particularly for drying;
3. emphasis on marketing, food uses, and possibly, new product development;
4. emphasis on pest control interventions. Linkage with the project in Bolivia (UFL 16) may be beneficial;
5. strengthening of seed production systems and technologies for eventual deployment of new varieties.

10. General Observations

Rate of progress has been very satisfactory and major gains have been achieved in a short time. This can be attributed to a broad-based and experienced US team, who have developed a good working relationship with the HC. The main production constraints have been identified and interventions are being introduced. Over-production, resulting potential environment degradation is of concern, but is fully recognized by the team.

The project has been successful and has created the potential for future success and the generation of income increase which would be shared by all. The project's potential would appear to be without bounds, granted the regional market unfolds and given the continuation of a strongly funded and supported peanut CRSP.

The visit with local USAID officials generated the impression that the project is of significance to the plans and initiatives of the Agency. Presently, the Agency has a keen interest in a program to expand and improve trade capacity within Guyana. It goes without saying that the support of the local mission is a key to the success of the project. The mission is presently pursuing training in aflatoxin eradication and certification.

Peanuts in storage in Guyana (left) and members of a women's group show their factory.'

1. Project Title and Investigators

NMX53: Valencia Peanut Breeding For High Yield, Early Maturity, and Resistance to Fungal Diseases, and Good Quality

USA Principal Investigator	Naveen Puppala	New Mexico State University, Clovis, NM
HC Principal Investigator	Stanko Delikostadinov	Institute of Introduction and Plant Genetic Resources, Sadovo, Bulgaria
USA Co-Principal Investigator	Dr Curtis Jolly	Auburn University, Auburn AL
HC Co-Principal Investigator	Dr. Nelly Bencheva	

Host Country : Bulgaria

1.1 2004-2005 Phase II Project Objectives

Objective	Goals	Status
1	Economic analysis of peanut production and its efficiency in Bulgaria	Active
2	Peanut germplasm enhancement with new accessions and traits using molecular marker approach	Active
3	Investigation of USA varieties in Bulgaria and Bulgarian varieties in USA for yield, maturity, and fungal disease resistance.	Active

1.3 Annual Budget:

This project is also reported in AUB30 where economic analysis has been conducted as a sub-activity of this project.

The budget for 2004/05 totaled $75000 (NMSU $60,000 and AUB30 $15,000)

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

This is a well-planned, well-consolidated project with clear objectives to improve yield and quality of Valencia peanut types that are grown in New Mexico and Bulgaria.

Although molecular biological research is somewhat longer-term, it has already provided cluster analysis of a wide range of Valencia lines and given new information on genetic relationships among germplasm lines. This technique should also aid in introgression of beneficial traits.

There is a strong collaboration with the host country, with free exchange of germplasm.

3. Outputs/Achievements

3.1 Technical Outputs in Host Country:

A good range of Valencia lines has been assembled for evaluation in Bulgaria and Bulgarian lines have been brought to NM for evaluation. Some new Valencia material appears to be performing well in Bulgaria but the growth cycle may be too long.

In Bulgaria, US Valencia cvs. were compared to Bulgarian Valencias, characters assessed included maturity, yield and fungal disease resistance. The US cvs. were compared to Kalina, the standard Bulgarian check.

US Accessions were later maturing than Kalina and were also lower yielding. *Fusarium* was the most important disease followed by *Alternaria* and *Phyllosticta*. The US cvs. were also more susceptible to carbonate chlorosis.

Average yields of Kalina in the field were 4824 kg/ha and the best of the US cvs. was Sunland at 3591 kg/ha. Kalina also had larger seeds.

Expertise in processing and food technology of this type of peanut in the U.S. will be of benefit to Bulgaria.

Crosses between NM Val A and C, and Kalina and Rossitzka, have been made. Selections are currently being advanced.

3.2 Technical Outputs in US:

A good range of Valencia lines has been assembled for evaluation in Bulgaria and Bulgarian lines have been brought to NM for evaluation. Some new Valencia material appears to be performing well in Bulgaria but the growth cycle may be too long.

The Sadovo lines are performing well in New Mexico. However, they are 2-3 seeded, of shorter stature, and earlier than the US material. S3663 is performing well in US, even in Nebraska.

Crosses between NM Val A and C, and Kalina and Rossitzka, have been made. Selections are currently being advanced.

Molecular biology techniques and use of cluster analysis has given insight of germplasm grouping. Hopefully this will help in identifying more widely differing genotypes for hybridization.

3.4 US Training and Capacity Development/Maintenance:

There have been no US trainees. The US PI has benefited by the contact and interaction with Dr. Stanko Deliostadinov the Bulgarian PI, because of the competence of Stanko as a breeder of Valencia type peanuts.

3.4 HC Training and Capacity Development/Maintenance:

HC scientists and technical support staff have benefited from training and capacity building.

It would be desirable to have a graduate student from Bulgaria study at NMSU, but the current visa restrictions are a major stumbling block. Dr Stanko was also concerned about language difficulties for Bulgarian students in the US. There is potential for U.S. and HC graduate student training in molecular biology techniques.

Processing technology (in-shell roasting) advances could be of benefit to processors. The use of cluster analysis techniques could be of use to breeders.

3.5 Tech Transfer:

A number of publications have been published or submitted. These include results on the development and use of markers, and cluster analysis of germplasm groups.

Publications:

A. Muitia, M.Burow, J. Aiyers, N. Puppala: 2004 "Selection for Early Maturity and High-Oleic from Valencia x Spanish Lines". Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

Bencheva NA, Delikostadinov SG, Jolly CM and Puppala N: 2003 Peanut Production Development in Bulgaria. Proc. Amer. Peanut Res. Edu. Soc. [Publication type: ABSTRACT]

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Delikostadinov, SG, and Puppala N: 2003 Evaluation of Valencia Peanut Varieties Investigated in Bulgaria. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

GK Krishna, J Zhang, and Puppala N: 2003 Estimating Genetic Diversity in Valencia Peanuts Using SSR Markers. Agron. Abstract [Publication type: ABSTRACT]

Krishna, GK and N Puppala: 2004 Cross-taxa transferability of Sequence Tagged Micro-satellite Site (STMS) primers from Pulses to Peanut *in* Fischer T et al. New directions for a diverse planet: Handbook and Abstracts for the 4th ICSC; Brisbane, Australia, 26 Sept. - I Oct. 2004. [Publication type: PROCEEDINGS]

Krishna, GK, and Puppala N: 2004 Transferability of Sequence Tagged Micro-satellite Site (STMS) Primers from Pulses to Peanut. Proc. Amer. Peanut Res. Educ. Soc. [Publication type: ABSTRACT]

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Rowley, DM, Puppala N and YD Cho: 2003 Nictotinic Acid Betaine in Stressed and Non-Stressed Genotypes of Peanut (Arachis hypogaea) Agronomy Abstract [Publication type: ABSTRACT]

Stanko G. Delikostadinov and Naveen Puppala: 2005 Collaborative Valencia Peanut Breeding between Bulgaria and USA. *In* Prospects and Emerging Opportunities for Peanut Quality and Utilization Technology [Publication type: ABSTRACT]

There are questions on the use of jointly developed germplasm in terms of IPR. Apparently breeders in Bulgaria receive royalties and the implication of IPR on this practice needs clarification.

4. Demonstrated/Potential Impacts:

The release of a cultivar in the US from Bulgarian germplasm will have great impact for New Mexico.

5. US/HC Beneficiaries and Benefits:

In the U.S.: Development of new varieties could stimulate production and quality for the in-shell market. Improved disease resistance, particularly to pod rots, will reduce yield losses and improve quality, which will benefit processors and consumers. Use of the Sadovo lines in breeding may improve quality and yield. These are shorter-season and shorter-stature and generally do not have 3- and 4-seeded pods, but have good quality. U.S. growers will benefit from a wider range of improved genotypes, and the potential for development of new varieties.

Improved molecular biology and cluster analysis techniques will be useful for scientists and Refinement of techniques will benefit researchers. In Bulgaria: Development of new varieties will stimulate production of the crop and improved quality will add value to production for the in-shell market. Improved pod rot disease resistance will improve quality. This will result in improved farmer income and better quality, safer food, especially for children.

The Bulgarian industry will benefit from improved processing technology, and scientists and institutions will benefit from exposure to molecular biological capacity and techniques. Improved pest and disease resistance will reduce the use of pesticides and risk of environmental degradation.

Seed production agencies will benefit from the stimulation of seed production technology.

Increased production of better quality groundnuts will have important benefits to industry, both in the U.S. and Eastern Europe.

6. Building Partnerships:

There is good collaboration with Mark Burow, TAM 17 project, and NMSU has developed good relationships with growers and processors and work very closely with end users.

The food science group at Griffin is monitoring nutritional aspects.

Expertise in processing and food technology of this type of peanut in the U.S. will be of benefit to Bulgaria.

7. Constraints and Recommended Solutions:

There have been difficulties and delays in the transfer of funds to Bulgaria.

9. Lessons Learned:

Collaboration between competent scientists in the US and HC is profitable.

9. Next Step:

Good progress is being made, and the project should continue with emphasis on:

Pathology investigations into the control of pod rots as these could have a major effect on pod and seed quality

Agronomy and mechanization - harvesting of plants of different stature may require system changes

Improved collaboration with food science and food quality projects, since sugar contents appear to be of importance in this type of processing.

Molecular biology work should continue in collaboration with the TAM 17 project, as this would provide nearby expertise and institutional capacity

10. General Observations:

The Bulgarian varieties are very short in stature, and are earlier than the NM Valencia varieties; this may have implications for mechanized harvesting, and may require changes in production technology.

Pod rots have been shown to be a major constraint in both countries, and effort needs to be directed towards reducing this risk to quality. Black hull is included in the list of diseases in NM and needs to be addressed.

Training of Bulgarian graduate students is highly desirable, but visa restrictions and language difficulties may be constraints.

Dr Stanko is due to retire shortly and risks losing some of his benefits if he continues. However, there is no clear succession procedure, and he is concerned with the continuation of the project. He would like to continue to be involved, even if exclusively with P-CRSP only, if possible.

It appears that the US is getting more benefits than Bulgaria at this stage in the project.

Trials of peanuts in New Mexico. Bulgarian lines provide a major advantage over existing US lines in this Valencia type growing area.

1. Project Title and Investigators

FAM51: **Biochemical and Molecular Responses of Peanut to Drought Stress and Their Role in Aflatoxin Contamination**

US PI	Mehboob Sheikh	Florida A&M University
Co-PI	Shah Alam	Bangladesh Agricultural University

Host Country: Bangladesh

1.1 Project Objectives and Budget

Objective	Objectives	% Complete
Objective 1	Determine differences in biochemical responses between drought-tolerant and drought-susceptible peanut genotypes following drought stress.	80%
Objective 2	Determine the anti-fungal activity of the seed extracts from drought- tolerant and drought-susceptible peanut germplasm	80%
Objective 3	Identify gene/s expressed differentially in the seed of drought-susceptible and drought-tolerant peanut genotypes following exposure to drought stress.	80%
Objective 4	Isolate cDNA clone (s) corresponding to differentially expressed transcripts, sequence and compare sequences to database for gene identification.	80%
Objective 5	Determine the response of drought-tolerant and drought–susceptible peanut genotypes to invasion by Aspergillus under drought stress and non-stress conditions.	80%

1.2 Annual Budget:

Annual Budget for 2004-2005 is $65,000.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

The project has a sound scientific and technical basis. It is a longer-term project, but has clear objectives to investigate differential gene expression, and biochemical responses, to drought and to use these indicators to evaluate germplasm for drought resistance. The project could provide significant benefits.

The scientists involved show a good spread of gender, all of whom are conscious of environmental impacts. The project is certain to have positive social, economic and environmental impacts.

There is a strong collaboration with a number of host country collaborators, including one university (BAU) and BARI in Bangladesh, two universities(Bangalore Univ and ANGR Agric Univ) and the Indian Instiute of Sciences in India, and ICRISAT. This is a good example of collaborative networking.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

The project has evaluated a wide range of germplasm and identified a number of genotypes having resistance to drought. Biochemical responses in these have been characterized. Drought-susceptible genotypes have also identified, and these include a range of recognized varieties. Techniques for drought resistance screening have been developed, and these have also benefited collaborators in host countries, including universities in India and Bangladesh, and ICRISAT.

3.2 Technical Outputs in United States

The US will benefit from germplasm with drought resistance, particularly resistance to short-term drought.

3.3 United States Training and Capacity Development/Maintenance

There have been no US students. US funds have not been used for equipment.

U.S. scientists have gained tremendously from biochemical and molecular laboratory capacity building and FAMU has an impressive laboratory setup at Tallahassee. Peptide analysis, and other analytical techniques have been developed.

3.4 Host Country Training and Capacity Development/Maintenance

In the host countries, the project has involved a wide range of locations and institutions and a large number of their scientists and technical support staff have benefited from training and capacity building. Scientists, students and technical staff have been trained in molecular biology techniques, and laboratory capacity has been enhanced. Host country universities are adding biotech courses to study syllabi. There is potential for U.S. and HC graduate student training in molecular biology techniques, and a number of post-doctoral students have been included.

3.5 Technology Transfer (workshops, publications, patents)

Workshops have been conducted in India and Bangladesh, and a number of papers have been published or are in press.

Publications: Two articles have been published in refereed journals and two are in press.

Presentations: Seven papers have been presented in various conferences.

4. Demonstrated/Potential Impacts

Marker genes have high potential impact for both the US and host countries.

5. United States/Host Country Beneficiaries and Benefits

In the U.S.: Potentially useful drought resistant germplasm has been identified, screening techniques have been improved, and markers for identification of drought tolerant genotypes have been identified. Laboratory capacity has been built and scientists and students have been trained in advanced screening techniques.

Host Countries: Will benefit from the wider range of useful germplasm identified. This has potential for use in crosses to develop drought resistant varieties that may avoid aflatoxin invasion and toxin production. New value, and improve incomes and food safety.

Scientists, students, and scientific institutions will benefit from capacity building. Seed production agencies will benefit from the stimulation of seed production technology.

6. Building Partnerships

The project has built an impressive network of collaborating institutions, involving countries, universities, research groups and International Agricultural Research Centers.

7. Constraints and Recommended Solutions **Constraints:**

No particular constraints were identified, except for the comment on delays in transfer of funds as the program was being initiated.

8. Lessons Learned

A well-equipped research and educational facility can be adopted to specific scientific needs for the US and Host Countries.

9. Next Steps and Future Directions

The project is worthy of continuation. Progress was slow initially, but has quickened, and there is good potential for success.

Suggestions for future direction include:

1. The involvement of breeders for the use of identified germplasm in conventional breeding should be encouraged.

2. The response of tolerant genotypes to drought at different growth stages should be investigated further to establish the relationship of tolerance at different times to overall drought resistance.

3. It would be useful if germplasm identified as drought tolerant was evaluated for other useful traits such as disease resistance, etc.

4. The possible relationship of drought resistance to aflatoxin avoidance must be kept in focus.

5. The obvious benefit of having the project being situated in an institution of such strong biochemical capacity, and having such good equipment, is very obvious.

6. The strong networking across countries and institutions is to be commended and strengthened.

10. General Observations

Progress has been slow as a result of delays in fund release. However, once overcome, the project has shown impressive progress. A new system of quarterly invoicing may provide some solution to these fund transfer delays. Another major constraint is the cost of consumables for this type of research. Equipment, reagents etc. are extremely expensive. No major problems have been encountered and, looking back, no changes in direction are deemed to have been necessary.

11. Recommendations:

Much of the work of this project is long-term, and usable results may yet be somewhat far off. However it is important that it continue. Equally important progress is being made in the transformation work done in UGA28, and the work on molecular biology, molecular markers, introgression of useful genes from wild species that is being done in TAM17.

There could be some overlap between the three projects, and these efforts could be rationalized in order to:

- Remove any duplication
- Reduce the effort and expenditure to fewer, better focused activities that are shared among the three PI's depending on comparative advantage
- Strengthen the involvement of conventional breeders in the utilization of the products of this research
- Reduce the involvement of HC's to the transfer of new technologies in a limited number of well-focussed areas
- Consolidate training effort in these disciplines for human and institutional capacity building

Winter peanuts in Bangladesh

Markets for peanut as a food and snack are strong. This picture from Indonesia shows peanuts roasted in the shell.

Peanuts spread out to dry in the sun – Guyana.

The Peanut Collaborative Research Support Program

External Evaluation Panel 2005 Report

Annex 4

Peanut butter on sale in a Philippines market kiosk

Postharvest and Utilization Sector Summary Report

Introduction: This technical area has a high degree of overlap with the Food Safety and Nutrition domain and many of the projects were reviewed by multiple EEP members to cover the many aspects that are common in each of the CRSP areas of activity.

Peanut CRSP projects for the, Post-Harvest and Marketing Technologies sector include:

UGA04: Development of Peanut Post-Harvest Handling and Processing Technologies for the Food Industry in the Philippines and Southeast Asia
NCA32: Development of Value-added Products from Peanuts and Aflatoxin Detoxification in Senegal and West Africa
UGA11: Development and Transfer of Peanut Technologies in Bulgaria, Eastern Europe

Projects also included in this annex by reason of their overlap from other technical areas are:-

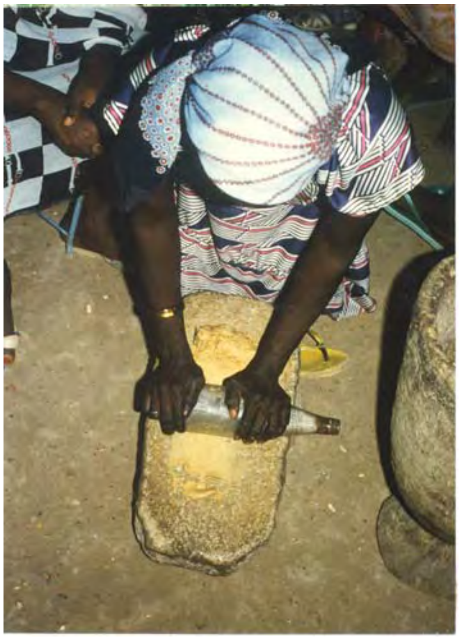
PUR10: Effects of Peanut Consumption on Hunger, Ingestive Behavior, Energy Expenditure and Coronary Heart Disease Risk involving Ghana, West Africa and Brazil, S. America
UGA01: Extrusion Cooking of Peanut Meal in the Presence of Lysine to Deactivate Aflatoxin and Improve Nutritional Quality in collaboration with Ghana, West Africa
OKS55: Use of Chemoprotection in Product Development to Improve Safety and Production of Peanut Products in Ghana, West Africa
And:
UGA37: Training for Southeast Asian Region

The lead reviewer of these projects was John Cherry, Director of the USDA Eastern Regional Research Laboratories.
Dely Gapasin assisted in the review of UGA04, UGA37and NCA32;
John Gilbert also reviewed UGA11 in Bulgaria, OKS55, PUR10 and UGA01.

Most of these projects were also covered in the review for food safety and nutrition.

1. Research Approaches:

The overall objectives for Postharvest and Marketing Technologies are:
(1) Physico-chemical, functional, nutritional and sensory properties of peanuts and traditional and newly modified/developed peanut products.
(2) Enhance quality (including eliminating aflatoxins) and nutritional properties of peanuts and peanut products.
(3) Transfer peanuts and peanut products technologies, including cost effective processing, storage, handling and packaging, to the food industries (entrepreneurial, cottage and small/large businesses), marketplace and the consumer.
(4) Enhance research capabilities in peanut utilization as quality/nutritional foods via training, educational workshops, and graduate student programs.



Making peanut butter with simple utensils.

Whether one discusses developing or developed countries, the agricultural sector's performance plays an important role in overall economic growth, trade expansion and increased income-earning opportunities. Clearly, this performance is shaped by global, regional and national trade standards, changing consumer preferences, and international advances in science and technology. To be successful, agricultural producers require training and infrastructure support, good governance and sound policies and a solid and progressive institutional base that supports processing and marketing participation.

With all this said, the USAID Agriculture Strategy, Linking Producers to Markets conceptual framework follows good governance as an essential element of the enabling environment for science-based, market-led, sustainable agriculture. Of course, the USAID challenge is with developing countries where overall economic growth, trade expansion and increased income earning opportunities depend on the performance of the agricultural sector. Research results should also enhance the agricultural sector in advanced developed countries, specifically the U.S.

The Peanut CRSP Technical Area, Postharvest and Marketing Technologies, has as its charge to improve health via increased prosperity by consumption of peanuts as safe, nutritious, value-added products. This must include expanding availability of peanut products meeting local preferences and increasing income and employment from production and processing of safe, nutritional, value-added peanuts and peanut products.

Selected general recommendations for Peanut CRSP in the 2001 External Review Panel (EEP) Report were (1) Utilization research is of great importance in that peanuts are a major source of value-added products for large and small businesses and women-based companies; and (2) Both food safety and nutrition research are necessary to ensure marketing of quality peanuts and peanut products. Additionally, the potential importance of exploiting the clay-adsorption technologies as a means to impart human health and child survival worldwide is an exciting prospect and both the Peanut CRSP and USAID should work to prove this technology is safe and works for human use. Moreover, the significant impact in the U.S. resulting from the research on human diet and health responses to peanut foods is important.

2. Outputs/Achievements

Surveys conducted in each of the Host Countries (HC), Philippines, Senegal, Ghana and Bulgaria, showed consumers' preferences for peanut and peanut products. The purpose of the surveys, as part of setting research priorities, was to focus the projects on the needs of the HC's and link them to support U.S. peanut food industries. This effort also educated those participating in the surveys, including industry/business representatives and the consumer, the mission of Peanut CRSP and the objectives of the research studies, i.e., to expand use of quality, nutritionally valuable peanut foods in diets.

UGA04: Major developments of peanut products have occurred both in the Philippines and U.S. The Philippine Food Industries, Grass-roots business organizations are partnering with the Food Development Center/National Food Authority, Manila; University of the Philippines at Diliman, Quezon City; Leyte State University, Baybay, Leyte; and the University of Georgia to develop and optimize new/improved peanut-based products considering preferences of Filipino consumers. The food products include: natural and stabilized (new for Philippines) peanut butter, Vitamin A-fortified peanut butter (new), chocolate peanut spread (new), peanut-based sauces such as "satay" sauce, "kare-kare" sauce, and curry sauce (improved and aflatoxin-free), peanut praline (improved), choco-peanut bar (improved), garlic-flavored roasted peanuts (improved), and peanut polvoron (new). Optimized new/improved peanut-based products were also developed considering preferences of U.S. consumers, including cracker-coated peanuts (new with 7-layered coatings), chocolate peanut spread (new), and roasted peanuts (improved). The Peanut CRSP developed a manual sorting technology that significantly reduced (to near 0 ppb levels) aflatoxin content of peanut-based products. The Philippine food industry groups, including factory workers and managers, have been trained on the application of this technology. The project standardized the processing and packaging of these peanut-based products appropriate for the medium-scale food industry and micro-, small- and medium-scale enterprises, farmers' cooperatives and grassroots village business organization in the Philippines. In the U.S., a method for post-harvest induction of resveratrol synthesis in peanut seed (new, patent May 2005) and the processing technology for production of Resveratrol Enhanced Peanuts (REP) and Peanut Butters containing REP, were developed.

NCA32: Large samplings were carried out by researchers at the Institut de Technologie Alimentaire (ITA), Senegal, to estimate the level of aflatoxin contamination in peanut products from local markets. The rates of product contamination (and aflatoxin contents) were 30% (403 ppb), 90% (490 ppb), 55% (62 ppb), 92% (42 ppb) and 15% (15 ppb) for peanuts, peanut cake, peanut paste, crude peanut oil and peanut enriched cereal foods, respectively. To enhance the safety of the above foods, local aluminosilicate clays, e.g., Attapulgite, were evaluated for their ability to reduce the level of aflatoxin contamination in cottage industry level peanut paste. Activated and non-activated Attapulgite were added to peanut flour at different levels (0.5, 1, 2 and 5%). Attapulgite reduced aflatoxin contamination of the reference paste from 33.3 and 24 ppb of B_1 and G_1, respectively, to levels ranging from 0 to 16.2 ppb. Both the concentration of Attapulgite and contact time affected the level of aflatoxin reduction.

Significant developments were achieved in the U.S. at North Carolina A&T State University (NCATSU) including (1) peanut-based products acceptable by consumers; (2) identification of antioxidants from peanut skins by-products (phenolics); and (3) successful application of inexpensive methods to detoxify aflatoxins in peanut-based products, such as ozone and mild heat treatment of peanut kernels and defatted flour. Heat (roasting) treatment and fermentation technologies were used at NCATSU to successfully modify defatted peanut flour for use in the development of meat analogs and as fish extender. Modified peanut flour was used in ground beef analog, extended fish mince and fortified bakery snacks. Peanut-based meat analogs were suitable for use in three meat-based

Hispanic-style snacks, including Tamales, Taquitos and Chili. Tamales and Taquitos made from peanut-based meat analog were as acceptable as those prepared with ground beef. Tilapia and catfish minces or nuggets were extended with defatted peanut flour at levels of 10 to 15% without affecting their sensory properties. The sensory characteristics of the best fish nuggets were further optimized via enhanced formulation and optimized extrusion technologies. Overall, the extrusion process produced a better texture, improved flavor product compared to the non-extruded fish nuggets. Cookies and Chin Chin (a wheat-based West African bakery snack) were fortified with raw and roasted peanut flours at 0-60%. Fortification with 40% roasted defatted peanut flour yielded snacks with the best physicochemical and sensory properties as judged by West African and non-West African students at NCATSU in taste panel studies. All studies included composition, functional and sensory analysis to optimize quality of produced peanut food products.

Health promoting antioxidants were extracted from peanut skins and their total antioxidant activity (TAA) evaluated. Data show that one gram of dry peanut skins contain 90-130 mg of total phenolics. Peanut skin phenolics are mainly procyanidin monomers, A-type and B-type procynidin diners, trimers and tetramers as well as phenolic acid and resveratrol. TAA's of peanut skin extracts were higher than that of green tea extracts. TAA's and free radical scavenging capacities of peanut skin extracts were higher than those of Trolox and Vitamin C. This indicates that peanut skins, a by-product of the peanut processing industry, contains potent antioxidants and could provide an inexpensive source of health promoting nutraceuticals that can be used as functional ingredients or dietary supplements.

OKS55: To determine the ability of hydrated sodium calcium aluminosilicate (HSCAS) clay to function as a chemoprotectant against aflatoxins in peanut products, nutritious and functionally acceptable peanut foods as carriers of this material needed to be formulated. HSCAS-clay is a processed product with promise for use in removal of aflatoxins from contaminated foods and feed in the digestive tract and subsequent discharge from the body. Market screening for peanut products was conducted in Ghana and based on consumer preference and popularity – five products were chosen for these studies: peanut paste, chocolate pebbles, starch-coated chocolate pebbles, Kurikuri and Nkatie burger. Peanut paste is used as a spread in snacks and for soup, chocolate pebbles are a confectionary product popular among children, Kurikuri is a crispy peanut chip enjoyed by children and the Nkatie burger is a tasty snack enjoyed by all age groups. A collaborative agreement was developed between the Kwane Nkrumah University of Science and Technology (KNUST), Kumasi, and the Cocoa Processing Company, Tema, Ghana, to develop formulations, processing protocols and scale-up production of these peanut foods. Once the formulations for making repeatable quality peanut products, including physicochemical, functional, nutritional and sensory properties, were in place, protocols for preparing varying concentrations of HSCAS clay-supplemented products were developed. The levels of HSCAS clay were selected based on studies showing effective aflatoxin binding activity in the gut of rodents and poultry at Texas A&M University (TAM50), and short-term FDA approved human feeding trials with HSCAS clay capsules at Texas Technological University in collaboration with the TAMU team following the protocols (0.25-0.60%) set by the rat studies.

Results of shelf-life (0-6 months) studies indicate that HSCAS clay levels of 0.0625-0.25% have no effects on texture and flavor of Kurikuri chips. These high levels of

HSCAS clay decrease the rates of lipid oxidation and degradation of flavor compounds in products more efficiently than the lower levels (0.005-0.01%) of HSCAS clay. Hence, HSCAS clay will enhance quality of stored products by minimizing formation of compounds that impart rancid and off-flavors, as well as minimize loss of the roasted peanut flavor. The feeding studies at TAMU showed that Kurikuri containing 0.25% HSCAS clay had no adverse physiological effects on rats. Further studies on quality of the products containing >0.25% HSCAS clay (up to 0.60%) are showing that these levels are feasible. A finely ground HSCAS clay is needed at these high levels to prevent an unacceptable mouth feel. From the results of the shelf-life studies to ascertain the optimum level of HSCAS clay with quality enhancing properties and mouth feel of the peanut products and results of the rat studies at TAMU and human studies at Texas Technological University, Naguchi Memorial Institute for Medical Research and Ghana University, on optimum aflatoxin-binding efficacy, the USPI and HCPI with the TAMU (TAM50) collaborator will be able to establish the levels of HSCAS clay that need to be incorporated into peanut products to reduce risk of aflatoxicosis.

UGA01: Notwithstanding the project title (which is quite focused) this is a multi-faceted project examining aflatoxin detoxification during extrusion cooking incorporating clays and other agents, and examining ways of inactivating the allergenic potential of peanut proteins. Progress has been made with studies at the University of Georgia. There is a need to determine the aflatoxin degradation products to determine their toxicological, if any, properties. Apparent protection of aflatoxin by lysine when co-extruded rather than destruction was unexpected, and binding from 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.

UGA11: Bulgarian scientists/researchers at the Institute of Cryobiology and Food Technology (ICFT) have developed and tested six peanut products acceptable to Bulgarian consumers, based on an earlier Consumers' survey: (1) peanut butter breakfast tart, (2) low fat peanut-flour based beverage as 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, chocolate. They continue to use the pilot peanut processing plant established during 1996-2001 with support from Peanut CRSP.

The development of new peanut products in the U.S. has been successful and (apart from the peanut drink with a short shelf-life), the others will be evaluated at the Plovdiv Fair, May 2005, by asking consumers to taste the product and complete evaluation sheets. The plan is to get 6000 consumers to carry out the tests over the 1-week period which should provide a useful insight into Bulgarian consumer preferences. The Plovdiv Fair will be instrumental in development of 'market pull' of peanut products rather than a production push of the raw peanuts.

PUR10: Seventeen million people die of cardiovascular disease (CVD) each year. Low and middle income countries contribute 85% of CVD deaths. By 2010, it is projected that CVD will be the leading cause of death in developing countries. There are over 300 million obese adults and 1.1 billion overweight people worldwide. In the U.S., obesity and CVD are among the leading causes of health problems and death. Hence, the scientific/technical importance of this project's objectives is very relevant economically, socially and environmentally.

Recently, the Food and Drug Administration (FDA) approved a health claim for nuts, including peanuts. The FDA approved qualified health claim stated: "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 fat and cholesterol may reduce the risk of heart disease". The research work of this Peanut CRSP project PUR10, was reviewed by FDA in consideration of the claim. This claim is promoting increased peanut consumption by supporting recommendations to include peanuts in the diet and by increasing consumer demand, a major impact in support of the U.S. peanut industry, and worldwide.

The USPI has worked closely with the HCPI to set in place a research capability, including an infrastructure at the Food Research Institute, Accra, Ghana. Emphasis has been to develop the nutrition program at the Food Research Institute (FRI) that includes building a core of students, local collaborations and equipped laboratory to allow the conduct of independent nutrition studies in Ghana. The objective was to conduct similarly designed experiments at both the U.S. and Ghana institution. A third site, Vicosa University in Brazil, was added to the program and the experimental design was structured so that the same work was conducted as a single multi-center study. The first study was designed to explore the effects of peanut oil on appetite, food choice, energy balance and selected cardiovascular disease risk factors. Collaborative plans were set in place, graduate students identified, training of students in human subject research conducted and the pilot studies required to develop the testing materials and protocols undertaken and completed with the final procedures submitted and approved by the Human Subject Review Committees (IRB's) at each site. To ensure the data from all three sites could be combined for the final analyses, all participants were to receive the same test materials, peanut oils.

The available results from the experiment explore the affects of peanut oil on appetite, food choice, energy balance and selected cardiovascular disease risk factors. 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. These observations are consistent with findings from whole peanuts and support the recommendations that peanuts may be a healthful component of the diet. In Brazil, the data suggest that peanut oil had little effect on the cholesterol components and may promote weight gain. Results from the work in Ghana are being analyzed. 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 in responses were observed between countries.

A study examined the effects of chronic peanut oil consumption on appetite and food choice. Healthy adults (129) from the U.S., Ghana and Brazil were randomly assigned to one of four treatments, consumption of peanut oil or safflower oil or no dietary test sample for eight weeks. They completed subjective appetite questionnaires on hunger, fullness, desire to eat and prospective consumption during all waking hours for selected time periods. No significant differences across countries were observed in appetite ratings or dietary compensation. These data suggest that components other than the lipid fraction in peanuts play a role in promoting satiety. Moreover, other principal observations from the studies of energy balance relative to oil intake were no significant differences in resting energy expenditure, thermogenic effect of feeding or physical activity among participants ingesting peanut, olive or safflower oil or no supplemental oil were observed; body weight increased significantly in all intervention groups, but not in the control group; and there were no significant differences across countries.

In another study, the effects of chronic peanut consumption on diet composition as well as serum lipids, magnesium and homocysteine concentrations in free-living subjects were examined. The results showed that regular peanut consumption lowers serum triacylglycerol, augments consumption of nutrients (α-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.

The health benefits of peanuts and peanut products are growing more obvious with each experiment run by the team of nutrition scientists on Peanut CRSP project PUR10. The data are showing that the strong effects of whole peanuts on appetite, energy balance and lipid levels are not replicated via ingestion of just oil. Other nutrients may be responsible for these effects. In any case, peanut consumption promotes strong energy compensation, increased energy expenditure and upon further study results in fecal fat loss. Peanuts contributed 12% to fecal fat while peanut butter and peanut oil contributed 2.7% and 2.2%, respectively. Hence, eating peanuts is good for you because this may lead to energy balance (weight maintenance) via high satiety value, possibly increase in energy expenditure and an increase in fecal fat loss most likely due to the physical properties of the whole peanut, i.e., just the efficiency of chewing the peanuts while eating them will affect the level of nutrient absorption and affect the three factors noted above. Moreover, chronic consumption of peanuts did not lead to a decline in pleasantness or hunger ratings for peanuts nor did it lead to any pleasure shifts for selected snack foods with other taste qualities. These data are supporting the evidence that peanuts may be incorporated in the diet with little impact on body weight. This is important since it has been shown that peanut consumption is associated with reduced CVD risk and the health chain has been approved by the U.S. FDA recognizing this association (note: data obtained through Peanut CRSP support were used for the claim). Thus, dietary recommendations are expected to shift and encourage inclusion of peanuts in the diet.

New studies supported by Peanut CRSP are comparing peanut consumption patterns, “with meals,” specifically lunch, versus “as snacks,” relative to optimal intake pattern(s) and energy balance. In the peanut meal treatment, hunger during the 2-hour post-lunch interval was suppressed. This work is supporting a role for peanuts in reducing subjective hunger ratings, and possibly reducing additional snacking during a common mid-afternoon eating time. This is another beneficial outcome of the Peanut CRSP research program. Snacking prevalence in the U.S. adult population has risen 77% to 84% from 1977 to 1996. Mid-afternoon is a common snacking time. A high consumption frequency of a common snack food (peanuts, in these studies) has been related to lower Body Mass Index (BMI) (obesity), i.e., including peanut snacks in the diet may reduce subjective ratings of hunger and in time reduce BMI.

UGA37: New/improved postharvest processing technologies were introduced to Thai nationals and Southeast Asian individuals (researchers) extension workers, private processors) and women- and men-operated small-scale processors through training. Planning and implementation of training courses involve many institutions besides Kasetsart University, such as Khan Kaen University, the Agricultural Extension Department of the Ministry of Agriculture, Farmer's and Women's Associations, development projects such as the Thai Princess' Project, other donors such as the Foreign Agriculture Organization and USAID, among other stakeholders. The technologies include manual sorting to reduce aflatoxin contamination, use of Elisa Kits for quick analysis of aflatoxins in peanuts, postharvest storage technologies, etc., which benefit the local food industries and consumers. The significant feature of the training is that it occurs at the village level and at Kasetsart University.

3. Demonstrated/Potential Impacts

UGA04: Commercialization of Vitamin A-fortified peanut butter was one of the most significant impacts of the work of Peanut CRSP in the Philippines. 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 Philippines now processes only Vitamin A-fortified peanut butter. Prior to 1999, there was no fortified peanut butter produced or marketed in the Philippines. The availability of Vitamin A-fortified peanut butter has implication to children's health in the Philippines. 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 tested.

The use of sorting technology improved the quality of peanut-based products with longer shelf stability (from six months to 1-2 years); about a 30% increase in the volume of domestic sales; about a 39% increase in the export market share of sales of the collaborating company (Marigold Commodities, Inc.) and introduction of one more peanut-based product (Java sauce).

There is potential employment generation impact because of the introduction of new peanut-based products or the application of new peanut processing and post-harvest technologies. An increase in the market of peanut-based products also resulted in hiring of 4-8 employees, two production personnel, and five-month seasonal employees at Newborn Foods, Inc., the collaborating food industry company. Both industrial partners moved to larger manufacturing facilities after the collaboration. There is also a potential for developing micro- industry association such as the Wright Peanut Processors Association (WPPA in Samar to have sustainability in the production and marketing of high quality peanut products due to strong support and coordination from stakeholders.

NCA32: Production of new high-protein food products and nutraceuticals from under-utilized peanut processing by-products has potential to add value to the peanut industry in the U.S., Senegal, and other countries. It could also meet the fast growing demand for meat substitutes in vegetarian diets. The U.S. meat analog industry is growing rapidly and is expected to exceed $2.6 billion of annual sales within the next five years, an opportunity to promote peanut-based products. Peanut-derived nutraceuticals will also tap into the large and growing nutraceuticals and functional food market, currently estimated at $17 billion per year. Ongoing studies of aluminosilicate clays were shown to reduce aflatoxin contamination in local Ghana cottage industry peanut products.

OKS55: Compositional, functional and sensory studies on the five selected peanut products, peanut paste, chocolate pebbles, starch-coated chocolate pebbles, Kurikuri and Nkatie burgers have been valuable in that in the U.S. the food industry has been interested in learning more about them for possible commercial sale. Noteworthy is that the TAMU (TAM50) studies with HSCAS clay supplemented peanut products fed to rats work well, i.e., aflatoxins are reduced and the animals are healthy. Preliminary results from studies with humans show no adverse physiological effects in blood and urine tests and the digestive tract. Hence, these studies show promise that use of HSCAS clay to reduce the negative effects of aflatoxins in peanut foods will be a major technology breakthrough in studies planned at the Ghana institutions.

UGA11: Joint efforts of scientists from Peanut CRSP and ICFT, its partner institution in Bulgaria, have resulted in strengthening the research facilities of ICFT and its human capital to carry out and sustain peanut processing and post-harvest research in the country. A strong technical partnership with UGA scientists is continuing.

The planned impact study in Bulgaria in 2005 will show the extent of benefits from the adoption of Peanut CRSP technologies derived by various stakeholders, especially consumers and private small- and large-scale food industry enterprises. These benefits would result from aggregated achievements of many years of collaborative efforts by U.S. scientists and their Bulgarian partners from the government and the private sector.

Development of the local peanut industry would encourage Bulgarian farmers to grow peanuts that stopped when the large government farms were broken into individual small farms. However, this industry development is just now beginning to develop. There is a tradition of peanut production in Bulgaria so farmers could produce again, if there is a ready market. A key advantage of the locally grown peanuts is that they do not contain aflatoxin, so exporting to EU would be possible (EU has the most stringent aflatoxin standard in food products). The Bulgarian Peanut Breeding Project has identified selected improved varieties suitable in Bulgarian agro-climate. A key factor would be the development of a viable seed production scheme to support farmers who are willing to produce peanuts. The peanut raw material for processing in-country, is imported from China and India.

The critical nature of the Business Plan in delivering the outcomes of UGA11 was examined. ICFT needs external help to develop a Business Plan and has internal procedures that require advertisement and essentially undertake a 'competition' to select a company to develop a plan. The plan needs ownership within ICFT and support from the political agencies.

Bulgaria is ready to start commercialization of the peanut products that have been developed by ICFT researchers in collaboration with Peanut CRSP scientists. There are a few groups who are interested in producing peanut products, since there is a long tradition of peanut consumption. Most of the peanut products are imported from Greece, Turkey and Western Europe, but in the high-end market. The Mayor of Plovdiv wants to export peanut products to Europe. An emerging peanut industry could provide market pull that would enhance local peanut production.

UGA01: Detoxification of aflatoxin in peanut meal per se is unlikely to be acceptable other than a beneficial consequence of a processing operation undertaken for other technological reasons. Extrusion cooking while of interest in terms of new peanut based products for the U.S. market has the disadvantage for developing countries that investment would need to be made in a high cost processing plant. The incorporation of clays into the diet in Ghana would thus need to overcome the additional hurdle of marketing a new food.

To some extent the work on extrusion of clay with peanut meal duplicates project OKS55 but the latter has the advantage of working with local foods rather than introducing new technology. The work on allergenicity is novel and tackles a significant U.S. problem.

PUR10: The demonstrated impact of this work is major due to its 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". As a result of this health claim, and the continued groundbreaking discoveries made from each ongoing experiment in the Peanut CRSP PUR10 project, peanut consumption is growing because of consumer demand, a major impact to the U.S. peanut industry, the collaborative HC's, Ghana and Brazil, and for that matter worldwide.

UGA37: There has been an increased capacity of researchers in Thailand and in the Asian region resulting from the training courses held in Thailand. A large number of villagers participated in the training workshops on postharvest, processing, and packaging technologies. One of the main beneficiaries of training is Thai 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.

A key impact is the leveraging of funds from the Thai government that has provided substantial funding for the training of Thai nationals and villagers. The Thai Princess' project has supported village-level training. Another impact was of a "community building" nature which the Peanut CRSP induced by developing the multi-entity collaboration around a single project in search of specific outcomes of improving local incomes and health by eliminating the aflatoxin risk and creating new products to increase peanut consumption. Another easily overlooked impact is the building of connections between scientists and other individuals from several nations around common foci setting the foundation for future technology transfer and collaboration though not necessarily pertaining to peanut or aflatoxin reduction. Continued benefits of the Peanut CRSP presence in Thailand is the result of working with them as a "graduate country" for Regional training and technology transfer, rather than in the traditional research and development mode of a "developing country" in USAID terminology.

4. Building Partnerships

UGA04S: One of the most significant achievements of this project has been the establishment of strong linkages with the private food industry in the Philippines, which made it possible for the development of an Industry Incubator Model to transfer Peanut CRSP technologies. Peanut CRSP has linked with the food industry to test and commercialize peanut-based products developed in the Philippines and the U.S., through UGA. This linkage is with medium-sized companies (Newborn Foods, Inc. and Marigold Commodities, Inc.). The availability of improved and safe peanut products in stores and super markets in Metro Manila, generated by the Vitamin A-fortified peanut butter, increased local consumption. An increase in peanut export, because of aflatoxin-free peanut-based products (i.e., Mama Sita's "Kare-kare" Mix), also contributed to this achievement.

Peanut CRSP has established linkages with strong Philippine research institutions including: (1) the Food Development Center of the National Food Authority, Manila, (2) the University of the Philippines at Diliman, Quezon City, (3) the Leyte State

University (LSU), Baybay Leyte. Additional linkages were forged with the following agencies: the Bureau of Post-harvest Research and Development of the Department of Agriculture, Quezon City; Department of Agriculture (Region VIII); Department of Labor ad Employment Region VIII); Department of Trade and Industry (Region VIII); TESDA; and Local Government Units (Region VIII).

Another initiative introduced by Peanut CRSP is to link up with micro- and small-scale business enterprises in the Visayas. Through LSU/Philippine researchers, Peanut CRSP technologies were transferred to Wright Peanut Processors Association (formerly St. John's Farmers Producers Cooperative in Paranas, Samar) to the Bucarez Food Processing Cooperatives in Bohol, and to the Small Industry Association of Eastern Visayas in Samar. FDC/NFA started to work with theChamber of Agriculture, Fisheries and Food Industries of Northern Mindanao (CAFFINORMIN) and the Northern Mindanao Peanut Industry Associations (NMPIA) of Cagayan de Oro to transfer production, processing, and post-harvest technologies.

In the U.S., strong linkages have been established with the Georgia Peanut Commission, the Georgia Peanut Foundation, the Southeast Peanut Commission, etc. which leveraged Peanut CRSP funding for UGA researchers. As in the Philippines, the role of the food industry was critical in the use of the Industry Incubation Model to initiate commercialization of peanut-based products developed by Peanut CRSP scientists. For example, negotiations are underway for Bell Plantations Inc., a producer of peanut flour, who is interested in commercializing at least five of the eight peanut-based products from Peanut CRSP noted in the section, Output/Achievements.

NCA32: The main partner institution in Senegal is the Institut de Technologie Alimentaire in Dakar. The USPI visited ITA twice to train scientists and researchers on various methodologies and laboratory techniques and to exchange ideas. Three ITA scientists carried out short-term technical visits in the U.S. and NCATSU and to attend conferences. Partnerships are continually being cultivated with private sector entities, agricultural extension and research providers, NGOs, village level marketers and other stakeholders as the research program grows in Senegal at ITA and in the U.S. at NCATSU.

OKS55: In Ghana, the partnership between KNUST, the Cocoa Processing Company, Noguchi Memorial Institute for Medical Research and Ghana University has been a positive impact. The HCPI and the Ph.D. graduate student have benefited in career growth. The collaborations among scientists involved in Peanut CRSP projects TAM50, OKS55 and AUB30, have been a positive result for the program. It is noted that the OKS55 PI and HCPI collaborate with the AUB30 PI. The OKS55 PI's collaborations involve work prior to the present project; studies done in Caribbean countries.

Work in Peanut CRSP project UGA01 (R. Phillips, University of Georgia; S. Sefa-Dedeh, University of Ghana) is developing technologies for reducing aflatoxin contamination in peanut meal by extrusion in the presence of HSCAS clay. This is part of multifaceted studies using a number of methods and processes to eliminate substances in peanut foods affecting health. The work on HSCAS clay in UGA01 complements OKS55, but the latter has the advantage of working with local peanut foods in Ghana rather than trying to introduce new food technologies.

UGA11: The main collaborating institution in Bulgaria is ICFT (formerly Institute of Horticulture and Canned Foods, later the Canning Research Institute). Peanut CRSP and ICFT are linked with two government institutions: (1) the University of Food Technology, formerly Higher Institute of Food and Flavor Industries and (2) the Institute of Plant Genetic Resources. The latter is also the collaborating institute for the Peanut CRSP breeding project (NMX53) with New Mexico University. Peanut CRSP scientists provided technical advice to prepare a Protocol between the Bulgarian Academy of Agrarian Sciences and the Ministry of Agriculture and Forestry to establish a parasitical food enterprise, ECONATURE. An agreement was signed. A Cooperative Research Agreement was signed by the University of Georgia and the Bulgarian Academy of Agrarian Sciences to formalize their linkage. This agreement gives an opportunity for research between these two institutes.

In two conferences held in 2003, sponsored by Peanut CRSP and the Bulgarian Academy of Agrarian Sciences, the participants discussed the establishment of a Food Research and Development Center for Southern and Eastern Europe (FRDC-SEE). The Center will also serve as a Food Certification Laboratory and Training Center for the Balkan region. The conference was attended by 15 representatives of 9 countries (Bulgaria, Croatia, Israel, Moldova, Rumania, Russia, Turkey, Ukraine, etc.). The establishment of this Center will improve regional research collaboration in the Balkan region. The status of FRDC-SEE needs political support from participating countries to establish it. Croatia is very interested to collaborate with Bulgaria and has invited the USPI to visit Croatia to participate in the Second Food Technology Conference.

UGA01: The U.S. and HCPI have agreed to conduct all research in the U.S., with a strong training component for HC students and visiting scientists. It remains to be seen if this arrangement will continue. Due to the importance of peanuts in Georgia agriculture, it has been possible for the USPI and other colleagues to attract peanut projects funded by the Georgia Food PAC program, the Georgia Peanut Commission and the Southeastern Peanut Research Initiative. These have enabled related research to be conducted including work on peanut-based snacks and peanut allergens.

PUR10U: The USPI's concept of addressing the objectives of the PUR10 project via single- multi-center studies, a team concept has resulted with the three partnering institutions - Purdue University, U.S., Food Technology Institute, Ghana, and Viscosa University, Brazil. In all three countries, close relationships have been developed with consumers who participate in the studies as Subjects and benefit from the learning experience about their personal health relative to diet. In Accra, Ghana, researchers have developed a partnership between the Food Research Institute and the Noguchi Memorial Institute for Medical Research. The partnership is helping to understand the nutritional needs of populations in three parts of the world, North America, South America and West Africa. Much of the nutrition technology coming from these studies show our problems and ways to overcome them are similar, at least in these three parts of the world.

Noted is that the Purdue University Administrators are strong supporters of international programs. Peanut CRSP, because of the USPI, is a highly regarded program at the university. The USPI is a collaborating scientist on three CRSP programs, Peanut, Bean-Cowpea and Sorghum/Millet bringing nutrition expertise to these programs. A number of University Departments benefit from this nutrition expertise. Recently, the development of a Nutragrain Bar made with bean paste fitting the sensory and nutritional needs of the peoples of Honduras, Central America was successful because of the Peanut CRSP PI.

UGA37: A key factor in the success of training and technology transfer activities in Thailand, especially at the village level, is the active partnership of Kasetsart University researchers with the Department of Agricultural Extension of the Ministry of Agriculture. Government extension workers were trained early on by the project and are now active trainers and facilitators at the village level. This strong linkage between research and extension, especially in training, should be considered in Peanut CRSP projects in other areas of the world. Since extension is a public service in most developing countries, training extension staff would ensure sustainability of the technology transfer support for peanut producers and processors especially in the rural areas, as in the case of Thailand.

A partnership in training with the Food and Agriculture Organization (FAO) was initiated. With FAO-Peanut CRSP-Kasetsart University joint sponsorship, efforts to enhance the participation of men and women in peanut production and utilization are underway.

5. Next Steps/ Future Directions

UGA04: The collaborating research institutions should provide assistance and to periodically monitor the changes in the uptake of safer (aflatoxin-free) and fortified peanut-based products by private food companies, including the micro- and small-scale business enterprises at village levels.

The Philippine collaborating research institutions should work closely with the extension service to ensure sustainability of the provision of technical services, especially to small peanut producers, micro- and small-scale enterprises, and other field level clients. The collaborating researchers should continue to provide technical advice and relevant training. The Philippines can learn from successful experiences in Thailand where extension workers are trained and work closely with researchers at the community level. Appropriate extension-type media materials should be prepared. Regional/provincial government offices will have to be tapped to assist in the implementation of the projects to ensure multiplier effects, especially for micro- and small-scale enterprises at the village level.

The U.S. scientists continue to work with the U.S. food industry to facilitate commercialization of safer (aflatoxin-free) and high quality peanut-based products developed by Peanut CRSP to ensure that they reach the marketplace at a reasonable timeframe. Future directions of a food technology project should be based on the requirements of the market and products preferred by consumers in the U.S. or the HC, and this may differ. Hence, any intervention by the project should agree with local situations.

The Industry Incubator Model that was developed by the Peanut CRSP in the Philippines can be introduced in other countries where Peanut CRSP is working, with appropriate modifications. Priority should be given to countries where increased peanut production has occurred due to the introduction of new peanut varieties and improved production technologies. Examples are in Bolivia and Guyana where peanut production has increased 2-3 times in the past two years and had caused problems in marketing and reduced prices. Senegal and countries of West Africa could benefit from this Philippine model. The use of manual sorting technology to produce aflatoxin-free peanut products would be a significant improvement towards safer peanut-based products for consumers where aflatoxin contamination is currently at very high levels.

NCA32: Product development and testing should be continued and prepared for transfer of technologies (peanut-based food products, nutraceuticals and processes) developed by the Peanut CRSP scientists at NCATSU to Senegal. Focus of the next phase should be technology transfer and training activities involving village-level processors, traders in Senegal, and private food industry partners in Senegal and U.S. Technology Transfer activities would require new institutional arrangements, involving the private sector, NGOs, agricultural extension providers, and other stakeholders.

A plan has been prepared to introduce a Peanut Food/Processing Industry Incubator at ITA in Senegal. The industry incubator model developed in the Philippines (UGA04) would facilitate technology transfer to the local food industry and provide solutions to local peanut processing and safety problems. Future plans include expansion of the project to four additional countries in West Africa (Mali, Niger, Mauritania and Bangladesh) because of proximity and similarity in processing and safety issues with peanuts.

OKS55: The following studies are recommended for support by Peanut CRSP: Continue support for development of the five peanut products identified in Ghana and studied for market-level production in the HC and the U.S.; Complete studies to optimize HSCAS clay supplementation and use of all five peanut products in human feeding trials; Complete human studies on HSCAS clay supplemented peanut products to reduce-eliminate aflatoxin contamination of the foods in Ghana in collaboration with the TAM50 project; Expand studies in Ghana and neighboring West African countries where health issues due to aflatoxin contamination exist. This latter objective is to make application of HSCAS clay a successful technology where needed.

UGA11: Peanut CRSP will continue providing technical guidance to ICFT and the Bulgarian Academy of Agrarian Sciences to facilitate the establishment of a private peanut processing enterprise in Bulgaria. Funding assistance has been sought by the government from VOCA (an NGO), the USAID Office in Bulgaria, and the USDA Foreign Agriculture Service Office in Sofia.

The activities in Bulgaria could be expanded to include technology transfer and product commercialization activities, including a study to determine the impact of Peanut CRSP technologies in Bulgaria. Extend peanut products, processes, and research activities to Croatia and other Eastern European countries to transfer successful technologies. Using Bulgaria's ICFT as the center for excellence in peanut research in the region, exploit links with other donors to pursue funding opportunities to expand in Eastern Europe.

During the review in Bulgaria, there was an awareness and concern about the potential change of status of Bulgaria with respect to Peanut CRSP and the effect on future funding. Part of the time spent at ICFT was devoted to discussing opportunities for EU funding in FP6 and mechanisms for support through Twinning and Maria Curie Fellowships that might be used. The assessment is that the EU is very unlikely to directly continue funding along the same lines as Peanut CRSP but that there might be opportunities to continue to develop the "Establishment of a Food Research and Development Center for Southern and Eastern Europe." Peanut CRSP has established excellent sensory panel facilities at ICFT that will have applications in areas other than peanut sensory work and funding to utilize these facilities and continue to develop expertise might be forthcoming. Once a baseline funding albeit in other areas is established this should provide the flexibility needed to continue with some of the Peanut CRSP initiatives.

UGA01: The emphasis on extrusion cooking may not be very relevant in Ghana nor is allergenicity a developing country problem – the technical focus is more towards U.S. interests than the HC. There is considerable interest in peanut allergens and development of non-allergenic peanut butter which may have a significant impact as well as a better understanding of the proteins involved in allergenicity.

PUR10: This project is very attractive and quite different and discrete from the seven other projects in the Peanut CRSP Research Thrust, Food Safety, which is focused on controlling or reducing exposure to aflatoxins. In contrast, the focus in this project is on nutritional aspects related to peanuts and peanut products. The training and transfer of scientific skills in the nutrition field has been of major importance in the U.S. and the collaborating HC's. The work is promoting peanut consumption as a healthy food. This is a sound project area where translation of the outcomes for practical benefit are obvious and thus continuation of work on both satiety and nutritional effects, especially related to heart disease and obesity, of peanut consumption is strongly recommended.

UGA37: Thailand has sponsored a well-organized International Peanut Conference in January 2005 in Bangkok, with Peanut CRSP. This international event was carried out successfully and was participated by about 150 peanut scientists and researchers and their partners from the U.S., Thailand, and other countries participating in Peanut CRSP, like Bulgaria, Philippines, etc.

The Industry Incubator Model that was developed in the Philippines could be transferred to Thailand to expand the commercialization of peanut products from village-level micro- and small-scale enterprises to medium- to large-scale food industry companies. Training of managers, factory workers, and other business groups is an important activity. The Ministry of Industry is providing funds to Kasetsart University, through its Small- and Medium-Enterprise Funds, to train private companies.

Thailand has been developed as a center for excellence in training of trainers and technology transfer and should continue this training project in the HC. The Thai project should continue to train Southeast Asian scientists, private food industry representatives, and extension workers on new/improved peanut products and methods to improve their quality and safety. It should expand its coverage to other regions to train trainers on peanut technologies based on the demand from other Peanut CRSP participating countries. The U.S. could likely benefit by modeling the Thai approach to collaboration (between industry/universities/government) in the development of new peanut products and improved processing and packaging technologies.

6. Recommendations

UGA04: In the next program phase, the successful initiatives in the Philippines have to be maintained, especially those involving the private sector food industry and the emerging work involving micro- and small-scale food enterprises in the rural areas. The focus should be on monitoring and evaluation of changes as the food industry builds on the significant achievements to push for an increased share in the peanut-based products market. Linkages with extension service providers for wider public dissemination of information and to markets (traders/processors) with peanut producers (farmers) need to be strengthened. U.S. scientists should continue to provide technical guidance to Philippine research institutions on new technologies and research methodologies. The strong research network that was established with UGA scientists, through the project, needs to be maintained.

Peanut CRSP in the Philippines should promote the Industry Incubator Model to transfer processing and post-harvest technologies to other regions where Peanut CRSP is intensively working, i.e., West Africa. Latin America, and Eastern Europe. This necessitates a strong technology transfer component of the ongoing/new projects that should include training of key stakeholders. In some cases, a new institutional arrangement would be needed with new partners besides the current collaborating research institution to enlist support from a food science group. Facilitate active involvement of the private food industry (focusing on small- to medium-scale businesses), public (government), and private (non-government organizations, civil society groups, etc.) extension providers, health workers, traders, and other stakeholders (i.e., donors).

NCA32: The Peanut CRSP project should be funded to continue product development. Further development of value-added peanut products and improvement and fine tuning of the processes are needed to bring them to pilot plant production stages. Integrating a strong technology transfer component, especially in Senegal would facilitate the transfer of Peanut CRSP technologies (new food products and processes) to the neighboring countries in the West Africa region. The efforts in the U.S. and Senegal will focus on commercialization of the new technologies and intensive training of key stakeholders in Senegal. This would necessitate strengthening partnerships involving the private food industry (focusing on small- to medium-scale traders) and other stakeholders. ITA should continue to provide research support and coordination to ensure sustainability and quality of the products produced in Senegal.

The Peanut CRSP project at NCATSU includes emphasis on development of aflatoxin-free value-added peanut foods, feeds and nutraceuticals from peanut products and co-products suitable for the Senegal and U.S. markets. Work is examining the use of aluminosilicate clays (Attapulgite) to reduce levels of aflatoxins in cottage industry peanut paste. The results are very promising. It is recommended that this work be expanded to include that of Peanut CRSP project OKS55. The combined effort could focus on the aflatoxin problem throughout countries in West Africa. Proper funding would be required to assure success of the program.

UGA11: Peanut CRSP should continue to support the project in Bulgaria. Collaborations should be expanded to include technology transfer activities involving the private food industry to promote commercialization of successfully tested peanut products preferred by Bulgarian consumers. To facilitate the food industry linkage, U.S. and Bulgarian Project Investigators should review and modify the Industry Incubator Model developed in the Philippines (UGA04) to suit specific situations in Bulgaria. Field visits to the Philippines (for commercial-scale processing) and Thailand (for small-scale village processing) would be useful for the key people involved (researchers and private sector). They can discuss with representatives of the private food processing industry and researchers their experiences and lessons in the Philippines and Thailand. Peanut CRSP should facilitate that this is done before the project closes in 2006. This would facilitate their preparation for the next phase of the Peanut CRSP in Bulgaria.

UGA01: The work on extrusion cooking, other detoxification techniques and incorporation of clays into extrusion cooked products adds little to other work (e.g., OKS55, NCA32) on clays. The funds from this project could be redirected to NCA32 to support clay work. Another recommendation is that the limited resources supporting this project could be better redirected or focused on allergenicity.

PUR10: It is recommended that this Peanut CRSP PUR10 be transferred to the Research Thrust Post Harvest Processing and Marketing. This thrust focuses on utilization research of peanuts and peanut products as major sources of value-added foods for small and large businesses. Quality and nutrition relative to human health responses to peanut and peanut products in the diet are closely related. The nutrition of new foods has relevancies, regionally and globally, especially in living a healthy life style and where protein-deficient diets exist especially in weanling children. Support for this Peanut CRSP project should be strengthened as it is having, and will continue to have, major impact on the peanut industries in the U.S., HC's and worldwide.

UGA37: Peanut CRSP should maintain its presence in Thailand as a center for excellence in training of trainers for the Asian region and to show case successful technology transfer activities. The environment in the country is more open and Thai trainers are very willing to share information and their expertise to Asian and international collaborating scientists. There are examples of successful promotion and commercialization of Peanut CRSP technologies, especially at the village-level involving small-scale entrepreneurs who are mainly women. The Thai government has provided consistent support for this project for the past 10 years. The ongoing impact study of past training courses would provide ways to improve the training program. Thailand is already the focal point for training Asian scientists and there are active village-level technology transfer activities to show participants. Participating countries in other regions should consider sending participants for training of trainers to Thailand and to get experience in field application and benefits derived from Peanut CRSP technologies. Peanut CRSP should enhance technology transfer and beneficiaries training in all Peanut CRSP projects. The experience in Thailand and the Philippines showed that active involvement of beneficiaries, through training and actual application, facilitated the promotion and commercialization of Peanut CRSP technologies. The experience in Thailand of involving extension workers as trainers and organizers of training activities facilitated the process of technology transfer and adoption.

Thailand became a "graduate country" economically as classified by USAID at the beginning of this 10-year Peanut CRSP grant period. The conversion of this project to a training program is an excellent example of the USAID intention of graduate countries continuing to extend technologies in a Region based on capabilities developed during the active project period.

In Africa peanut is a major source of income for women.

Peanuts for sale in a Thai market

1. Project Name and Participants

UGA01A: Extrusion Cooking of Peanut Meal in the Presence of Lysine to Deactivate Aflatoxin and Improve Nutritional Quality.

US PI	R. Phillips	University of Georgia, Dept. of Food Science
Co-PI	Samuel Sefa-Dedeh	University of Ghana
Co-PI	Larry Beuchat	University of Georgia,
Co-PI	Esther Sakyi-Dawson	University of Ghana, Dept of Food Science

Host Countries: Ghana

1.1 Objectives

Objective	Objectives	Status
Objective 1	To develop technologies for reducing aflatoxin contamination of peanut meal by extrusion in presence of sodium calcium aluminosilicates (HSCAS) clays, food-grade nucleophiles, and other agents. To investigate use of electrolyzed (EO) water for removing aflatoxin from intact peanut kernels.	Active
Objective 2	To determine the effect of extrusion of peanut meals, singly and in combination with other food ingredients on allergenic potential of peanut proteins.	Active
Objective 3	To develop peanut-based food products with improved toxicological and allergenic safety.	Active
Objective 4	To investigate the presence of bioactive peptide sequences in peanut protein by simulated gastric-intestinal (pepsin-pancreatin) and alkalase digestion.	Active

1.2 Budget:
The budget for 2004-2005 was $60,000

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches:

Notwithstanding the project title (which is quite focused) this is in fact a multi-faceted project examining detoxification during extrusion cooking incorporating clays and other agents, and examining ways of inactivating the allergenic potential of peanut proteins. Progress has been made on all fronts but the objectives in three areas are ambitious and will be difficult to meet them all with the limited resources. The apparent protection of aflatoxin by lysine when co-extruded rather than destruction was unexpected, and binding from clay during extrusion was less than in solution. The more interesting findings have been in relation to bioactive proteins in peanut meal and attempts to prepare hypoallergenic peanut butter from extruded peanut flour.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

The emphasis on extrusion cooking may not be very relevant in Ghana nor is allergenicty a developing country problem - the technical focus is more towards U.S. interests than of the host country.

3.6 Technical Outputs in United States

Most work is being undertaken in the U.S. with the links being provision of training in the Food Science Department at the University of Georgia. Dr. F.K. Saalia is conducting aflatoxin research at the university with the U.S. Project Investigator (Dr. Phillips). There is potential for creating desirable foods with reduced aflatoxin content and reduced potential for allergenicity such as "hypo-allergenic peanut butter" made from extruded peanut flour and peanut oil. Although the texture and color were not too different from the control, the sensory quality was not acceptable due to "overcooking". Another product that has been extensively tested is peanut extruded puffed snacks from blend of rice (up to 50%) and defatted peanut flour.

The major focus of this project has been the destruction of aflatoxin in contaminated peanut meal by extrusion in the presence of either food-grade nucleophiles or HSCAS. This approach was chosen because of the unique high temperature, high shear environment created by extrusion and the present state of knowledge of aflatoxin chemistry. These efforts have been moderately successful, although results have been complex and difficult to interpret. As expected, processing at elevated pH enhances destruction, but lysine seems to actually protect the toxin. Further, proteolysis released toxin bound to protein, reducing the apparent efficacy of this approach. Co-extrusion with clay reduced toxin content by about 60% in contrast to complete binding from solution.

Thus far only in vitro studies on reduction of peanut allergy by extrusion have been possible. Based on the results, the ability of peanut protein to bind to soluble IgE following extrusion is drastically reduced, even when most of the protein is solubilized by SDS. This implies reduced allergenicity. However, only clinical tests can confirm this, and attempts to acquire additional funding have not been successful.

Peanut butter with similar physical characteristics to the control could be made from extruded peanut flour and oil. However, sensory quality was not good due to overcooking in the extruder. This remains a promising method for making reduced allergy peanut products if optimal combinations of processing can be identified. In related work, extruded snack products containing significant levels of peanut flour have been developed and extensively evaluated.

Proteolysis of peanut flour protein generates peptides that inhibit angiotensin-converting enzyme (a controller of blood pressure). Three promising groups of peptides have been identified and are being characterized. Peanut protein hydrolysates also have antibacterial activity against *listeria* and *E. coli*.

3.3 United States Training and Capacity Development/Maintenance

Three graduate students completed their degrees (2 with Ph.D. and 1 with M.S.), with research on physico-chemical characteristics of fortified peanut spreads, reduction of allergenicity by extrusion, and sensory characteristics of puffed snacks.

3.4 Host Country Training and Capacity Development/Maintenance

Two researchers from Ghana completed their advanced degrees at UGA: (1) Firibu Saalia completed Ph.D. in 2001 and is currently doing post-doctoral fellowship, and (2) Enyonam Quist completed M.S. in 2005 and is continuing his Ph.D. program at Michigan State University. The involvement for host country has to date only included the training component at UGA/Griffin.

3.5 Technology Transfer (workshops, publications, patents)

Technology transfer will be difficult as extrusion cooking will not be a developing country priority.

Publications:

- 4 thesis and dissertations (2001-2002)
- 4 journal articles (2002-2004)
- 7 manuscripts in review
- 18 abstracts and presentations

Chen, L.: 2001 Reduction of Peanut Allergenicity by Extrusion Cooking
PhD Dissertation, UGA [Publication type: THESIS]

Chen, L., Phillips, R.D., Nordlee, J.A., Taylor, S.L., Hefle, S.L., and Doyle, M.P.: 2001 Reduction of peanut allergens by extrusion cooking.
Abstracts, 11th World Congress of Food Science and Technology, Seoul, Korea [Publication type: ABSTRACT.]

Choi, I. and Phillips, R.D.: 2001 Physical properties of peanut based extrudate snacks Abstracts, 11th World Congress of Food Science and Technology, Seoul, Korea [Publication type: ABSTRACT, ABSTRACT]

Choi, I.-D, Phillips, R.D., Jeong, H.-S.: 2004 Cellular structure of peanut-based extruded snack products using scanning electron microscopy J. Text. Stud. 35: 353-370. [Publication type: JOURNAL]

Choi, I.-D.: 2002 Development, Physical, and Sensory Characteristics of Extruded, Indirectly Puffed Peanut-Based Snack Products.
PhD Dissertation, UGA [Publication type: THESIS]

Choi, I.D., Resurreccion, A.V.A. and Phillips, R.D. : 2002 Optimization of sensory characteristics and consumer acceptability for peanut-based extruded snack products using response surface methodology.
Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K.: 2001 Degradation of Aflatoxins in Peanut Meal by Extrusion Cooking in the Presence of Nucleophiles PhD Dissertation, UGA [Publication type: THESIS]

Saalia, F.K. and Phillips, R.D.: 2001 Optimization of extrusion conditions to degrade aflatoxins in peanut meal. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D.: 2001 Degradation of aflatoxins in the presence of nucleophiles. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D. : 2002 Reduction of aflatoxins in contaminated corn by extrusion cooking
Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D.: 2002 Examining the influence of screw paddles on the severity of extrusion of corn meal Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K. and Phillips, R.D. : 2002 Reduction of aflatoxins in contaminated corn by extrusion cooking
Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Saalia, F.K., and Phillips, R.D.: 2000 Decontamination of aflatoxins in peanut meal by extrusion cooking in the presence of nucleophiles and starch Technical Program, Annual Meeting, IFT [Publication type: ABSTRACT]

Yeh, J.Y. Phillips, R.D., and Hung, Y.-C. : 2001 Physical stability and textural attributes of nutritional modified peanut spreads. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Yeh, J.-Y., Phillips, R.D., and Hung, Y.-C. : 2003 Optimizing protein-and vitamin-fortified peanut spreads containing soybean or milk powder. J. Food Qual. 26: 243-256 [Publication type: JOURNAL]

Yeh, J.-Y., Phillips, R.D., Resurreccion, A.V.A., and Hung, Y.-C. : 2002 Physicochemical and sensory characteristic changes in fortified peanut spreads after 3 months of storage at different temperatures.
J. Agric. Food Chem 50: 2377-2384.[Publication type: JOURNAL]

Yeh, J-Y., Phillips, R.D., and Hung, Y.-H: 2002 Overall acceptability and sensory profiles of peanut spreads fortified with protein, vitamins, and minerals. J. Food Sci. 67(5): 1979-1985 [Publication type: JOURNAL]

Duplicate
Yeh, Y.-Y.: 2001 Effect of Storage Temperature on Physicochemical and Sensory Characteristics of Fortified Peanut Spreads MS Thesis, UGA [Publication type: THESIS]

Quist, E.E. 2005. Peanut (Arachis hypogaea) as a source of antihypertensive and antimicrobial peptides MS Thesis, UGA [Publication type: THESIS]
Quist, E.E., Saalia, F.D., and Phillips, R.D. 2005. Angiotensin converting enzyme inhibitory activity of proteolytic peanut digests. Book of Abstracts, Annual IFT Meeting [Publication type: ABSTRACT]

Quist, E.E., Phillips, R.D., and Chen, J. 2005. Antimicrobial activity of proteolytic peanut hydrolysates against Escherichia coli O157:H7 and Listeria Monocytogenes. Book of Abstracts, Annual IFT Meeting. [Publication type: ABSTRACT]

4. Demonstrated/Potential Impacts

There is considerable interest in peanut allergens and development of non-allergenic peanut butter may have significant impact as will a better understanding of the proteins involved in allergenicity.

5. United States/Host Country Beneficiaries and Benefits

The purpose of this project is to discover mechanisms by which peanut can be transformed into safer, more nutritious, and more desirable foods, and to investigate specific non-nutritional effects of peanut protein. Achieving these goals will increase demand for peanuts and peanut-based foods in the U.S. and other countries, including developing countries, and will assure that those foods will make a positive contribution to health.

6. Building Partnerships

UGA has worked with some U.S. research laboratories to carry out complementary studies: (1) toxicology study with the USDA Russell Laboratory in Athens (Dr. Ken Voss), and (2) breakdown products study with USDA, Tifton (Dr. Tom Potter).

Other related peanut projects were funded by the Georgia FoodPAC Program, the Georgia Peanut Commission, and the Southeastern Peanut Research Initiative.

These partnerships in the U.S. have enabled a broader range of related research to be conducted on peanut-based snacks and peanut allergy.

7. Constraints and Recommended Solutions

There have been some Visa problems for Dr Saalia who has had to return to Ghana but will be able to return to Griffin at the end of the project. There appeared also to have been problems over submitting work for publication where referees have requested either supporting analytical data (on degradation products) or supporting toxicological studies. The supporting analytical data and toxicological studies were not foreseen. Arrangements to address some of these problems were made through collaborative research.

Most recently, the necessity for Dr. F.K. Saalia to return to Ghana when his visa expired has seriously impeded progress. His expertise in aflatoxin chemistry, analysis, and the processing techniques able to destroy the toxin cannot be replaced quickly. Fortunately, it appears that he will be able to return to the US on another J-1 visa to the end of the project.

The refractory nature of aflatoxin in foods is also a challenge. While great care must be taken to prevent accidental loss of the toxin during analysis, it is very difficult to destroy >95% of the toxin by processing. Likewise, difficulties in moving from in vitro studies to allergy clinical trials for extruded peanut protein mean that there is more work to be done.

8. Lessons Learned

Working with excellent young scholars from the host country has been an ongoing source of gratification by U.S. Project Investigators. They have shown an excellent degree of preparation and diligence in the pursuit of their training and research goals. But they have to be encouraged to return to their host country research institution to ensure that their expertise could be utilized to strengthen the host country's peanut research program.

There have been problems over submitting work on detoxification for publication where referees have requested either supporting analytical data (on degradation products) or supporting toxicological studies neither of which were foreseen. This work is expensive to undertake.

9. Next Steps and Future Directions

Detoxification of aflatoxin in peanut meal *per se* is unlikely to be acceptable other than a beneficial consequence of a processing operation undertaken for other technological reasons. Extrusion cooking while of interest in terms of new peanut based products for the U.S. market has the disadvantage for developing countries that investment would need to be made in processing plant.

The incorporation of clays into the diet in Ghana would thus need not only to overcome the additional hurdle of marketing a new food product. To some extent the work on extrusion of clay with peanut meal duplicates project OKS55, but the later has the advantage of working with local foods rather than introducing new technology.

10. General Observations

The project has adequately managed although the U.S. Project Investigator was pleading for additional administrative support to handle financial matters.

11. Recommendations

The work on allergenicity is novel and tackles a significant U.S. and developed country problem and should be continued. The work on extrusion cooking, other detoxification techniques and incorporation of clays into extrusion cooked products adds little to other work on clays and it is recommended the limited resources would be better focused on allergenicity.

1. Project Title and Investigators

UGA04U: Development of Peanut Post-harvest Handling and Processing Technologies for the Food Industry

This project is one of the most prolific projects in the Peanut CRSP portfolio. An impact study carried out in collaboration with NCSU Investigators (NCS07) and host country collaborating institutions, showed significant benefits to consumers of Vitamin A-fortified peanut butter and safe aflatoxin-free peanut-based products. Industry innovators that were originally involved in processing these products increased their share of the local and export markets (to U.S.). The UGA Principal Investigator is commended for developing the successful Industry Incubator Model for technology transfer involving the private food industry and other key stakeholders. This model could be used, with appropriate modifications, in other countries.

U.S. Principal Investigator	Dr. Anna Resurreccion	University of Georgia, Griffin, Georgia
Co-PI	Dr. Manjeet Chinnan	University of Georgia, Griffin, Georgia
Co-PI	Dr. Larry Beuchat	University of Georgia, Griffin, Georgia
HC Principal Investigator	Dr. Alicia Lustre	Food Development Center/National Food Authority, Manila, Philippines
Co-PI	Dr. Flor Galvez and Prof. Leonora Francisco	University of the Philippines at Diliman, Quezon City, Philippines
Co-PI	Dr. Lutgarda Palomar and Prof. Lucy Palomar (2003)	Leyte State University, Baybay, Leyte, Philippines

Host Country: Philippines

1.2 Project Objectives and Budget

Phase 2 Objectives	Objectives	% Completed
1	Identify new market opportunities for peanuts and peanut products in the Philippines.	75
2	Conduct research on peanuts and peanut products to understand physical, chemical, nutritional, functional and sensory properties.	80
3	Develop processing technologies for fortified peanut products for Philippine markets.	90
4	Transfer to the Philippine food industry post-harvest, processing and packaging technologies.	75
5	Enhance research capabilities of Philippine collaborators/partners in the government and private sector.	90
6	Conduct regional and national workshops and training on peanut processing and utilization in Thailand (moved to UGA37).	

1.2 Annual Budget: In 2003-2004, the budget for this project was US$105,000, of which US$18,678 (18%) was transferred to the Philippine partner institution (FDC/NFA). Considerable leveraging of funds occurred within UGA beyond the 25% counterpart funding required. Other sources of funds included: The Georgia Peanut Commission, the Peanut Foundation, the Southeast Peanut Commission, etc. The Philippine collaborating institutions also provided funding on a cost-sharing arrangement. Representatives of private food companies who participated in seminars and workshops paid their own cost.

The Budget for this project In 2004-2005 was $105,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches

A nationwide survey was carried out in the Philippines in 2001, participated by 387 households, to determine Filipino consumers' preferences for peanuts and peanut-based products.

UGA04 partnered with the Philippine Food Industries and Grass-roots business organizations to develop and optimize new/improved peanut-based products considering preferences of Filipino consumers: Natural and stabilized (new for Philippines) peanut butter, Vitamin A-fortified peanut butter (new), chocolate peanut spread (new), Peanut-based sauces such as "satay" sauce, "kare-kare" sauce, and curry sauce (improved and aflatoxin-free), Peanut praline (improved), choco-peanut bar (improved), garlic-flavored roasted peanuts (improved), and peanut polvoron (new). Optimized new/improved peanut-based products were also developed considering preferences of U.S. consumers, including cracker-coated peanuts (new with 7-layered coatings), chocolate peanut spread (new), and roasted peanuts (improved).

The project standardized the processing and packaging of these peanut-based products appropriate for the medium-scale food industry and micro-, small- and medium-scale enterprises, farmers' cooperatives and grassroots village business organization in the Philippines.

In the U.S., a method for post-harvest induction of resveratrol synthesis in peanut kernels (new, patent by May 2005) and the processing technology for production of Resveratrol Enhanced Peanuts (REP) and Peanut Butters containing REP, were developed.

Before the peanut products were introduced, the Investigators conducted systematic and extensive research on peanuts and peanut products to test and understand the physical, chemical, nutritional, functional, and sensory properties, using different techniques, sometimes developing improved techniques.

3. Outputs/Achievements

3.2 Technical Outputs in Host Country

The 2001 survey on consumers' preferences in the Philippines showed that peanut butter was the best-liked product; 66% of the families preferred stabilized peanut butter; and over 90% of respondents were willing to pay more (about PhP1) 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 (new) peanut butter, (2) Vitamin A-fortified peanut butter (commercialized), (3) chocolate peanut spread (to be commercialized); (4) peanut based sauces such as "satay" sauce, "kare-kare" sauce, and "satay" sauce, (5) peanut praline (commercialized), (6) chocolate peanut bar (commercial 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 were standardized with assistance from the U.S. Project 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.

A successful effort was carried out to transfer to the Philippine food industry and to Cooperatives and Grassroots Business Organizations (micro-and small-scale enterprises) the improved post-harvest processing and packaging technologies. This included the Peanut CRSP developed manual sorting technology that significantly reduced aflatoxin content of peanut-based products. The Philippine food industry groups, including factory workers and managers, have been trained on the application of the technology. An EEP member visited the manufacturing facilities of the partner food companies to discuss with the managers their experiences in collaborating with Peanut CRSP, which they indicated as very positive.

3.2 Technical Outputs in the United States

Five new/improved peanut-based products were developed; and some are being considered for commercial production 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,(4) chocolate peanut spread, and- (5) roasted peanuts.

A peanut product (chocolate peanut spread) was introduced in the U.S. from the Peanut CRSP work in Philippines and tested with private food company. A corresponding product was developed and optimized considering the preferences of American consumers. A consumer Home-use test on two flavored cracker coated peanuts was conducted to determine their effect on quality and taste.

3.3 United States Training and Capacity Development/Maintenance

There had been a significant contribution of the project to U.S. capacity building on peanut research, as follows:

6. An M.S. graduate student at UGA, Glencia Walker (American, woman), completed research on cracker-coated peanuts;
7. An M.S. graduate student at UGA, Christine Chu (American, woman), completed research on chocolate peanut spread;
8. An M.S. graduate student at UGA, Jamie Rudolf (American, woman), completed research on resveratrol enhanced peanut;
9. Four Post-doctoral Associates completed their work in Georgia or collaborated with UGA scientists. Dr. Nelson Grosso (Argentinian, man), Dr. Kayanush Aryana (American, man), Dr. Marlene Bulgarelli (American, woman) and Dr. Isam Hashim (African, man) - a collaborator on honey-peanut spreads; and
10. U.S. Graduate students received awards for their work on peanut processing and post-harvest in graduate paper competitions during the IFT annual meetings, and other graduate competitions (i.e., Phi Tau Sigma).

3.5 Host Country Training and Capacity Development/Maintenance

Degree training: There were no Filipino researchers were supported for degree training by Peanut CRSP. However, as part of Peanut CRSP project implementation in the Philippines, several B.S. and M.S. students completing their thesis on peanut research, as follows:

4. B.S. student at LSU/ Philippines, L, J. Oclarit (Filipino, man), completed his thesis on garlic oven-roasted peanuts
5. B.S. student at LSU/ Philippines, L.C.Honor (Filipino, woman), completed her special problem peanut butter
6. M.S. student at LSU/Philippines, Imma A. Licayan (Filipino, woman), completed her thesis on peanut praline

Non-degree training and awards: Many Filipino collaborating scientists and researchers benefited from non-degree training. Some researchers were recognized by their institutions for their work on peanut research. The following benefited from short-term training:

7. two women researchers from Philippines trained at UGA in 2002 on peanut processing and sensory and consumer evaluation; both participated in IFT meeting, the Georgia Peanut Tour, and a PCRSP processing workshop at UGA;
8. three women scientists and investigators trained for six months at UGA on peanut processing methods and peanut quality measurements;
9. two women scientists participated in International course on processing of aflatoxin-free peanut products in Thailand in 2003;
10. six women scientists will attend the PCRSP-sponsored International Peanut Conference in Thailand in January 2005 (planned); five scientists will present papers in said conference;
11. In recognition for their significant contributions and quality of their research on peanut processing and post-harvest topics, three LSU/ Philippines collaborating scientists received awards: Dr. Lutgarda Palomar, Dr. Lemuel Diamante, and Dr. Roberta Lauzon; and
12. An FDC scientist received an award for 3rd Best Paper in the 2003 NFA Project Review; two papers from UP received awards as 2nd place Best Undergraduate Research Paper (Nutrition Category), FNRI-DOST and FNRI Research Foundation Inc, 29th Seminar Series on Food and Nutrition Researches ("Assessment of the Vitamin A fortification of peanut butter on middle-income and low-income Filipino families and consumers in Metro Manila.") and 2003 International Publication Award (Manual sorting to eliminate aflatoxin from peanuts, J. of Food Protection, 66(10):1979-1884").

3.5 Technology Transfer (workshops, publications, patents)

Workshops: The project carried out 18 workshops and seminars in 2001-2004, a significant number, participated by a total of 487 farmers, entrepreneurs, factory employees, and managers. An estimated 57% of the participants were women (some gender disaggregated data are missing). The private sector representatives paid for their own cost of participation. The list of workshops and seminars, including the topics and number of participants are in **Appendix Table 1**.

Publications: One of the main outputs of this project are 69 publications and presentations, with eight scientific papers - in refereed journals (2002-2004), which are significant; an additional three in press and 16 are in review or have been prepared as part of Students' theses/dissertations and will be submitted; and six are in preparation by host country investigators. These types of publications are the traditional outputs of researchers. The two training manuals, especially the Pilipino and Visayan versions are significant. The EEP noted the many publication outputs of the project during the meeting with the Project Investigator.

Six monographs were prepared, and 3 have been published. Five training manuals were prepared. An extension-type media material (laminated poster containing pictures of damaged peanut kernels) was prepared to facilitate dissemination of aflatoxin-contaminated peanut kernels to various clients.

The different types of publications produced by the U.S. and Philippine Project Investigators are summarized in **Appendix Table 2**. As expected, most of the publications were prepared or published within the past two years. Philippine collaborators are also preparing four manuscripts for publication.

Patents: One (1) U.S. patent for resveratrol-enhanced peanut is provisional and will be final in May 2005. No other patents were approved for any peanut-based products developed by Peanut CRSP scientists and the host country partners. In the U.S., a new peanut-based product, Chocolate Peanut Spread, had potential for patenting but it was not eligible because the data were presented at an IFT meeting before the patent application was submitted. However, a food company in Georgia (Bell Plantations, Inc.) is interested in commercializing the product in the U.S.

4. Demonstrated/Potential Impacts

Commercialization of Vitamin A-fortified peanut butter was one of the most significant impact of the work of Peanut CRSP in the Philippines, as shown by the Impact Study carried out by Moxley et al. 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 Philippines now produces only Vitamin A-fortified peanut butter. Prior to 1999, there was no fortified peanut butter produced or marketed in the Philippines. 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 tested.

The availability of Vitamin A-fortified peanut butter has implication to children's health in the Philippines. The Impact Study carried out by NCS07 in 2004 showed that older children ages 7-12 years showed highest consumption, followed by children ages 2-6, which is the most vulnerable age group.

An increase in the production of peanut-based products by the food industry in the Philippines showed that: (1) slight decrease in shelf life due to vitamin fortification did not decrease product returns because of fast turnover; and (2) a 10% increase in production cost did not increase the price of peanut butter because the company was willing to absorb any added cost due to expansion of the market.

The use of sorting technology improved the quality of peanut-based products with longer shelf-stability (from six months to 1-2 years); about 30% increase in the volume of domestic and sales; about 39% increase in the export market share of sales of the collaborating company (Marigold Commodities Inc.) and introduction of one more peanut-based product (Java sauce) as cited by Moxley et al (2004).

There is potential employment generation impact of the introduction of new peanut-based products or the application of new peanut processing and post-harvest technologies. Moxley et al. (2004) showed that an increase in the market of peanut-based products also resulted to hiring of 4-8 employees, two production personnel, and five-month seasonal employees at Newborn Foods, Inc., the collaborating food industry company. Both industrial partners moved to larger manufacturing facilities after the collaboration. There is also a potential for developing micro- industry association such as the Wright Peanut Processors Association (WPPA) to have sustainability in the production and marketing of high quality peanut products due to strong support and coordination from stakeholders.

5. United States/Host Country Beneficiaries and Benefits

Philippines: Filipino consumers (both here and abroad) are benefiting from greater availability in the market of healthy and safe (aflatoxin-free) peanut-based products. With the application of manual sorting technology by the Philippine food industry, aflatoxin-free products are now commercially available in local and export markets. In addition, Filipino consumers, especially children, are benefiting from the increased availability of Vitamin A-fortified peanut butter in local stores and supermarkets. Based on the consumers' survey, families were willing to pay extra for this product (about PhP1). As a spill-over, the food company that has the largest share of the peanut butter market, is now producing Vitamin A-fortified peanut butter under its own brand.

Filipino entrepreneurs that own village-level, micro- and small-scale food enterprises are benefiting from the improved/optimized aflatoxin-free peanut-based products with improved packaging and product quality and longer shelf-life and lower production cost. The owners of these rural enterprises are mainly women.

The Philippine food industry (medium- to large-scale businesses), would benefit from the application of improved processing and post-harvest technologies, such as manual sorting technology and new standardized and optimized peanut-based processing methods, resulting in safer products, better packaged, and have longer shelf-life. This was shown to be successful by collaborating medium sized food companies such as Newborn Food, Inc., (Lily's brand), and Marigold Commodities, Inc. (Mama Sita's brand).

United States: In the U.S, the peanut processing industry would benefit from the availability of new value-added products, optimized for consumer acceptability, for manufacture. Peanut processors, globally, will benefit from the introduction of Resveratrol-enhanced peanuts for use in many peanut products. Consumers will benefit from the nutraceutical properties of resveratrol, having anti-cancer and anti-cardiovascular disease properties.

Potential beneficiaries are Peanut CRSP Project Investigators and collaborating research institutions in other countries would benefit from the successfully developed Industry Incubator Model in the Philippines as a strategy to enhance transfer of food technologies to the private food industry and facilitate commercialization of these products. Peanut CRSP Project Investigators and collaborating institutions would also benefit from a grassroots business organization model used in villages in rural areas in the Philippines as a strategy to enhance commercialization of peanut products. Host country researchers and institutions have benefited from capacity building and training programs funded by Peanut CRSP.

6. Building Partnerships

Philippines: One of the most significant achievements of this project has been the establishment of strong linkages with the private food industry in the Philippines, which made it possible for the development of an Industry Incubator Model to transfer PCRSP technologies. Even in Phase I of the project, PCRSP had already linked with the food industry to test and later commercialize peanut-based products developed in the Philippines and the U.S., through UGA. This initial linkage is with medium-sized companies (Newborn Foods, Inc. and Marigold Commodities Inc.). The availability of improved and safe peanut products in stores and supermarkets in Metro Manila, generated by the Vitamin A-fortified peanut butter, increased local consumption. An increase in peanut export, because of aflatoxin-free peanut-based products (i.e., Mama Sita,s "Kare-kare" Mix), also contributed to this achievement.

PCRSP has established linkages with strong Philippine research institutions including: (1) the Food Development Center of the National Food Authority, Manila, (2) the University of the Philippines at Diliman, Quezon City, (3) the Leyte State University, Baybay Leyte. Additional linkages were forged, with the following agencies: (i) the Bureau of Post-harvest Research and Development of the Department of Agriculture, Quezon City, (ii) Department of Agriculture (Region VIII), (iii) Department of Labor and Employment (RegionVIII), (iv) Department of Trade and Industry (Region VIII), (v) TESDA, and (vii) Local Government Units (Region VIII).

Another initiative introduced by PCRSP is to link up with micro- and small-scale business enterprises in the Visayas. Through LSU/Philippine researchers, PCRSP technologies were transferred to Wright Peanut Processors Assocation (formerly St. John's Farmers Producers Cooperative in Paranas, Samar) to the Bucarez Food Processing Cooperatives in Bohol, and to the Small Industry Association of Eastern Visayas in Samar. FDC/NFA started to work with the Chamber of Agriculture, Fisheries and Food Industries of Northern Mindanao (CAFFINORMIN) and the Northern Mindanao Peanut Industry Associations (NMPIA) of Cagayan de Oro to transfer production, processing, and post-harvest technologies.

United States: In the U.S., strong linkages have been established with the Georgia Peanut Commission, the Georgia Peanut Foundation, the Southeast Peanut Commission, etc. which leveraged PCRSP funding for UGA researchers. As in the Philippines, the role of the food industry was critical in the use of the Industry Incubation Model to initiate commercialization of peanut-based products developed by PCRSP scientists. For example, negotiations are underway for Bell Plantations Inc., a producer of peanut flour, is interested to commercialize at least five peanut-based products from PCRSP.

7. Constraints and Recommended Solutions

Inadequate supply of raw peanuts. The volume of peanut produced in the Philippines is not sufficient for the needs of processors. Poor communication between producers and processors had magnified the problem. The Peanut CRSP project and the Growth and Equity Project (GEM), an initiative funded by USAID, are assisting farmers in securing funds to establish a Peanut Service Station in Mindanao. This is a proposed collecting point for peanut produced locally so food processors can procure the volume of peanuts in the form they need for their factory, and free from aflatoxin.

Few publications by host country researchers: Although the Philippine researchers were highly qualified and were very active in peanut research, and in developing and testing new and improved peanut-based products, writing papers for publication in refereed journals is not given high priority. Up to 2004, only one paper was published, two are in review, and five are in preparation. In FDC, performance of researchers is not measured by publications. Philippine institutions need to provide adequate incentives and training for their scientists to publish papers. It was noted that after some researchers trained at UGA, they became more aware of the need to publish.

IPR provisions: When testing new products or methods with the private sector, project policy requires them to hold on to the successfully tested product or method for a period one to two years) before sharing with other companies. Knowledge of provision of Intellectual Property Right laws should be considered early and to tap the opportunities for patenting of new products/processes.

Fund management: Transfer of funds from UGA to host country research institutions continues to be a problem, as already noted by the last EEP. The problem had caused delays in research and technology transfer activities in the Philippines. The Management Entity needs to come up with improve fund transfer mechanism for the next phase.

8. Lessons Learned

To ensure success and sustainability of Peanut CRSP processing and post-harvest technologies in the Philippines, the selection of the right collaborating institutions, including private food enterprises, was critical in building trust and working relationship; training of collaborating researchers in the US (at UGA) and establishing a strong network between the US researchers and the host country partners, were equally important.

Experience in the Philippines showed that early and continued partnering with the private food industry ensured an understanding of consumers' needs by researchers, facilitated product development and testing of Peanut CRSP products at the commercial scale, and assured that safe and preferred products quickly get to the market place. A key actor in the Industry Incubator Model in the Philippines is the private food industry.

9. Next Steps and Future Directions

Philippines: The collaborating research institutions should provide assistance and to periodically monitor the changes in the uptake of safer (aflatoxin-free) and fortified peanut-based products by private food companies, including the micro- and small-scale business enterprises at village level.

Philippine collaborating research institutions should work closely with the extension service to ensure sustainability of the provision of technical services, especially to small peanut producers, micro- and small-scale enterprises, and other field level clients. The collaborating researchers should continue to provide technical advice and relevant training. The Philippines can learn from successful experiences in Thailand where extension workers are trained and work closely with researchers at the community level. Appropriate extension-type media materials should be prepared. Regional/ provincial government offices will have to be tapped to assist in the implementation of the projects to ensure multiplier effects, especially for micro- and small-scale enterprises at the village level.

United States: UGA scientists continue to work with the US food industry to facilitate commercialization of safer (aflatoxin-free) and high quality peanut-based products developed by PCRSP to ensure that they reach the marketplace at a reasonable timeframe. Future directions of a food technology project should be based on the requirements of the market and products preferred by consumers in the U.S. or the host country, and this may differ. Hence, any intervention by the project should suit specific local situations.

Developing Countries: The Industry Incubator Model that was developed by the PCRSP in the Philippines can be introduced in other countries where PCRSP is working, with appropriate modifications. Priority should be given to countries where increased peanut production has occurred due to the introduction of new peanut varieties and improved production technologies. Examples are in Bolivia and Guyana where peanut production has increased 2-3 times in the past two years and had caused problems in marketing and reduced prices. The use of manual sorting technology to produce aflatoxin-free peanut products would be a significant improvement towards safer peanut-based products for consumers where aflatoxin contamination is currently at very high levels.

10. General Observations

Strengths: It was noted that very significant synchrony resulted from the work of three different experts (Food Scientist, Microbiologist, and Food engineer) in the Food Science and Technology Department of UGA. The close working arrangement facilitated that expert backstopping needed for product development, testing, and other analytical work. The UGA team worked well together in a complementary manner.

Weakness: The impact study involving social scientists and economists from NCSU enabled the evaluation of the impact of the food technology PCRSP initiatives in the Philippines. This experience showed the need for more multi-disciplinary inputs, especially in the socio-economic aspects, and should be available as early as the planning and design stage, to ensure that benchmark information is collected using the agreed key performance indicators. Because of this weakness, the impact study could only use post-scenario analysis.

Strengths: The scientific expertise, experiences, and dedication of both the US and Philippine partners are commendable and have been critical in the success of PCRSP initiatives in the Philippines. The institutional arrangements for research backstopping, and strong linkages with the private food industry, contributed to the significant achievements of the project. A stronger linkage with extension service providers (from both public and private sectors) at all levels could further enhance the linkage of traders and food processors to peanut producers and their organizations.

11. Recommendations

Specific: Peanut CRSP to maintain initiatives in the Philippines. In the next program phase, the successful initiatives in the Philippines have to be maintained, especially those involving the private sector food industry and the emerging work involving micro- and small-scale food enterprises in the rural areas. The focus should be on monitoring and evaluation of changes as the food industry builds on the significant achievements to push for an increased share in the peanut-based products market. Strengthen linkages with extension service providers for wider public dissemination of information and to strengthen linkage of markets (traders/processors) with peanut producers (farmers). U.S. scientists should continue to provide technical guidance to Philippine research institutions on new technologies and research methodologies. The strong research network that was established with UGA scientists, through the project, needs to be maintained.

General: Peanut CRSP to promote the Industry Incubator Model to transfer processing and post-harvest technologies to other regions where Peanut CRSP has intensively worked (i.e., West Africa, Latin America, Eastern Europe). This would necessitate a strong technology transfer component of the ongoing/new projects that should include training of key stakeholders. In some cases, a new institutional arrangement would be needed with new partners besides the current collaborating research institution to enlist support from a food science group. Facilitate active involvement of the private food industry (focusing on small- to medium-scale businesses), public (government), and private (non-government organizations, civil society groups, etc.) extension providers, health workers, traders, and other stakeholders (i.e., donors).

Appendix Table 1. List of Workshops and Seminars Conducted by Peanut CRSP (UGA04).

Title of Trainings Conducted	Date of Training	Venue	Source of Support	No of Participants		
				Male*	Female*	Total
1. Consultative Meeting with Industry on Feasibility of Establishing a Peanut Sheller Industry	March 16, 2001	Food Dev. Center	FDC and PCRSP	12	8	20
2. Workshop on Control of Aflatoxin in Raw Peanuts through Sorting	April 2, 2001	Food Dev.	FDC Philfoodex members	1	6	7
3. Seminar on Post-Harvest Technologies for Upgrading Peanut Quality and Expanding Peanut Production and Markets	April 3, 2001	Food Dev. Center	FDC, PCRSP and Industry	19	30	49
3. Post harvest Handling of Peanuts to Meet Marketing Standards and Needs and Peanut Processing	August 22, 2001	Cagayan de Oro City	FDC and Dept. of Agriculture	18	8	26
4. Seminar on Impact Assessment of Technology for Vitamin A Fortification of Peanut Butter and Sorting of Peanuts for Aflatoxin	December 18, 2002	Food Dev. Center	FDC, PCRSP and Industry	13	36	49
5. Workshop Food Product Development for Industry Managers	June 24, 2003	Griffin, Georgia USA	Food PIC	No Data	No Data	25
6. Developing New Products for a Changing Market place	July 11-12, 2003	Chicago, Illinois USA	Institute of Food Tech. and Food PIC	27	23	50
7. Record keeping transactions, producer costing, Incomes and Expense	July 5, 2003	Buray, Samar	PCRSP, LSU	5	19	24
8. Basic Plant Sanitation and Hygiene for Food Plant Workers	August 21, 2003	Cagayan de Oro City	FDC and PCRSP	3	7	10
9. Basic Plant Sanitation and Hygiene for Plant Workers	August 22, 2003	Bukidnon	FDC and PCRSP	11	9	20
10. Developing Value-added Products for a Changing Marketplace	September 5-6, 2003	Griffin, Georgia, USA	PCRSP and FoodPIC	No Data	No Data	No Data
11.Training Workshop on Processing of Roasted Peanuts and Peanut Sauces	October 15 –16, 2003	Food Dev. Center	FDC and Industry	7	21	28
12.Peanut Quality and Safety, Hazards on Foods	October 29, 2003	CSCST, Cebu City	Academe	16	39	55**
13. Peanut Quality and Safety Hazards on Foods and Aflatoxin Kit	October 27, 2003	Buray, Samar	PCRSP, LSU	4	18	22

14. Food Quality and Safety. Unoptimized peanut products (oil roasted and oven roasted peanuts)	November 15, 2003	Buray, Samar	WPPA members	4	17	21
15. Seminar on Good Manufacturing Practices and Development of HACCP Plans for Product Development	November 6-7, 2003	Cagayan de Oro City	FDC, PCRSP and Industry	9	15	24
16. Business, Expense, Saving Training (BEST) Game,	February 13, 2004	Buray , Samar	PCRSP, LSU	4	17	21
17. Current and Future Status of Consumer Testing In Product Development	February 17-20, 2004	Chiang Mai, Thailand	Chiang Mai University	No Data	No Data	22
18. Food Product Development Process for the Georgia Food Industry	February 23-24, 2004	Atlanta Georgia USA	FoodPIC	6	8	14
TOTAL				159	281	487

*columns do not equal 487 due to missing gender disaggregated data.
**Staff and students of Cebu State College of Science & Technology, Cebu City.

Industry partners of the CRSP in the Philippines. Processing to assure control of aflatoxin allowed this company to increase production 40% in a single year..

Appendix Table 2. List of Publications Prepared by U.S. and Host Country Project Investigators, 2001-2004.

Type	2001-2002	2003	2004	Total
Monographs	-1 Monograph1: Tech. and policy issues in strengthening peanut markets -1 Monograph2: Peanut butter consumption patterns of Filipinos		-1 Monograph3: Control of Aflatoxin through manual sorting of peanuts -1 Monograph4: Techno-economic Feasibility of Peanut Sheller Industry (In Press.) -1 Monopgraph5: Peanut butters and spreads (In Press.) -1 Monograph6: Impact of Vitamin A-fortified peanut butter (In Press)	-3 monographs published -3 monographs in press.
Manuals		-1 Standard Sanitation Operating Procedure Manual for food industry	-2 Training Manual on Sorting for Aflatoxin contaminated kernels (2 versions) -1 Training Manual translated into Pilipino and Visayan (same) -1 Training manual on Processing of Roasted Peanuts	-5 manuals
Papers (Refereed Journal Articles)	-3 manuscripts on peanut butter and spreads (published) -1 manuscript on cracker coated peanuts (published)	-1 manuscript on manual sorting (published) - 1 manuscript on peanut butter (published)	-1 Dev. And optimization of chocolate peanut spread (Chu and Resurreccion, published) -1 manuscript on Resveratrol enhanced peanut (Rudolf et al., published) -1 paper on roasted peanuts (in press/accepted) -2 manuscripts on peanut polvoron and chocolate peanut bar by FDC/NFA researchers (in-press) -1 manuscript on products containing honey (in review) -1 manuscript on chocolate peanut bar (in review). -4 manuscripts prep. on chocolate peanut spread (to be submitted) -3- manuscripts prep. on resveratrol enhanced peanut (to be submitted) -4 manuscripts on cracker coated peanuts (to be submitted) -3 manuscripts on roasted peanut (to be submitted) -2 manuscripts on chocolate peanut spread by UP Diliman researchers (in prep.) - 2 manuscripts on stabilizers and vitamin A fortification of peanut butter (in preparation) -1 manuscript on roasted peanuts (in prep) -1 manuscript on peanut brittle (in prep).	-8 publications in refereed journals -3 manuscripts in press -16 manuscripts (in review or to be submitted) -6 manuscripts in preparation

Presentations	-7 IFT presentations on peanut butter. -1 IFT presentation on cracker coated and roasted peanuts. -2 IFT presentations on choc-peanut spread -1 IFT presentation on shelf stability of peanuts -1 IFT presentation on peanut snacks -1 IFT presentation on resveratrol	-1 presentation at IFT on roasted peanuts -1 presentation at IFT on postharvest handling of peanuts -1 IFT presentation on peanut processing.	-1 presentation at PTS on chocolate peanut spread (Philippines). -1 presentation at IFT on roasted peanuts - 6 presentations at International Peanut Conference	-24 presentations
Proposal			-1 Establishment of Peanut Service Station in Mindanao	1 proposal
TOTAL	19	6	44	69

Food scientists and processors (not surgeons) at work in a CRSP partner industry.

1. Project Title and Investigators

UGA11: Development and Transfer of Peanut Technologies in Bulgaria

This project continues to have impact on peanut research in Bulgaria. The institutional and human capital that was developed in Phase I continues to be strengthened with support from the UGA11 project team. The development of the partner institution (ICFT) as a center of excellence in peanut research in Bulgaria and the Balkan region is being realized. New/improved and safe (aflatoxin-free) peanut-based products have been developed, tested, and accepted by U.S. and Bulgarian consumers. The next step is to commercialize these products by the private food industry, with continuing quality control and technical advice by U.S. and ICFT scientists.

US Principal Investigator	Dr. Manjeet S. Chinnan (PI, Food Engineer)	Dept. of Food Science and Technology, University of Georgia (UGA), Griffin, Georgia
Co-PI	Dr. Larry Beuchat (Co-PI, Food Microbiologist)	UGA, Griffin, Georgia
Co-PI	Dr. Wojciech Florkowski (Economist)	UGA, Griffin, Georgia
Co-PI	Dr. R. Dixon Phillips (Biochemistry and Nutrition Specialist)	UGA, Griffin, Georgia
C0-PI	Dr. Anna Resurreccion (Food Scientist)	UGA, Griffin, Georgia
HC Principal Investigator	Dr. Tana Sapoundjieva	Institute of Cryobiology and Food Technology, Plovdiv, Bulgaria
Co-PI	Dr. Pavlina Paraskova (Food Scientist)	Institute of Cryobiology and Food Technology ICFT), Plovdiv, Bulgaria
Co-PI	Dr. Nelly Bencheva (Economist)	Agriculture University, Plovdiv, Bulgaria

Comment [PC1]:

Host Country: Bulgaria

3.1 Project Objectives and Budget

Objective	Objectives	% Complete
1	Conduct research on peanuts and peanut-based ingredients to understand their physical, chemical, nutritional, functional, and microbiological properties.	80
2	Develop appropriate peanut-based products for consumers in Bulgaria and the region.	75
3	Enhance technological capabilities of ICFT on peanut processing, packaging, quality evaluation, and shelf-life prediction and leadership as Center of Excellence in Bulgaria and region.	85
4	Develop formal linkages between ICFT, the University of Georgia and other food processing research and development entities in Bulgaria.	75
5	Train scientists in Bulgaria through short-term training courses.	85
6	Develop business plan to process peanut-based products from pilot scale to production scale.	None

3.2 Annual Budget:

From 2001 to 2005, the budget for this project was US$426,000, of which US$136,659 (32.1%) was transferred to the Bulgarian collaborating institution (ICFT) and US$57,315 (13.5%) spent at UGA on behalf of Bulgarians for training and related aspects. There has been significant leveraging of funds from other sources: (1) US$10,000 from the Georgia Peanut Commodity Commission for an impingement oven; (2) US$200,000 in 2002-2005 from the Southeastern Peanut Research Initiative (SPRO) for peanut product development, (3) US$10,000 from Tara Foods for a graduate student at UGA, and (4) US$300,000 in 2001 for research competitive grants from the Food Processing Advisory Council of Georgia. The UGA Project Team is commended for their fund sourcing efforts.

The Budget for this project in 2004-2005 was $105,000.00

This evaluation covers the period from 1 August 2001 to the present.

2. Research Approaches

Research was conducted at the University of Georgia (UGA) by a multi-disciplinary team to test peanut products identified that are preferred by Bulgarian consumers, such as peanut butter tarts, peanut flour-based beverage as milk substitute, peanut snacks, etc. Extensive laboratory testing was done to determine their physical, chemical, nutritional, functional, and microbiological characteristics.

Bulgarian scientists and researchers were trained at UGA by the U.S. Project Investigators on processing techniques and physico-chemical analysis. Further testing is being done in locally developed peanut products in Bulgaria, using upgraded laboratory facilities and equipment supported by Peanut CRSP.

Four M.S. graduate students at UGA carried out more intensive testing of some products (i.e., peanut-based beverage, peanut tarts, etc.) to determine key product characteristics such as stability and shelf-life, sensory properties, consumers' acceptance, etc.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

Bulgarian scientists/researchers at ICFT have developed and tested six peanut-based products acceptable to Bulgarian consumers, based on an earlier Consumers' survey carried out in Phase 1: (1) peanut butter breakfast tart, (2) lot fat peanut-flour based beverage as 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, chocolate (not yet tested extensively). They continue to use the pilot peanut processing plant established in Phase 1 with support from Peanut CRSP.

ICFT researchers have been trained at UGA to continue product development and to carry out product testing to better understand the properties of locally developed peanut product. Laboratory facilities established in Phase 1 of the project allowed them to determine physical, chemical, nutritional, functional, and microbiological characteristics of these products in Plovdiv. Studies have been completed on various peanut and peanut spread formulations that were preferred by consumers in Bulgaria and the region. Work is continuing on further development of peanut-based beverages and snack products acceptable to Bulgarian consumers.

The development of new peanut products undertaken largely in the USA has been successful and (apart from the peanut drink with a short shelf-life) the others will be evaluated at the Plovdiv Fair by getting consumers to taste in booths and complete evaluation sheets. The plan (very ambitious) is to get 6000 consumers to carry out the tests over the 1-week period which should provide a useful insight into Bulgarian consumer preferences. Much seemed to be on-hold regarding future work until after the Plovdiv Fair as this was seen as instrumental to taking forward development of 'market pull'.

3.2 Technical Outputs in United States

Negotiation is ongoing for a Licensing Agreement between a private company and the Technology Commercialization Office of the University of Georgia Research Foundation to commercialize five peanut products. Three of these products were developed in association with UGA11: (1) peanut butter tarts, (2) backed snack chips, and (3) peanut flour-based beverage.

Peanut flour-based beverage showed great potential as substitute for cow's milk. It was formulated in the pilot plant by combining liquid skim milk, fine sugar, stabilizer, liquid caramel, and peanut butter. Amino acid requirement patterns show that peanuts combined with high lysine ingredients such as soybeans gives improved nutritional profile for the product.

A UGA graduate student tested several rapid methods to determine shelf-stability of peanuts and identified the use of the sophisticated Rheometer as the most reliable method; but the equipment is expensive. Study to determine the thermo-tolerance and viability of *Listeria monocytogenes* on peanut-based beverage and chocolate peanut spread showed that viable cells are recoverable up to 24 weeks when product is exposed to 70% relative humidity at 20 degrees C.

3.3 United States Training and Capacity Development/Maintenance

The UGA Food Science Team for this project was strengthened by the addition of an agricultural economist who carried out a consumers' survey in Bulgaria, a good development towards building a multi-disciplinary project team.

Eight persons from various parts of the world (Senegal, Thailand, The Philippines, Ghana, and Guyana) participated in a workshop at UGA on Storage, Processing, Quality Evaluation and Marketing of Peanuts and Peanut Products in 2003. They also participated in the 2003 Georgia Peanut Tour sponsored by the Georgia Peanut Association.

Three M.S. graduate students and one Ph. D. graduate student have completed or doing their studies at UGA:

1. A Ph. D student (Antonio Zenere, male) completed his degree with dissertation on formulation and testing of peanut flour-based products (partially funded by Peanut CRSP);
2. An M.S. student at UGA (Vandana Totlani, female) completed her degree; she developed rapid methods to determine shelf-stability of peanuts; she tested 4 methods and determined that using Rheometer was best but the equipment is expensive. She is currently doing her Ph.D. at Pennsylvania State University;
3. An M.S. student (Joy Dubost, female) completed her degree; she studied nutritional analysis of selected peanut products (partially funded by Peanut CRSP); and
4. Another M.S. student (Rashmi Desphande, female) has studied stability and sensory analysis of peanut four-based beverage.

3.8 Host Country Training and Capacity Development/Maintenance

Institutional: In the past 3-4 years, Peanut CRSP has upgraded the ICFT laboratories by providing additional equipment and computers. ICFT has the following laboratories developed with support from Peanut CRSP: (1) Food Design and Formulation Laboratory, (2) Peanut Processing Laboratory, and (3) Physical Properties Laboratory, and a pilot processing plant. An ICFT engineer designed and built equipment (a pan coater) for less than US$2,000 which was several folds costly if bought in the U.S.

An EEP member, who visited Bulgaria, held discussions with ICFT scientists and toured the site which provided some fascinating insights. The canning equipment available, although extensive, was old and looked as if operating most of the equipment would be verging on the foolhardy – this equipment would not meet U.K. safety standards. Some interesting work (unrelated to Peanut CRSP) was being undertaken by Prof Krivoshiev, an expert in near infra-red spectroscopy. He has developed an impressive machine which can look 'inside' fruits and vegetables to identify defects and could be used by industry for sorting. The EEP member was privileged to see a demonstration of sorting potatoes into four classes depending on the degree of defects. This work had been EU-funded through and RTD project QLK1-2000-00455 called 'Non-destructive assessment of virtually peeled fruits and vegetables' which had recently been completed. Interestingly, Prof. Krivoshiev was part of a new integrated project application in FP6 coordinated by Leeds University of which CSL is involved and if successful will bring additional much needed funding to the Institute.

The 10-booth taste panel facilities funded by Peanut CRSP were excellent and as good as anything facility elsewhere. With 10 computers linked into a network to facilitate data processing, the unused facilities are state-of-the-art. The taste panel booths were complemented by a new 'kitchen' area for food preparation and a room specially designed for work with focus groups complete with a one-way mirror to observe discussion and note for example body language. These facilities have not been used yet partly because the taste panel is waiting for software to be provided (which is expensive) and was obviously to be funded through Peanut CRSP. The EEP member sensed a nervousness to start work in earnest despite full training for Dr Dida Iserliyska having been provided in the U.S. There were concerns about the costs of consumables and the need to pay panelists and clearly the Institute is running on a shoe-string and do not even have these minimal funds available.

The pilot plant facilities for roasting peanuts, coating peanuts and for various other operations to make peanut products were modern and in a well provided area. These facilities again have been funded by Peanut CRSP and provide a tremendous resource that should be exploited in seeking new funding opportunities. The roasting facility was being used during my visit and I understood that the other facilities were going to be used to manufacture the new peanut products for testing during Plovdiv Fair.

Degree: None

Non-degree: The following persons benefited from training carried out by the project:

1. An ICFT scientist visited UGA in 2003 and 2004; Dr. Dida Iserliyska, (female) worked on peanut butter-based beverage and sensory and consumer testing techniques for nine months; she will continue to work on sensory and consumer evaluations to optimize the product and process in Bulgaria (with Dr. Chinnan in 2003 and with Dr. Resurreccion in 2004).
2. In 2003, two International Workshop on peanut post-harvest handling and processing) organized by Kasetsart University in Bangkok, Thailand.
3. An ICFT researcher (Nikolina Milcheva, female) trained at UGA for six months in 2004 on techniques for determining nutritional value of food products (with Dr. Phillips).

4. Two ICFT researchers participated and presented poster papers during the International Peanut Conference held in Bangkok, Thailand, in January 2005.
5. Further training had been identified to be undertaken in the U.S. as part of UGA11 as follows: (i) 'Techniques for economic and market analysis' – seen as supporting Business Plan activities. Nobody had yet been identified for this training and it seemed doubtful that such a person was available from existing staff; (ii) 'Techniques for testing texture and viscosity of food' – skills needed to support sensory area as part of evaluation of success of new product development; and (iii) 'Training in modern microbiological techniques' – Dr Tania Sapoundjieva will receive training at University of Georgia as part of peanut CRSP. This seems to have been agreed and will take place in May 2005. It was not clear how this practical microbiology training fitted with the objectives of UGA11 nor was it consistent with Tania's role as the Institute senior manager. Nevertheless, undertaking the training will ensure continued commitment from the Institute to UGA11.

3.5 Technology Transfer (workshops, publications, patents)

Workshops: Workshops were held in Bulgaria at ICFT to train 18 local researchers and technicians (8 females, 10 males) on product processing methods and laboratory analysis techniques of peanuts and peanut products.

Publications: The following publications were prepared through the project: (1) 15 papers published in refereed journals, six in preparation; (2) three book chapters; (3) one Ph. D. dissertation and three M.S. thesis reports; and (iv) 13 Presentations at the annual IFT and APRES meetings, and other national and international professional meetings in 2001 to 2004.

Patents: UGA has filed a U.S. patent application for the peanut-based beverage as a potential substitute for cow's milk, and ICFT is checking if this peanut-based beverage could also be patented in Bulgaria.

4. Demonstrated/Potential Impacts

Joint efforts of scientists from Peanut CRSP and ICFT, its partner institution in Bulgaria, have resulted to strengthening the research facilities of ICFT and its human capital to carry out and sustain peanut processing and post-harvest research in the country. A strong technical backstopping from UGA scientists is continuing.

The planned impact study in Bulgaria in 2005 will show the extent of benefits from the adoption of Peanut CRSP technologies derived by various stakeholders, especially consumers and private small- and large-scale food industry enterprises. These benefits would result from aggregated achievements of many years of collaborative efforts by U.S. scientists and their Bulgarian partners from the government and the private sector.

Development of the local peanut industry would encourage Bulgarian farmers to produce peanut that stopped when the large government farms were broken into individual small farms. However, this industry development has not yet occurred. There is a tradition of peanut production in Bulgaria so farmers could produce again, if there is a ready market. A key advantage of the locally grown peanuts is that it does not contain aflatixon, so exporting to EU would be possible (EU has the most stringent aflatoxin standard in food products). The Bulgarian Peanut Breeding Project has identified some improved varieties suitable in Bulgarian agro-climate. A key factor would be the development of a viable seed production scheme to support farmers who are willing to produce peanuts. The peanut raw material for processing in-country is imported from China and India.

The critical nature of the Business Plan in delivering the outcomes of UGA11 was discussed with the EEP. ICFT needs external help to develop a Business Plan and has internal procedures that require advertisement and essentially undertake a 'competition' to select a company to develop a plan. This process seems to be 'stuck' and it was unclear what was needed to move it forward. The staff seem traumatized by the notion of a Business Plan and may not really understand what needs to be done and why. The difficulty of getting someone from outside is ownership of the plan within ICFT and critical support from the political agencies.

Bulgaria is ready to start commercialization of the peanut products that have been developed by ICFT researchers in collaboration with Peanut CRSP scientists. But the local peanut industry is rudimentary. There are a few groups who are interested to produce peanut products, since there is a long tradition of peanut consumption. Most of the peanut products are imported from Greece, Turkey and Western Europe, but in the high-end market. The Mayor of Plovdiv is interested to export peanut products to Europe. An emerging peanut industry could provide market pull that would enhance local peanut production.

5. United States/Host Country Beneficiaries and Benefits

The main potential beneficiaries of the project are peanut consumers in Bulgaria and the U.S. when healthy and safe peanut-based products (aflatoxin-free) are commercialized and become readily available in the market. For example, a private company (Bell Plantations, Inc.) is planning to commercialize five peanut-based products in the U.S.; three were developed by Peanut CRSP scientists.

Other beneficiaries are scientists and researchers in Bulgarian research institutions who have been trained on food processing and post-harvest handling of peanut and peanut-based products, including laboratory testing techniques. ICFT, the Bulgarian collaborating institution, continue to benefit. Peanut CRSP has assisted it to become a Center for Excellence for Peanut Research in Bulgaria and in the Eastern European region.

The U.S. Project Investigators and graduate students at UGA continue to benefit from their periodic visits to Bulgarian and Croatia through professional interactions with scientists and policy-makers in Bulgaria and other Balkan countries. Their exposure to local conditions and to the private food industry has given them another perspective in their research.

6. Building Partnerships

The main collaborating institution in Bulgaria is the Institute of Cryobiology and Food Technology or ICFT (formerly Institute of Horticulture and Canned Foods, later the Canning Research Institute). Since 2001, the institute was reorganized three times; most recent changes are still ongoing and are causing some problems such as changes in personnel (both Project Investigators have been changed). There is a need for more stability in the institution to ensure continuity of the research effort. The intensive and consistent support by the Peanut CRSP scientists has helped ICFT to deal with the upheavals caused by many institutional and personnel changes.

The ICFT has a run-down building on the outskirts of Plovdiv that originally housed 250 scientists and support staff in the days when it was the Canning Institute. It has been recently renamed The Institute of Crybiology and Food Technology (ICFT) reflecting the lesser importance now attached to canning and the desire to establish a research centre that is more focused around food technology. The Institute now has 40 staff, as many of the original staff has been made redundant. ICFT is managed with 'command and control' from Sofia with the strong impression being given that there was little local autonomy permitted to the present Head, Dr. Tania Sapoundjieva, who regularly travels to Sofia to report to the boss who makes most decisions including those related to the Peanut CRSP. Funding also flows from Peanut CRSP to Sofia and then to Plovdiv with permission being sought from Sofia for most spending decisions.

Peanut CRSP and ICFT are also linked with two other government institutions: (1) the University of Food Technology, formerly Higher Institute of Food and Flavor Industries (Prof. D.G. Hadjikinov) and (2) the Institute of Plant Genetic Resources (Prof. Stanko Delikostadinov). The latter is also the collaborating institute for the Peanut CRSP peanut breeding project with New Mexico University.

In 2002, UGA scientists provided technical advice to prepare a Protocol between the Bulgarian Academy of Agrarian Sciences and the Ministry of Agriculture and Forestry to establish a parastatal food enterprise, ECONATURE. An agreement was signed but it has not been implemented because of changes in the government and reorganization of the research institutes. The potential for enhancing the development of the food industry of Bulgaria, through ECONATURE, needs to be assessed, with possible technical inputs from Peanut CRSP. Other options should considered by ICFT, such as collaboration with the existing food industry that produces dairy products, wine, confectionaries, but not peanut.

In July 2003, a Cooperative Research Agreement was signed by the University of Georgia and the Bulgarian Academy of Agrarian Sciences to formalize their linkage. This agreement gives an opportunity for research between these two institutes; however, not much progress has been made to date due to economic constraints and administrative changes in Bulgarian Academy of Agrarian Sciences. Peanut CRSP scientists need to assess the feasibility of linking with the Academy for future work in Bulgaria.

In two conferences held in 2003, sponsored by Peanut CRSP and the Bulgarian Academy of Agrarian Sciences, the participants discussed the establishment of a Food Research and Development Center for Southern and Eastern Europe (FRDC-SEE). The center will also serve as a Food Certification Laboratory and Training Center for the Balkan region. The conference was attended by 15 representatives of 9 countries (Bulgaria, Croatia, Israel, Moldova, Rumania, Russia, Turkey, Ukraine, etc.). The establishment of this center will improve regional research collaboration in the Balkan region. The status of FRDC-SEE is uncertain since it would take political support from participating countries to establish it. Croatia is very interested to collaborate with Bulgaria and has invited the U.S. Project Investigator to visit Croatia to participate in the Second Food Technology Conference.

7. Constraints and Recommended Solutions

Political changes: Political changes in Bulgaria resulted to several government reorganizations which affected the Peanut CRSP collaborating institutions. Personnel changes resulted to the designation of new Project Investigators, which affected the implementation of collaborative activities.

There was an extensive presentation on UGA11 during the review in Bulgaria given by Dr Pavlina Paraskova that was based on work presented at the 2005 Workshop in Thailand and provided a useful basis for discussion. Dr. Pavlina Paraskova remains the Program Investigato for the project. Although Ms.

Tania Sapoundjieva is now the Head of the Institute (replacing Pavlina) this does not affect operational matters regarding the project nor the Project Investigator position.

Political changes also affected the planned establishment of a parastatal food enterprise (ECONATURE) that was expected to commercialize the peanut products developed and tested by the project. The status of this enterprise is still uncertain. Other more feasible options needs to be assessed, such as collaboration with existing food industry what might include peanut products in their current production lines..

Regional collaboration: Although representatives from nine countries have agreed in principle to establish a Food Research and Development Center for Southern and Eastern Europe (FRDC-SEE) bur there has been little progress. The center will be based in Bulgaria to build on the improved research capacity and laboratory facilities at ICFT. Participating countries will have to approve their formal participation, which is a long process. Recent political changes in Bulgaria have further delayed the process.

8. Lessons Learned

Peanut CRSP could be a key player in sustaining the peanut research effort in Bulgaria and the potential expansion to the Balkan region, through the planned Food Research and Development Center for Southern and Eastern Europe (FRDC-SEE). A USAID Partnership proposal for Food Industry Development (US$2.5 million) is being considered by USAID for Bulgaria and Croatia, because of the presence of Peanut CRSP in the region.

It is difficult to promote commercialization of Peanut CRSP technologies, involving the private food industry, without capacity to assist the local institutions on how to prepare a Business Plan. The Peanut CRSP Project Investigators are technical experts and would need additional expertise in business planning and development. The quickest way is to partner with local NGOs (i.e., VOCA Consulting) in Plovdiv to assist ICFT to prepare the business plan but it would require additional funding.

9. Next Steps and Future Directions

Peanut CRSP will continue providing technical guidance to ICFT and the Bulgarian Academy of Agrarian Sciences to facilitate the establishment of a private peanut processing enterprise in Bulgaria. Funding assistance has been sought by the government from VOCA (an NGO), the USAID Office in Bulgaria, and the USDA Foreign Agriculture Office in Sofia.

Continue to improve the research and quality testing capability of researchers in Bulgaria and provide additional critical equipment or upgrade existing ones. In 2004, the project procured a homogenizer and temperature- and relative humidity-controlled incubators. Peanut CRSP and ICFT are planning to showcase the products developed through this project at the 2005 Plovdiv Fair.

The activities in Bulgaria could be expanded to include technology transfer and product commercialization activities, including a study to determine the impact of Peanut CRSP technologies in Bulgaria. Extend peanut products, processes, and research activities to Croatia and other Eastern European countries to transfer successful technologies. Using Bulgaria's ICFT as the center for excellence in peanut research in the region, exploit links with other donors to pursue funding opportunities to expand in Eastern Europe.

Continue to support the planned degree and non-degree training of Bulgarian researchers at UGA during the remaining program period: (1) Nikolina Michleva for M.S. degree in 2005 on analytical techniques (with Dr. Phillips), (2) Tania Sapoundjieva for six months training in 2005 on microbiological analysis of foods (with Dr. Beuchat), and (3) a researcher for six months training in 2006 on techniques for testing textures and viscosity of foods (with Dr. Chinnan). There is a need to improve English proficiency of Bulgarian researchers to facilitate their acceptance in U.S. for training.

During the review in Bulgaria, there was an awareness and concern about the potential change of status of Bulgaria with respect to Peanut CRSP and the effect on future funding. Part of the time spent at ICFT was devoted to discussing opportunities for EU funding in FP6 and mechanisms for support through Twinning and Maria Curie Fellowships that might be used. The assessment is that the EU is very unlikely to directly continue funding along the same lines as Peanut CRSP but that there might be opportunities to continue to develop the 'Establishment of a Food Research and Development Center for Southern and Eastern Europe'. Peanut CRSP has established excellent sensory panel facilities at ICFT that will have applications in areas other than peanut sensory work and funding to utilize these facilities and continue to develop expertise might be forthcoming. Once a baseline funding albeit in other areas is established this should provide the flexibility needed to continue with some of the peanut CRSP initiatives.

10. General Observations

Strength: The multi-disciplinary team at UGA has done an excellent job to initiate the Peanut CRSP collaborative research in Bulgaria, which is hoped to expand to the Eastern European region. Considering continuing funding constraints, Peanut CRSP Project Investigators should consider the expansion to the region in a phased manner, starting with countries that have firm commitments in terms of institutional, human capital, and funding capability. A work plan and budget should be prepared for this expansion to be approved by the Peanut CRSP Management Entity.

Strength: Peanut CRSP has supported the regional effort to establish a Regional Food Research and Development Center. This initiative shows the growing interest of countries in the region to organize a network of peanut scientists and other stakeholders, using the experience of Bulgaria. A regional meeting was held to discuss this initiative, participated by representative from nine countries. The most active to pursue such collaboration is Croatia that was visited by the U.S. Project Investigator in 2003.

Overall assessment: The project had benefited Bulgaria significantly and that they have made very effective use of the funds to establish new facilities that offer tremendous opportunities for exploitation. The 'market pull' is moving along and may be successful in stimulating opportunities for expanding the peanut market. It was clear that domestic peanut production cannot satisfy even existing demand and would be incapable of responding. A Business Plan remains critical in terms of identifying what is really achievable – whether those involved are really capable of taking forward a Business Plan or even finding the key people to take it forward is debatable.

11. Recommendations

Specific: Peanut CRSP to continue supporting the project in Bulgaria in the next phase. Expand collaboration to include technology transfer activities involving the private food industry to promote commercialization of successfully tested peanut products preferred by Bulgarian consumers. To facilitate the food industry linkage, U.S. and Bulgarian Project Investigators should review and modify the Industry Incubator Model developed in the Philippines (UGA04) to suit specific situations in Bulgaria.

Field visits to the Philippines (for commercial-scale processing) and Thailand (for small-scale village processing) would be useful for the key people involved (researchers and private sector). They can discuss with representatives of the private food processing industry and researchers their experiences and lessons in the Philippines and Thailand. Peanut CRSP should facilitate that this is done during before the project closes in 2006. This would facilitate their preparation for the next phase of the Peanut CRSP.

Food industry pilot plant established with CRSP funds to allow industry and entrepreneurs to evaluate new products.

1. Project Title and Investigators

NCA32U: Development of Value-added Products from Peanuts and Aflatoxin Detoxification

U.S. Principal Investigator	Dr. Mohamed Ahmedna	North Carolina A&T State University, Greenesboro, North Carolina
Co-PI	Dr. Ipek Goktepe (Aflatoxin)	NC A&T at Greensboro, North Carolina
Co-PI	Dr. Jianmei Yu (Antioxidants)	NC A&T at Greensboro, North Carolina
H.C. Principal Investigator	Dr. Amadou Kane	*Institut de Technologie Alimentaire*, Dakar, Senegal

Host Countries: Senegal

3.3 Project Objectives and Budget

Objective	Objectives	% Complete
Objective 1	Produce functional ingredients from peanut and peanut processing by-products.	90
Objective 2	Develop value-added products from peanut alone or in combination with fish mince.	100
Objective 3	Optimize physical, chemical, and sensory properties of the peanut-based products for consumers in the US and Senegal.	90
Objective 4	Select inexpensive treatments and/or additives that eliminate aflatoxin in the end products.	90

1.2 Annual Budget: In 2003-2004, the budget for this project was US$70,000, of which US$10,683 (15%) was transferred to the Senegalese collaborating institution (ITA). Significant leveraging of funds from NCA&T management occurred with the university providing over US$200,000 to procure critical pieces of laboratory equipment, beyond the 25% const-sharing required. The Principal Investigator has also received a USDA grant of US$300,000 for another food science project. The salary of a team member working on antioxidant is paid through another source but she works full time on Peanut CRSP activities.

This evaluation covers the period from 1 August 2001 to the present.
Selected general recommendations for Peanut CRSP stated in the 1996-2001 External Review Panel Report were (1) Utilization research is of great importance in that peanuts are an important source of value-added products for small businesses and women-based companies; and (2) Both food safety and utilization research are necessary to ensure markets for peanuts. The potential importance of exploiting the clay-adsorption technologies as a means to impart human health and child survival worldwide is an exciting prospect, and both the Peanut CRSP and USAID should work to prove that this technology works for human use and are safe. The significant impact in the U.S. resulting from the research on human health responses to peanut

diets justifies continued efforts in this area. The objectives of this project NCA32U were set in place to develop and advance technologies for quality and safe peanut products.

2. Research Approaches

This study was designed to sustain the market competitiveness of peanuts in the US and Senegal by addressing aflatoxin contamination (Senegal) and by reducing the level of fat calories (US) to meet the new threshold fat calories level (33%)set by the National Institutes of Health (NIH). By reducing the fat level in daily diets, it expected that the risk level for coronary heart disease in the general population would be lowered. The 50-55% fat level established in peanuts made it imperative that ways be found to bring it down - in line with the new NIH guidelines- so that the consumption of peanuts would not suffer a significant decline. Maintaining market share and reducing the levels of health risk from fat and aflatoxin became the core of the project. Successfully designed new products and new uses would essentially permit an expansion in market share.

Defatted peanut flour was prepared from peanut factory processing by-products. Heat treatment and fungal (Rhizopus sp.) fermentation were used to modify defatted peanut flour, which was used successfully in developing new products such as meat analogs, peanut-based fish nuggets using tilapia and catfish mince, and high protein snacks. Extensive testing was done in the laboratory to identify physical, functional, and chemical properties of these products and consumers' acceptability tests were carried out using U.S. and West African sensory panels.

Antioxidants or nutraceuticals were extracted from peanut skins, another by-product from peanut processing. Phenolic extracts were separated and identified using HPLC and LC/MS. Antioxidant and radical scavenging capacity of crude and purified peanut skin extracts were determined and compared with Trolox and Vitamin C. Effect of skin removal methods and extraction solvent used on relative TAAs were determined. Shell fragments from the shelling process were separated from kernels as feedstocks for making value-added products. Shell fragments were processed as activated carbon and chemically activated absorbents.

Inexpensive treatments to detoxify aflatoxin in peanut products were tested using ozone, ultraviolet light, biological agents, and mild heat treatment in the U.S. Attapulgite clay was tested in Senegal for detoxification of aflatoxin in peanut products, such as peanut paste.

Transfer of the new/improved technologies to cottage- small-scale processors (many are women) in Senegal and to interested food industry partners in the U.S. have been initiated through intellectual property contact with stakeholders. This is currently being pursued. An assessment was carried out in Senegal to establish the level of aflatoxin contamination of peanuts and peanut products through sampling. The baseline information is being used as basis for providing guidance on the best methods to reduce aflatoxin by cottage- and small-scale processors in the country. Socioeconomic improvements are related to the availability of aflatoxin-free value-added peanut products and co-products in the marketplace. Safe, quality products contribute to healthier people.

3 Outputs/Achievements

3.1 Technical Outputs in Host Countries

Use of technologies adaptable/appropriate to Senegal include local clays, UV light for aflatoxin detoxification by cottage level peanut processors, peanut milk and protein isolates for protein deficient children, and fish by-products used to produce high protein peanut-based snacks. Peanut-based fish nuggets could enable recovery of fish by-products in Senegal and the U.S., where fishing industries are strong, and add value thereby enhancing both the fish and peanut industries.

Product development: Two high-protein baked snacks from defatted peanut flour were developed and tested in the U.S. and Senegal: (1) cookies, and (2) chin-chin (a West African snack). Substitution of up to 40% roasted defatted peanut flour yielded snacks that was most acceptable to consumers. U.S. and West African sensory panels tested both snacks; the West African panel gave higher acceptability ratings to peanut-based snacks especially chin-chin compared to the U.S. panel. Shelf-life of chin-chin was determined to be good. The high protein-low fat products have health implications. Peanut milk from defatted peanut flour is being developed in Senegal by collaborating researchers for testing for acceptance 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 on health risks to consumers and provide guidance on ways to reduce aflatoxin especially at the village/small-scale processor level.

Aflatoxin detoxification: B1 and G1 Aflatoxin detoxification of peanut products using Senegalese Attapulgite clay was tested in Senegal in collaboration with NCA&T researchers. Addition of clay as low as 0.5% level resulted to non-detectable levels of aflatoxin in all samples. Samples of all peanut products in local markets in Senegal showed aflatoxin contamination; the products showing high levels of over 30% were: crude peanut oil (92%), peanut cake (90%), and peanut paste (55%), and kernels in local market (30%). Sorting and removal of skins proved effective in lowering aflatoxin for some uses, and the utilization of the Senegalese attapulgite clay reduced aflatoxin to none detectable levels in other uses of peanut.

3.2 Technical Outputs in United States

Significant outputs were achieved in the U.S. by the NCA&T Project Team in the past four years, including: (1) developing peanut-based products developed from peanut processing plant by-products acceptable to consumers, (2) identification of antioxidant components of peanut skin by-products (phenolics), and (3) successful testing of inexpensive methods to detoxify aflatoxin in peanut-based products, such as use of ozone and mild heat treatment of peanut flour and kernels.

Product development: Two sets of new peanut-based products were developed and tested: (1) Meat analogs as substitute for ground beef in taquitos, tamales, and chili, and (2) peanut-based fish nuggets. Both products used defatted peanut flour made of peanut processing plant by-products. Fermentation enhanced the functional properties of heat-treated peanut flour.

(1) Peanut-based meat analogs were highly acceptable as ground beef substitutes in three Hispanic snacks (taquitos, tamales, and chili). These meat analogs are also potential candidates for incorporation into other meat-based formulations. Extrusion was used to produce high quality texturized meat substitute from fermented and unfermented peanut flour.
(2) High consumer acceptance of peanut-based fish nuggets incorporating up to 15% defat peanut flour. Addition of peanut flour masked the muddy taste of catfish and fishy taste of tilapia. Consumers' test showed that the product has potential for commercialization. The sensory characteristics of the best fish nuggets were further optimized via enhanced formulation and optimized extrusion technologies. Overall, the extrusion process produced a better texture, improved flavor product compared to the non-extruded fish nuggets.

NCA&T researchers showed that peanut skins (a by-product of peanut processing) are a good source of antioxidants. Peanut skin contains phenolic compounds (90-130mg/gm) with very high antioxidant properties. Peanut skin has more antioxidant power than green tea (standard), vitamin C, Trolox, and grape seed extracts. Phenolics are made up of procyanidins monomers, A-type and B-type procynidin dimmers, trimers, and tetramers, as well as phenolic acid and resvertrol. This extract is a potential source of inexpensive source health promoting nutraceuticals. Peanut skin makes up 3.0-3.5% of the whole seed; one gram of dry skins contains 90-130 mg of total phenolics. Currently, peanut skins by-products are used for animal feeds. Peanut skins could be used as functional ingredients in dietary supplements as value added products for local industry.

Peanut protein concentrate using defatted peanut flour is being developed at NCA&T for the U.S. market. Protein solubility, functional properties, and other characteristics of the concentrate have been established through extensive testing. Additionally, these peanut protein products are being tested in peanut milk in Senegal, a product that would add nutritional value to the diets of children.

Aflatoxin detoxification: Two inexpensive treatments and/or additives to eliminate/detoxify aflatoxin in peanut-based products were tested by NCA&T researchers: (1) use of ozone, and (2) mild heat treatment of peanut flour and peanut kernel. Gaseous ozonation could destroy about 80% of AFB1 and AFG1; 60% of AFB2 and AFG2. The process was more effective in peanut seed than peanut flour; and longer treatment at low temperature was as effective as shorter time at high temperature. Degradation by as much as 80% was achieved within 15 min. of exposure. Ozonation at room temperature for 10-15 min. would be the most economical since heat generation typically adds to the processing cost.

3.3 United States Training and Capacity Development/Maintenance

Exchange visits in Senegal: NCA&T Principal- and Co-Investigator visited in 2001 to initiate project activities and to attend a regional Peanut Workshop in Senegal; in 2003 the Project Investigator carried out a second visit to provide training for researchers at ITA, review progress of collaborative activities, and finalize work plans for the remaining period.

The Principal Investigators received Achievement Awards(a strong recognition program implemented by NCATSU administrators to recognize excellent work by their faculty). The PI received the 2002 Outstanding Young Investigator, and 2001 Gamma Sigma Delta Award of Excellence in Research. The Co-PI received the Outstanding Young Investigator Award in 2005.

Graduate students received nine awards in 2001-2004 in recognition for their excellent research papers through graduate student paper competition.

Five M.S. students completed their degrees at NCA&T and have presented their research findings at national meetings; theses topics were: development of meat analogs (2), fish mince (1), high protein snacks (1), and detoxification of aflatoxins (1). Technology transfer will be stimulated from new products developed during the training of the students and researchers. Techniques used and knowledge gained in the laboratory experiences are valuable indicators of the kind of tech transfer that can take place.

A contribution to the program was the development of a scientifically equipped laboratory with University funding ($200K) and refinement of analytical procedures. A USDA, CREES Capacity Building grant ($300K) was awarded to the PI, further strengthening support of research programs, including leveraging the Peanut CRSP program at NCATSU.

Because of strong administrative support and grants, major instrument and equipment buys were made to support the research program. They are FTIR, HPLC, Texture Analyzer, Color Analyzer, Nitrogen-Carbon Analyzer, Autotitration System, Spray Dryer (for protein concentrates, isolates), Twin Screw Extruder, Elisa System (allergens) and a UV light instrument. Note, the Twin Screw Extruder, contributing strongly to food product development in the program was purchased with Peanut CRSP funds.

3.4 Host Country Training and Capacity Development/Maintenance

Degree: M.S. candidate from Senegal (Nimsate Kane, female) has passed English proficiency test after completing language training in the U.S.; she is now pursuing her M.S. degree program in NCA&T; the EEP members met her in NCA&T to discuss about her program.

Funding for language communication capabilities proved to be a primary constraint. High out of state tuition charges presented a problem for Senegalese and other students that attend NCA&T. The small size of the grant funding made it difficult to underwrite the cost of a larger number of graduate students from the HC. The PI was innovative in setting aside Peanut CRSP funds for two years to allow support of the M.S. student from Senegal to participate in the Peanut CRSP program at NCATSU.

Non-degree: ITA Director (Dr. Amadou Guiro, male) attended the FDA Mycotoxin Workshop in Maryland in July 2002; he again visited U.S. in June 2004 to discuss additional collaborative activities with NCA&T Principal Investigators. Dr. Amadou Kane (Senegalese Principal Investigator) will attend the 2005 APRES meeting and present two papers on his peanut research in Senegal. These travels were/are being funded by Peanut CRSP. A Ph.D. graduate student is working with Dr. Kane in Senegal.

3.5 Technology Transfer (workshops, publications, patents)

Workshops: No workshop was held involving cottage-level, small-scale processors in Senegal because activities to transfer new/improved food products or food processing technology have not been initiated. However, training workshops for ITA researchers and technicians were timed with the visit of the U.S. Project Investigators to Senegal. Also, technical assistance is provided in product development and testing, quality control and characterization of peanut-based products for local markets.

Publications: The following publications were prepared by the scientists and researchers involved in the project:

(1) Three publications in refereed journals in 2004 on: (1) Peanut skin procyanidins: Composition and antioxidant activity as affected by processing (J. Yu, M. Amedna, I. Goktepe, and J. Dai); (2) Detoxification of aflatoxins in peanut kernels/flour gaseous oxonation and mild heat treatment (A. Proctor, A. Ahmendna, and J. Kramer); and (3) Effects of processing methods and extraction solvents on concentration and antioxidant activity of peanut skin phenolics (J.Yu, M. Ahmendna, and I. Goktepe).

(2) Five M.S. thesis reports by: (1) Carlyn Ray (2001) on Meat analogs from modified peanut flour, functional properties and potential food applications; (2) Vivian Ray (2001) on Modified defatted Peanut flour: functional properties and sensory acceptability as meat analogs and fish additive; (3) Kendra Mathews (2003) on Optimization of extrusion parameters and formulation of value-added snacks; (4) Alexandria Proctor (2004) on Detoxifixation of aflatoxin using ozone and mild heat treatment; and (5) Pauline Ireh (2004) on Development, sensory acceptability, and physiochemical properties of high protein peanut-based snacks.

(3) Nine papers and 7 abstracts presented at national meetings (Dr. Kane will present 2 research papers at the 2005 APRES meeting).

(4) 12 articles in local media: SAES Newsletter and News Releases, Aggie Report, SAES Website, and Greensboro Newspaper.

Patents: One invention disclosure has been submitted for potential patent consideration in the U.S.

4. Demonstrated/Potential Impacts

Production of new high-protein food products and nutraceuticals from under-utilized peanut processing by-products has potential to add value to the peanut industry in the U.S., Senegal, and other countries. It could also meet the fast growing demand for meat substitutes in vegetarian diets. The U.S. meat analog industry is growing rapidly and is expected to exceed US$2.6 billion of annual sales within the next five years, an opportunity to promote peanut-based products. Peanut-derived nutraceuticals will also tap into the large and growing nutraceuticals and functional food market, currently estimated at US$17 billion per year.

5. United States/Host Country Beneficiaries and Benefits

The main beneficiaries so far are five graduate students who have completed their M.S. degrees at NCA&T; two M.S. students from Senegal (Nimsate Kane) and Algeria (Djaafar Rehrah) who are undertaking their studies. Host Country scientists and researchers have visited the U.S. and NCA&T, and attended conferences, an addition to the capacity building effort.

In Senegal, the potential beneficiaries are consumers who will have access to new/improved, safe and aflatoxin-free peanut-based products to become available in the market. Village-level, small-scale processors and/or private food industry partners in the host country are expected to benefit from high potential commercialized new/improved peanut-based products.

In the U.S., potential beneficiaries are U.S. peanut processing industry which could have useful commercial uses of their peanut processing factory by-products. By-product use would reduce the potential environmental risk implications of the present disposition of the wastes. Food industry companies that would commercialize these new/improved peanut-based products would also benefit directly. Based on low-fat products, they also have a mechanism or route for addressing the fat/health challenge to the market head on. Collaborations are being discussed with the Peanut CRSP project PUR10U PI working on the effects of peanut consumption on hunger, ingestive behavior, energy expenditure and coronary heart disease risk.

6. Building Partnerships

The main partner institution in Senegal is the Institut de Technologie Alimentaire (ITA) in Dakar. The U.S. Project Investigator had visited ITA twice to train scientists and researchers on various methodologies and laboratory techniques and to exchange ideas. Three ITA scientists carried out short-term technical visits in the U.S. and NCA&T and to attend conferences.

Partnering outcomes were less than desirable leading to inability to transfer the knowledge and new technologies to the village level processors in Senegal. New partnerships will need to be cultivated with private sector entities, agricultural extension and research providers, NGOs, village level marketers and other stakeholders if appropriate technology transfer is to occur. Similarly, partnerships should grow in the U.S. to foster technology transfer.

7. Constraints and Recommended Solutions

A Senegalese candidate for graduate studies at NCA&T had problem for two years in complying with English proficiency requirement. To solve the problem, the graduate student was invited to the U.S. to undergo intensive language training. In the future, ITA needs to recruit researchers who are already proficient in English or start English language training for potential candidates so as not to delay the start of their graduate program.

High out-of-state tuition fees continue to disadvantage foreign graduate students at NCA&T because of compliance to a North Carolina state law. NCA&T management encourages Project Investigators to include this fee into the grant request. Since Peanut CRSP grants are medium-sized, only limited number of graduate students could be provided with fully funded graduate assistantships, without sacrificing the direct support to research activities. The NCSU Project Investigator (NCS07) also cited a similar problem.

Presently, the limited partnership opportunities in Senegal need to be addressed to continue program growth and insure technology transfer. This project would benefit from the experiences in partnership development in Philippines (UGA04) and Thailand (UGA37). The PI and Co-PI of NCA32 want to learn from these experiences and apply them in Senegal. A training plan should be developed and funded by Peanut CRSP.

8. Lessons Learned

The selection of a high caliber scientist (Principal Investigator), who is also a good leader was critical in maintaining significant progress in this project. Additionally, the selection of a capable Co-PI, provided a team has been able to turn around this project and achieved significant outputs in the past four years. The Project Team is fully supported by the NCA&T management. Principal investigators can be successful when provided with appropriate support from the university administration. Higher levels of scientific output and productivity can occur when the Principal Investigators are strong and the team is built on mutual respect and trust. Science continues to be a source of solutions to vexing problems affecting the food chain and markets.

Significant leveraging of funds had occurred in this project through the efforts of the Principal Investigator, with support from the NCA&T management. In this case, the Principal Investigator has to ensure that the activities are complementary so conflict in time allocation of researchers does not occur.

9. Next Steps and Future Directions

Product development and testing should be continued, and prepare to transfer to Senegal the technologies (peanut-based food products and nutraceuticals and processes) developed by Peanut CRSP scientists at NCA&T. Focus of the next phase should be technology transfer and training activities involving village-level processors, traders in Senegal, and private food industry partners in Senegal and U.S. Technology transfer activities would require new institutional arrangements, involving the private sector, NGOs, agricultural extension providers, and other stakeholders.

A plan has been prepared to introduce a Peanut Food/Processing Industry Incubator at ITA in Senegal. The industry incubator model developed in the Philippines (UGA04) would facilitate technology transfer to the local food industry and provide solutions to local peanut processing and safety problems.

Continue to strengthen the institutional and human capacity of ITA-Senegal and other partners through more intensive training at different levels involving as many stakeholders as possible.

Future plans include possible expansion of the project to two additional countries in the region.

10. General Observations

Strength: NCA32 Project Team consists of young professionals and technical experts who work well together. They have achieved significant outputs, and turned around a low-performing project in the past four years. Selection of a good and dedicated Principal Investigator was a key action taken by the NCA&T management, as well as sustained financial support for the project team, and providing solutions for their problems. For example, data obtained from the Peanut CRSP project was critical in securing USDA, CSREES funding for research on other aspects of value-added use of peanut and peanut by-products. Hence, Peanut CRSP was key in bringing together a peanut research program with funding from various sources at NCA&T

Strength: EEP met with three members of NCA&T management (Associate Dean, Department Head, and Peanut CRSP TC). They fully support the Principal Investigator and scientists working in the project, and were quite pleased with the significant outputs that they have accomplished. The project is used by NCA&T as a successful example in the briefing of visitors. NCA&T procured about US$200,000 worth of equipment to complete the laboratories needed by the project team. The management solved the problem of transfer of funds to Host Country collaborating institution by changing from reimbursement of expenditures scheme to advanced fund release scheme.

Strength: The result of the work in aflatoxin detoxification could provide a bridge between agricultural and health issues. Expansion of Peanut CRSP initiative to public health aspects of peanut research (i.e., aflatoxin, peanut allergies, HIV AIDS) would allow joint research by agriculture and health scientists. In Senegal, other funding sources from Belgium, Canada and France are supporting research programs in these areas and leveraging Peanut CRSP.

11. Recommendations

Specific: Peanut CRSP to continue product development in the next phase. Further development of value added peanut products and improvement and fine-tuning of the processes are needed to bring them to pilot production stage. Integrating a strong technology transfer component, especially in the host country would facilitate the transfer of Peanut-CRSP technologies (new food products and processes) to the region through Senegal. Refocus the efforts in the U.S. and Senegal towards more commercialization of these technologies and intensive training of key stakeholders, in the U.S. and Senegal. This would necessitate new partnerships involving the private food industry (focusing on small- to medium-scale businesses), the public (government entities), and public (or NGOs) extension providers, health workers, traders, and other stakeholders, including donors. ITA should continue to provide research support and coordination to ensure sustainability and quality of the products produced in Senegal.

The Peanut CRSP project at NCATSU includes emphasis on development of aflatoxin-free value-added peanut foods, feeds and nutraceuticals from peanut products and co-products suitable for the Senegal and U.S. markets. Work is examining the use of aluminosilicate clays (Attapulgite) to reduce levels of aflatoxins in cottage industry peanut paste. The results are very promising. It is recommended that this work be expanded to include that of Peanut CRSP project OKS55. The combined effort could focus on the aflatoxin problem throughout countries in West Africa. Proper funding would be required to assure success of the program.

Peanut products on the shelf in a Bolivian supermarket. American products are competitive by virtue of packaging and marketing.

1 Project Title and Investigators

OKS 55 Use of Chemoprotection in Product Development to Improve Safety and Production of Peanut Products in Ghana, West Africa.

U.S. Principal Investigator	Dr. Margaret J. Hinds	Oklahoma State University, Stillwater, Oklahoma
H.C. Principal Investigator	Dr. William Ellis	Kwame Nkrumah University of Science and Technology, Kumasie, Ghana

Host Country: Ghana

1.1 Project Objectives

Objective	Goals	% Completed
Objective 1	Develop formulations and processing protocols for HSCAS-supplemented prototypes of popular Ghana peanut-based products.	100%
Objective 2	Assess the effects of various levels of HSCAS and antioxidants, and processing techniques on the physical, chemical, and nutritional properties of freshly-processed and stored products selected from Objective 1, and determine their shelf-life.	80%
Objective 3	Evaluate sensory attributes and consumer acceptability of Optimal products selected from Objective 2 that also contain levels of HSCAS with potential for chemo-prevention of aflatoxicosis in humans. (HSCAS levels will be based on results of clinical studies from TAM50.)	Continuing
Objective 4	Establish appropriate protocols for production of acceptable HSCAS-supplemented peanut products in Ghana.	Continuing
Objective 5	Train processors in Ghana to manufacture peanut products containing levels of HSCAS appropriate for chemo-prevention of aflatoxin-induced diseases.	Continuing

Selected general recommendations for Peanut CRSP stated in the 1996-2001 External Review Panel (EEP) Report were: (1) utilization research is of great importance in that peanuts are a major source of value-added products for small businesses and women-based companies; and (2) both food safety and utilization research are necessary to ensure markets for peanuts. The potential importance of exploiting the clay-adsorption technologies as a means to impart human health and child survival worldwide is an exciting prospect and both the Peanut CRSP and USAID should work to prove this technology works for human use and are safe. The significant impact in the U.S. resulting from the research on human health responses to peanut diets justifies continued efforts in this area. The objectives of this project OKS55 were set in place to develop and advance technologies for quality and safe peanut products.

1.2 Budget:

The budget for 2004-2005 was $50,001

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

To determine the ability of hydrated sodium calcium aluminosilicate (HSCAS) clay to function as a chemoprotectant against aflatoxin in peanut products, nutritious and functionally acceptable peanut foods as carriers of this material needed to be formulated. HSCAS-clay is a processed product with promise for use in removal of aflatoxins from contaminated foods and feed in the digestive tract and subsequent discharge from the body. Market screening for peanut products was conducted in Ghana and based on consumer preference and popularity – the following five products were chosen for these studies: (1) peanut paste, (2) chocolate pebbles, (3) starch-coated chocolate pebbles, (4) Kurikuri, and (5) Nkatie burger. Peanut paste is used as a spread in snacks and for soup, chocolate pebbles are a confectionary product popular among children, Kurikuri is a crispy peanut chip enjoyed by children and the Nkatie burger is a tasty snack enjoyed by all age groups. A collaborative agreement was developed between the Kwane Nkrumah University of Science and Technology (KNUST), Kumasi, and a Cocoa Processing Company (Tema) in Ghana to develop and process these peanut foods.

Formulations and processing protocols were developed at the Cocoa Processing Company for the five selected products and after scale-up production sent to KNUST and OSU for studies. All ingredients were purchased from the open market in Ghana. HSCAS clay (NovaSil, made by Engelhard Chemicals, IL, U.S.A.) was shipped to Ghana for incorporation into the peanut products' recipes. NovaSil is off-white to tan colored free-flowing powder with particles ranging from 100-350 mesh. The properties of the peanut foods were studied and included proximates, microbiology (total plate count, mold, *E. coli*), color, texture, total moisture, water activity, oil absorption and pH. Also, protein, amino acids, fatty acids, flavor profiles and aflatoxins were analyzed. These studies were conducted at Oklahoma State University and/or in collaboration with KNUST.

Once the formulations for making repeatable quality peanut products were in place, protocols for preparing varying concentrations of HSCAS clay-supplemented products were developed. The levels of HSCAS clay were selected based on studies showing effective aflatoxin binding activity in the gut of rodents and poultry at Texas A&M University (TAMU) in collaboration with TAM50.

Short-term Food and Drug Administration (FDA) approved human feeding trials were conducted with HSCAS clay capsules at Texas Technical University in collaboration with the TAMU team following the protocols (0.25-0.60%) set by the rat studies. Studies are planned in Ghana in collaboration with the Noguchi Memorial Institute for Medical Research and Ghana University, in Accra, to establish the feasibility of HSCAS clay addition to the diets of humans who are exposed to high levels of aflatoxins. With the success of these studies, delivery mechanisms, peanut foods supplemented with the HSCAS clay and extending this practice, long-term studies will be conducted.

Because of budgetary constraints, only two products (chocolate pebbles and Kurikuri) were selected for the HSCAS clay-supplementation studies.

Studies on the five peanut products completed during the project's timeframe were composition, microbiological analyses, selective functionality and sensory screening via the untrained panel method. Similar work was done on the two products supplemented with

HSCAS clay. Storage stability or shelf-life work was also done on the latter products supplemented with HSCAS clay. The focus of the work during the life of this project has been on laboratory research studies. Selected rat and human feeding trials have been completed as a result of collaborative studies at TAMU (TAM50 project).

Access to instruments at Oklahoma State University to conduct the necessary studies, include a Denver IR-30 Moisture Analyzer, Rotronic Water Activity Meter, Minolta Chroma Meter Reflectance System, TA.XT2i Texture Analyzer and Tekmar 7000/7050 Static Headspace Autosampler. An Agilent GC-Mass Detector fitted with fused silica capillary columns is used to separate, identify and quantify volatile compounds. A High Performance Liquid Chromatography (HPLC) instrument for aflatoxin analyses is at KNUST.

3 Outputs/Achievements

The Principal Investigator at Oklahoma State University studied the use of the chemoprotectant HSCAS clay against aflatoxin in selected peanut products from Ghana. The HSCAS clay was shown to effectively bind aflatoxins in the gastrointestinal tract of rats and chickens at Texas A&M University. The host country Principal Investigator at KNUST, identified five peanut products favored in a survey of Ghana residents for use in this project's studies. The formulation and processing protocols for HSCAS clay-supplemented compared to non-supplemented prototypes of popular Ghana peanut-based products have been completed. Processing of the peanut products has been made possible via a collaboration by the host country Principal Investigator in Ghana with a local Cocoa Processing Company.

The U.S. Principal Investigator developed the proximate, functional, and sensory properties for two selected peanut products (chocolate pebbles and Kurikuri or peanut chips) at varying concentrations of HSCAS clay. Also included were storage or shelf life studies up to six months. Product formulations with as much as 0.6% HSCAS clay have acceptable food properties. The collaborations between the U.S. and host country Principal Investigators worked well in that selected analyses were conducted in both countries with the host country Principal Investigator supplying the peanut products for studies at Oklahoma State University. The achievements were mainly with laboratory studies and selected rat and human feeding trials in collaborations studies with the U.S. Principal Investigator of TAM50 project.

The success of the human feeding studies (TAM50) was shown when the HSCAS clay was introduced into the diet in capsule form. Human feeding studies of peanut products containing 0.25, 0.40, 0.50 and 0.60% HSCAS clay are in progress. These levels were selected based on the positive findings of the TAMU rat metabolic studies and methodology for the human studies at Texas Technical University. Based on initial studies with Kurikuri chips, no physiological effects occurred with rats at levels of 0.25% HSCAS clay.

Working with the host country Principal Investigator in Ghana (OKS55) in preparation for the human feeding studies at the Noguchi Memorial Institute for Medical Research and Ghana University, Accra, traditional peanut products have been formulated to incorporate 0.5-1.0% HSCAS clay. This food/consumer science project has looked not only at practical considerations (e.g., grittiness), but also at storage parameters, flavor stability, and acceptance and ways of making these traditional products more attractive to consumers in Ghana and the U.S.

3.1 Technical Outputs in Host Country

Development of formulations and processing protocols for the selected traditional peanut products were completed in Ghana. A collaborative agreement between KNUST and the Cocoa Processing Company, Tema, in Ghana, has enabled the researchers on the project to have access to production facilities for processing of peanut products. Formulations and processing protocols for large-scale production of the five selected products are ongoing. This has also allowed studies to develop appropriate processing parameters for production of consistent quality peanut products containing varying amounts of HSCAS clay for composition and functional properties studies. Collaboration is in place by the KNUST host country Principal Investigator with Noguchi Memorial Institute for Medical Research and Ghana University to study the effects of HSCAS clay-supplemented peanut foods of humans exposed to high levels of aflatoxins.

3.2 Technical Outputs in United States

Results of shelf-life (0-6 months) studies indicate that HSCAS clay levels of 0.0625-0.25% have no effecs on texture and flavor of Kurikuri. These high levels of HSCAS clay decrease the rates of lipid oxidation and degradation of flavor compounds in products more efficiently than the lower levels (0.005-0.01%) of HSCAS clay. Hence, HSCAS clay will enhance quality of stored products by minimizing formation of compounds that impart rancid and off-flavors, as well as minimize loss of the roasted peanut flavor. The feeding studies at TAMU showed that Kurikuri containing 0.25% HSCAS clay had no adverse physiological effects on rats. Further studies on quality of the products containing >0.25% HSCAS clay (up to 0.60%) are showing that these levels are feasible. A finely ground HSCAS clay is needed at these high levels to prevent an unacceptable mouth feel. From the results of the shelf-life studies to ascertain the optimum level of HSCAS clay with quality enhancing properties and mouth feel of the peanut products.

Results of the rat studies at TAMU and human studies at Texas Technical University, Naguchi Memorial Institute for Medical Research, and Ghana University, on optimum aflatoxin-binding efficacy, the U.S. and host country Principal Investigators, with the Texas A&M University collaborating scientist (TAM50), will be able to establish the levels of HSCAS clay that needs to be incorporated into peanut products to reduce risk of aflatoxicosis.

The five peanut products selected for the OKS55 project have marketing potential as nutritious foods in the U.S.

3.3 United States Training and Capacity Development/Maintenance

Three female and two male M.S. level graduate students began their studies with the U.S. Principal Investigator but left before completing their degree requirements at Oklahoma State University. The students found better paying graduate assistant positions in other programs at the university. An M.S. graduate student (Saritha Gedela) is presently working with the U.S. Principal Investigator. Undergraduate students are hired for technical support as time and money permit. HATCH funds of US$15,000 are available for laboratory supplies, a US$12,000 grant from NASA and US$1100/month to support students at 20 hours/week leverage by the US$40,000-50,000 provided by Peanut CRSP to this project. Of the US$40,000-US$50,000 from Peanut CRSP, 56% is taken as overhead by Oklahoma State University and half was sent to the host country collaborating research institution. Hence, there are very limited funds available to this project for training and capacity development.

The U.S. Principal Investigator has developed a working partnership with Peanut CRSP TAM50 Principal Investigator at Texas A&M University. With available HATCH monies, collaboration was developed with the Food Protein R&D Center in Texas A&M University, which made available an extruder for studies to develop new peanut products. The following papers and presentations have resulted from the project:

- The results were presented at the 2005 96th AOCS Annual Meeting and Exposition on: Processing, Properties and Potential Application of Extruded Peanut, M.J. Hinds, M.N. Riaz, D. Moe and D.D. Scott.
- Two papers were presented at the 2004 Annual Meeting of the IFT on: Volatile Flavor Compounds of Kurikuri Containing Hydrated Sodium Calcium Aluminosilicate, M.J. Hinds, W.O. Ellis, K. Frimpong, A. Salem and S. Gedela and Quality issues and Potential Market Segments for Spicy Haitian Peanut Products, M.J. Hinds, C.M. Jolly, R.G. Nelson, Y. Donis and E. Prophate.
- One paper was presented at the 2003 Annual Meeting of the American Peanut Research and Education Society: Characterization of Peanut-based Products from Ghana, M.J. Hinds and W.O. Ellis.
- Two papers, including the PI and HCPI, will be presented at the 2005 Annual APRES meeting as: Optimization of Physical Properties of Textured Peanut Patties Using Binders, M.J. Hinds and M.N. Riaz and Determinants of Aflatoxin Levels and Health Effects in Ghana, P.E. Jolly, Y. Jiang, F. Obuseh, W.O. Ellis, R. Awuah, J.S. Wang, T. Phillips, C. Jolly and T.J. Williams.

3.4 Host Country Training and Capacity Development/Maintenance

The host country Principal Investigator (Dr. W.O. Ellis), has one male Ph.D. graduate student, (Kwabena Frimpang), a female research associate (Genevieve Pawar), and two technicians, (Gloria Koomson and Frank Asante). Dr. Ellis has built an excellent network with the Cocoa Processing Company in Kumasi, and other entrepreneurial businesses in the area working with peanut products. His collaborations extend to the Noguchi Memorial Institute for Medical Research and Ghana University, Accra. He also has strong connections with the Food Science Institute, Accra, government and university programs in Ghana. He has been a strong collaboration with the U.S. principal Investigator at Oklahoma State University, even though Dr. Hinds has not traveled to Ghana because of health concerns.

3.5 Technology Transfer (workshops, publications, patents)

During the initial phase of the research program, the Ghana Principal Investigator conducted market screening and discussions with consumers that resulted in the selection of five peanut products for the studies. The basis for the studies and their potential value resulted in interest from the consumers to present their preferences and popularity. This effort attracted the interest in and support for the research by the Cocoa Processing Company, Tema, Ghana. Formulations and processing protocols for large-scale production of the peanut products was a major development of these efforts in Ghana. The remaining years, to present, of the project have been focused on basic and applied research studies in the laboratories at KNUST, OSU, TAMU and Texas Technical University. Use of the peanut products supplemented with HSCAS clay by humans exposed to aflatoxins must await the outcome of the TAMU and Noguchi Memorial Institute for Medical Research and Ghana University studies.

No manuscripts related to this work have been published. Two manuscripts related to the work of project OKS55 co-authored by the U.S. and host country Principal Investigators are in preparation. The following :

- M.J. Hinds and W.O. Ellis, Physicochemical characterization of Ghana peanut-based products. African J. Food, Agric. Nutrition Development, 2005,
- M.J. Hinds and W.O. Ellis, Fatty acid and headspace flavor profiles of Kurikuri as affected by hydrated sodium calcium aluminum silicate, Food Chemistry, 2005,
- Seven published, and one in preparation, manuscripts related to past Peanut CRSP and present collaborative peanut work with J.M. Jolly, of Peanut CRSP project AUB20, are credited to the OKS55 Project Investigator during this period, and
- Presentations at meetings on developments/progress have occurred as described in the U.S. Training and Capacity Development section of this report.

4 Demonstrated/Potential Impacts

Compositional, functional and sensory studies on the five selected peanut products, peanut paste, chocolate pebbles, starch-coated chocolate pebbles, Kurikuri and Nkatie burgers have been valuable in that in the U.S. the food industry has been interested in learning more about them for possible commercial sale. Noteworthy is that the Texas A&M University studies with HSCAS clay supplemented peanut products fed to rats work well, i.e., aflatoxins are reduced and the animals are healthy. Preliminary results from studies with humans show no adverse physiological effects in blood and urine tests and the digestive tract. Hence, these studies show promise that use of HSCAS clay to reduce the negative effects of aflatoxins in peanut foods will be a major technology breakthrough in studies planned at the Ghana institutions.

5 United States/Host Country Beneficiaries and Benefits

Benefits will come to the U.S. from sale of potential new peanut products, and to Ghana, via use of HSCAS clay supplemented peanut and other food products to reduce health effects of aflatoxins. These developments can be extended into Western Africa and elsewhere in the world where the aflatoxin problem exists.

6 Building Partnerships

In Ghana, the partnership between KNUST, the Cocoa Processing Company, Noguchi Memorial Institute for Medical Research and Ghana University has been a positive impact. The host country Principal Investigator and the Ph.D. graduate student have benefited in career growth. The collaborations among scientists involved in Peanut CRSP projects TAM50, OKS55, and AUB30, have been a positive result for the program. It is noted that the OKS55 and host country Principal Investigators collaborate with the AUB30 Principal Investigator.

Work in Peanut CRSP project UGA01 (R. Phillips, University of Georgia; S. Sefa-Dedeh, University of Ghana) is developing technologies for reducing aflatoxin contamination in peanut meal by extrusion in the presence of HSCAS clay. This is part of multi-faceted studies using a number of methods and processes to eliminate substances in peanut foods affecting health. The work on HSCAS clay in UGA01 complements OKS55, but the latter has the advantage of working with local peanut foods in Ghana rather than trying to introduce new food technologies.

7 Constraints and Recommended Solutions

The original OKS55 project was to be funded at US$120,000, instead it has been at $40,000-US$50,000. The high overhead charges of 56% by Oklahoma State University have further limited funding for the research studies. Because of limited funds, it has been difficult for the U.S. Principal Investigator to compete with salaries for quality graduate students and support scientists to assist in the research studies and this has slowed progress on the project. The limited funds have made it difficult to maintain functioning equipment in Ghana. For example, the maintenance contract for the important HPLC instrument at KNUST has not been funded and as a result has not functioned in running analyses of aflatoxin levels in peanut products in support of the farm to food processing industries in Ghana.

8 Lessons Learned

Commitment to provide sufficient funding the Peanut CRSP projects is needed. Closer evaluation of overhead costs by the university must be done and where necessary negotiated to reasonable levels so the researchers can have the funds to do the assigned research work. Support by administrators at all levels need to be closely scrutinized to assure that full support for the program and personnel are in place.

9 Next Steps and Future Directions

Consideration should be made to redirect this project (OKS55), to another site and increase the level of funding. This is an opportunity to consolidate projects and funds to strengthen the research studies and enhance success with impact.

Continuation of the research studies identified in this OKS55 Peanut CRSP project should continue. The work with TAM50 should continue. However, consideration should be given to moving the project from Oklahoma State University to another university, possibly consolidating with the Peanut CRSP program (NCA32 at North Carolina A&T State University. This will expand the program in West Africa, but coordinated by one project.

10 General Observations

This project is intended to determine the challenges that the addition of Novasil to foods in order to protect against aflatoxin exposure may present in the deployment of that strategy. In that sense it is anticipating that the clay based enterosorption will be proven effective and can be deployed to improve health in Africa.

11 Recommendations

The following studies are recommended for support by Peanut CRSP in the future: (1) continue support for development of the five peanut products identified in Ghana and studied for market-level production in the host country and the U.S.; (2) complete studies to optimize HSCAS clay supplementation and use of all five peanut products in human feeding trials; (3) complete human studies on HSCAS clay supplemented peanut products to reduce-eliminate aflatoxin contamination of the foods in Ghana in collaboration with the TAMU55 project; (4) expand studies in Ghana and neighboring West African countries where health issues due to aflatoxin contamination exist; and (5) this latter objective is to make application of HSCAS clay a successful technology where needed.

Peanuts packaged in soft-drink bottles.

The Peanut Collaborative Research Support Program

External Evaluation Panel 2005 Report

Annex 5

Farmers briefed on results from trials in Guyana

Information, Technology Transfer, and Program Management Projects Sector Summary Report

Purpose.

Information, training and management activities for the Peanut CRSP are coordinated through six projects (UGA 37, UGA 38, UGA 39, UGA 40, UGA 41 and UGA 05). The Peanut CRSP Management Entity provides leadership for training host country personnel and U.S. graduate students, organizes scientific workshops, manages USAID funds, publishes and distributes the International Arachis Newsletter, coordinates submission of project reports, provides outreach to international and U.S. stakeholders and partners, and supports the Board of Directors and Technical Committee governance activities through four projects (UGA 38-41). The UGA 05 project is funded to provide all available knowledge regarding peanut food system components related to production, socioeconomic considerations, utilization and food safety through a comprehensive database on the World Wide Web. In addition, UGA 05 conducts studies documenting available information about peanut production, processing and utilization in specific countries. UGA 37 provides Thailand and Southeast Asian scientists in peanut post-harvest processing and utilization technologies.

Accomplishments

UGA 05 has developed the "World Geography of the Peanut" web site. This data base is an excellent outreach and educational tool that provides useful information to wide range of people interested in peanut production and utilization. In addition, Peanut CRSP principal investigators may archive their publications in the data base. Country studies document peanut production and utilization in specific countries.

UGA 37 introduced new/improved post-harvest and processing technologies to Thai nationals, Southeast Asian individuals (researchers, extension workers, private processors), and small-scale processors through training. Approaches used included training courses, internships, "hands on" workshops, extension education programs, web sites and written materials.

UGA 38 has achieved success through post-graduate education of host country and U.S. students which increased the number of scientists having appropriate research skills and knowledge of peanut production and utilization. The sponsorship of periodic principal investigator conferences and scientific workshops has also been highly useful to Peanut CRSP participants in upgrading research skills.

UGA 39 provides flexibility for funding Peanut CRSP activities that are not identified in individual principal investigator projects and are not a part of UGA 41. Notable activities of UGA 39 include sponsorship of special publications, organization of special meetings and External Evaluation Panel costs.

UGA 40 accomplishments include publication and distribution of the CRSP newsletter and other technical materials; sponsorships of seminars, workshops and training programs for host country scientists; and collaborations with other CRSPs, CGIAR centers, NARS and NGOs on programs of mutual interest.

UGA 41 has developed an innovative suite of web based management tools that minimizes the administrative burden on principal investigators, minimizes duplication in reporting accomplishments, and makes reports and transactions transparent to all. The use of electronic data bases has lowered administrative costs of the Peanut CRSP and allowed a greater proportion of funds to be provided to individual projects. The data bases also allows the Director to become more involved in technical projects and to seek supplemental funding for the program rather than be tied up with administrative trivia. The data bases simplify project reporting for both scientific accomplishments and financial management.

Areas for Improvement

UGA 05 could be better integrated into other Peanut CRSP activities including greater interaction of the principal investigator with the principal investigators of other projects. Although project leaders may post their publications on the "World Geography of the Peanut" web site, few principal investigators have chosen to do so.

UGA 38 has supported graduate education of host country students. However, universities have experienced difficulties in obtaining visas for host country graduate students using the USAID TraiNet system and have resorted to using alternative means of gaining visas. As a result Peanut CRSP funds are not directly supporting host country graduate students.

UGA 37 host country scientists report that a lack of time limits their ability to provide training for extension workers and villagers.

UGA 39 has no apparent weaknesses given the limited goals associated with the project.

UGA 40 could increase effectiveness with additional workshops, seminars and training programs for host country participants if funds were available. Additional focus on translating Peanut CRSP findings into policy documents useful of host country decision makers would be desirable.

UGA 41 is effectively managing the Peanut CRSP with minimal staffing. The Management Entity should evaluate if the administrative functions can be sustainable over the long term with the current staffing level. One challenge relates to the finding that some host country scientists and principal investigators reported difficulties in transferring funds from the participating U.S. University to the host country organization.

UGA 41 should be commended for excellent management of the Peanut CRSP. The Management Entity is innovative, fiscally efficient, and supportive of principal investigators. The development of web based management tools reduced administrative costs and improved efficiency of the principal investigators and the Management Entity. It is recommended that other CRSPs consider adopting the web-based management tools developed by the Peanut CRSP Management Entity. The Management Entity has provides excellent leadership in terms of programmatic direction by focusing on issues related to human health. Continued evaluation of programmatic thrusts will be needed to ensure that the Peanut CRSP addresses the most significant issues related to peanut production and utilization in host countries. The Management Entity should consider having the University of Georgia transfer all of the project funds to host country organizations rather than devolve this responsibility to the participating universities. Alternatively, U.S. principal investigators must be proactive to ensure that their universities transfer research funds to host countries in a timely manner. Continued emphasis on partnerships will be essential for continued success of the Peanut CRSP.

1 Project Title and Investigators

UGA05: The World Geography of the Peanut: Global Networking Approach to Social Equity, Environmental Protection, and Technology Exchange

U.S. Project Investigators	Dr. Robert Rhoades (PI) Dr. Virginia Nazarea (Co-PI)	University of Georgia at Griffin, Georgia University of Georgia at Griffin, Georgia

Host Country: Global

1.1 Project Objectives and Budget

Objective	Goals	Status
1	Build through a networking approach a low-cost Global Knowledge Base emphasizing the integration of data related to peanut food system components of production, socio-economic, utilization, and food safety.	Continuing
2	Enhance and maintain an interactive peanut food system website which allows data archiving, sharing and downloading information.	Continuing
3	Contribute to the Global Peanut Knowledge Base by conducting primary case study research in representative peanut food systems in select host countries.	Continuing

1.2 Annual Budget:

The Budget for this project in 2004-2005 was $55,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

UGA05 is a non-technical project aimed at disseminating information concerning peanuts through the World Wide Web. The Project Investigator has developed an excellent database of existing information on peanut production systems, peanut utilization, socio-economics, production constraints, and food safety. Much of the information was obtained from various international data sets such as the Food and Agriculture Organization (FAO) production database. The use of maps and simple tables increase understanding of the data. The Project Investigator has recently been adding research papers and reports to the database and has an annotated bibliography section that contains 456 entries. The project also undertakes studies of peanut production in key countries and has recently completed studies for Thailand and the Philippines.

3 Outputs/Achievements

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 socio-economics 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 is a unique and very worthwhile contribution of the Peanut CRSP. The Peanut CRSP is to be commended for this focus on 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 for public health workers.

3.1 Technical Outputs in Host Country

None of the current effort has taken place in host countries but the focus of the web site is directed at providing information important to students, scientists, development workers, and policy makers throughout the world. The country studies provide very detailed information about peanut production, utilization, and socio-economics in specific locations. These studies are useful to a wide range of individuals in those countries attempting to increase food supplies and products for export.

3.2 Technical Outputs in United States

All the effort in the project has taken place in the U.S. The development of the web sites involves sophisticated computer software skills coupled with the ability to find and utilize primary data sets. Country studies are carried out using primary data sets derived from governmental or international agency documents.

Information on the peanut system in Ecuador is available in the 'World Geography of Peanut' site.

3.3 United States Training and Capacity Development/Maintenance

The project utilizes computer science undergraduate and graduate students employed by the Project Investigator. The country studies are carried out largely by graduate students in the Sustainable Human Ecosystems Laboratory, Department of Anthropology, The University of Georgia. Very limited Peanut CRSP funds provided to the project is utilized for graduate research assistantships.

3.4 Host Country Training and Capacity Development/Maintenance

The project was not designed to educate host country graduate students or scientists. However, the information developed in the project is very useful to host country students and scientists in planning and conducting their peanut-related research. Many of the computer science students employed by the project are international students at the University of Georgia.

3.5 Technology Transfer (workshops, publications, patents)

The "World Geography of the Peanut" web site is a tremendous outreach and educational tool that provides useful information to a wide range of people interested in peanut production throughout the world. The annotated bibliography is important for those seeking additional information about peanut production. Likewise, the country studies provide a useful synthesis of existing information that is valuable to individuals seeking information and data about specific countries.

Publications:

Mallikarjunan, P Antonova, I and Chinnan M S: 2001 Edible protein-based coatings for fried foods Protein-based-films and coatings (ed.). A. Gennadios. CRC Press, Boca Raton, FL [Publication type: CHAPTER]
Shambhu Kattel, Ram B Chhetri, and Sanjaya Dhakal: Peanut cultivation and Consumption in Nepal: A Social and Cultural Perspective. Peanut in Local and Global Food Systems Series Report No. 7
Shankarappa Talawar, Robert E Rhoades and Virginia Nazarea: World Geography of Groundnut: Distribution, Production, Use and Trade
Shankarappa Talawar, Robert E Rhoades and Virginia Nazarea: World Geography of Groundnut: Distribution, Production, Use and Trade. Working Paper No.1. Laboratory for Agriculture and Natural Resources Anthropology.

4 Demonstrated/Potential Impacts

The potential impacts from the project are primarily providing information regarding world peanut production systems 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 is a "one-stop" location for most of the significant information on peanuts.

5 United States/Host Country Beneficiaries and Benefits

The web site and associated country studies are available to anyone with access to the World Wide Web. U.S. producers can assess the latest information about peanut production in other countries and can better understand production practices and utilization of peanuts in other parts of the world. Host country scientists, policy makers, producers, and students can gain a broad understanding of peanut production and utilization throughout the world to better understand competition and opportunities for increasing consumption in their countries or improving exports. Information about aflatoxin contamination of peanuts and ways to mitigate aflatoxin contamination is a highly important public health issue that is important to everyone but especially health workers.

Shelling peanuts in Ecuador

6 Building Partnerships

The Project Investigator has a good partnership with other Peanut CRSP Project Investigators. These other U.S. and host country investigators supply essential information for the web site and provide electronic copies of their publications for posting on the web site.

7 Constraints and Recommended Solutions

No constraints were identified. Funding appears adequate for the goals and objectives of the project. There are opportunities for other Project Investigators to post their journal articles and technical reports on the web site.

8 Lessons Learned

Peanut CRSP has successfully set up a means to exchange and access information about peanuts, through a Global Knowledge Base, compliments well the strengths of this research program. This project provides a low-cost, user-friendly tool to allow scientists, researchers, students, development workers, and policy makers to access such information freely.

9 Next Steps and Future Directions

Most of the goals have been achieved and the effort will now be devoted largely to maintenance of the web site and conducting additional country studies. The goal directed at "Monitor role of peanut in local and national economic growth, health and nutrition, social equity (including gender), and environmental soundness" is commendable and deserves increasing attention during the upcoming years. These sophisticated treatments of the issues are important. Peanut CRSP Project Investigators should be more aggressive in posting their journal articles and technical reports on the web site.

10 General Observations

This project is reasonably mature and is meeting its goals and objectives.

UGA05 is a strong project that meets an important need for archiving and making available existing information on peanut production, utilization and economics. The Project Investigator is to be commended for the innovative approach used to make information freely available. The country studies conducted to date are useful and present information and analyses in an understandable manner. Overall, this is a project that is achieving its goals and should be continued.

11 Recommendations

Overall, this is a project that is achieving its goals and should be continued.

Small scale peanut butter manufacture.

Community interest in Peanut trials in Guyana

A field day in the Community Center in Letham, Guyanna

1 Project Title and Investigators
UGA37: Training for Southeast Asian Region

This project allowed Kasetsart University and its partners to develop an excellent training program which the Thai government has strongly supported over many years. There is a cadre of well trained trainers, scientists and researchers trained by Peanut CRSP, and active training partners. Thailand could be developed into a center for excellence in training and technology transfer for the Asian Region as well as other Peanut CRSP projects in other countries. As recommended by the 2002 EEP, project leadership was transferred to Dr. Anna Resurreccion in 2002.

U.S. Project Investigator	Dr. Anna Resurreccion	Dept. of Food Science and Technology, University of Georgia, Georgia, USA
HC Project Investigators	Dr. Penkwan Chompreeda (PI)	Kasetsart University, Bangkok, Thailand
	Prof. Vichai Haruthaithanasan (Co-PI)	Kasetsart Agricultural and Agro-industrial Product Improvement Institute, Bangkok, Thailand
	Dr. Juangjun Duangpatra (Production)	Kasetsart University, Bangkok, Thailand
	Dr. Amara Chinaputhi (Aflatoxin)	Department of Agriculture, Bangkok, Thailand

1.1 Project Objectives and Budget

Phase 2 Objectives	Objectives	% Completed
1	To train Thai nationals and technicians on peanut post-harvest handling and processing technologies.	100
2	To train Southeast Asian scientists in peanut processing and utilization technologies.	100
3	To disseminate information on appropriate technology on post-harvest storage, processing, and shelf-life of peanut products via website and publications.	100

NOTE: Objective No. 6 of UGA04 was transferred to this project (under Objective 2).

The primary objective was to provide training for both Thai national and Southeast Asian scientists on post harvest handling, technologies for professing and utilization, technologies for post-harvest storage and technologies and conditions affecting shelf life of peanut products. A significant feature of the training is that it was to occur at the village levels and at Kasetsart University.

1.2 Annual Budget: In 2003-2004, the budget for this project was US$20,000, of which US$10,000 (50%) was transferred to the Thai collaborating institution (KU) to support training courses. There was significant leveraging of funds from the Thai government that provided cash outlay of Bhat700,000 (US$17,500 equivalent) in 2003, and Bhat400,000 (US$10,000 equivalent) as counterpart fund. The Thai Project Investigators indicated that as long as they receive Peanut CRSP funding, they could justify and receive government funds. Other donors, like USAID and FAO, have also funded some training, including gender training. The Thai Princess's Royal Project procured equipment for small-scale peanut processors, who are usually women, located in very poor communities.

This evaluation covers the period from 1 August 2001 to the present.

2 Training Approaches

Trainers at Kasetsart University have already good experience in training on legumes when they starting the peanut training. Courses were carried out at three levels: (1) international/regional that focused on Southeast Asian scientists, (2) national level for Thai researchers and extension workers, and (3) village level for owners of micro- and small-scale enterprises involving whole villages.

Planning and implementation of training courses involved many institutions besides Kasetsart University: other Thai universities such as Khon Kaen University, the Agricultural Extension Department of the Ministry of Agriculture, Farmers' and Women's Associations, development projects such as the Thai Princess' Project, other donors such as FAO and USAID, and other stakeholders.

The main topics for training were new/improved processing techniques, especially to remove aflatoxin contamination in whole kernels, and use of Elisa technique, a quick method to detect aflatoxin contamination. Participants also learned how to process improved traditional and new peanut products.

During the international and national training, Kasetsart University trainors used on-site training methods by bringing the trainees to the villages to experience actually processing of peanut products with village-level micro- and small-scale processors.
Overall evaluation of training courses has not been completed, although an impact study of six training workshops held in 2002 is ongoing to determine the impact of training on former participants. During the evaluation, survey data were being encoded, hence, a report was not available.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

New/improved post-harvest and processing technologies were introduced to Thai nationals and Southeast Asian individuals (researchers, extension workers, private processors) and women and men small-scale processors through training. The technologies include manual sorting to reduce aflatoxin contamination, use of Elisa kits for quick analysis of aflatoxin in peanuts, post-harvest storage technologies, etc., 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.

3.2 Technical Outputs in United States

There was no expected output in the U.S. since all training courses were held in Thailand involving Thai trainers. While there was no expectation of additional technical benefits in the U.S., the Principal Investigator and staff was able to reinforce knowledge of tried techniques, introduce modifications as necessary and possible, and introduce related changes in those publications developed released.

3.3 United States Training and Capacity Development/Maintenance

No direct training of U.S. PCRSP participants was included in this project.

3.4 Host Country Training and Capacity Development/Maintenance

Training of Thai Nationals: A significant number of Thai nationals (especially villagers, mostly women) and Southeast Asian researchers were trained by the project. The Thai Government has provided significant counterpart funding for this project, an important sustainability factor.

1. Six 3-day training courses were held in January to May 2003 for 120 Thai nationals (97 men and 23 women) on Processing of Aflatoxin-free Peanut Products at the Center for Technology Transfer for Production and Utilization of Peanut (SATT) in Kasetsart University. The participants were trained on manual sorting technology and rapid detection of aflatoxin in peanut. They were also trained on processing methods for six peanut products: Ground-roasted peanut (new), Oil-roasted peanut (new), Peanut butter (new), Peanut bar (toob-tab, traditional), Fried peanut patty (traditional), and Honey-roasted peanut (new). The focus of the 2003 and 2004 training was on village-level processing. Supachi village was selected as a site for the May 2003 workshop on aflatoxin and processing of aflatoxin free peanut products (roasted peanut, honey roasted peanut butter and peanut patties) and reduction of aflatoxin contamination by sorting raw peanuts.

2. A complementary internship program is supported by the government to allow private companies to access new technologies, some of which were introduced by the Peanut CRSP. The Thai Prime Minister wants "Thailand to be the kitchen of the world". It is funding food safety campaign since 2005 has been declared as Food Safety Year in the country.

Thai Aid, the Thai Government's Development Aid Agency, has a program to assist developing countries in the region, such as Timor-Leste, through its Thai International Cooperation Program (TICP). Thai Aid could leverage Peanut-CRSP funding and future training on peanut could be funded through the TICP Program in the other collaborating countries. Peanut CRSP scientists and the Management Entity should support the Thai Project Team to pursue this opportunity.

Kasetsart University-KAPI could access the Small- and Medium Enterprises Fund from the Ministry of Industry to support training activities. The objective is to train staff from private industry for 10-15 days on processing technologies and on good industry practices. The experience in partnering with private food companies using the Industry Incubator Model, developed in the Philippines in collaboration with Peanut CRSP, would be useful for the Thai trainers involved in this project.

Training of South East Asian Scientists: An international training course on Peanut Processing and -Uutilization Technologies was held in September 2003. Participants included 13 scientists (6 women and 7 men) from 9 countries: Bulgaria (2), Cambodia (2), Indonesia (1), Lao PDR (1), Malaysia (1), Mayanmar (1), Philippines (2), Thailand (2), and Timor-Leste (1). Similar topics, as the Thai nationals training, were covered, including the use of Eliza kits to detect aflatoxin in peanut.

The trainees visited villages where Peanut CRSP technology transfer activities were ongoing (Nakornrachasrima and Udorn Thanee Villages, Khon Kaen), and Suwan Research Farm where peanut experiments were conducted. Exposure to actual field/village situation facilitated the learning process and allowed the participants to meet with village processors and extension workers. Participants in the international training, held in 2003, paid their own travel cost and hotel accommodation. The project provided training materials and other costs such as transport to the village, etc. This allowed the project to stretch the limited fund from Peanut CRSP.

3.5 Technology Transfer (workshops, publications, patents)

In 2003, 166 villagers (mainly women) from Supachai Village, Khon Kaen, participated in a 3-day training on Manual Sorting Technology; the training also included improved processing of 3 products: Roasted peanuts (traditional), Honey-roasted peanut butter (new), and Peanut Patties (traditional). Trained villagers spear-headed the establishment of village-scale processing of aflatoxin-free peanut products involving the whole community. The Thai Princess Royal Project provided funds for buying basic equipment, especially for women processors/owners of enterprises, in poor, remote villages. Facilitators were extension workers from the Department of Agricultural Extension and teachers from the local school, who provided legitimacy and confidence to the villagers. Sale of peanut products has become a major source of cash income for the villagers, especially for women participants.

In 2004, 176 participants, consisting of government officials, entrepreneurs, private sector representatives, and the general public, in training courses held in two villages (Sakol-Nakorn and Nakorn Ratahasrina) on Peanut Production, Post-harvest, Quality and Standards. Extension workers from the Department of Agricultural Extension (DOAE) trained participants from two new villages on the implementation of One Village One Product Program of the government. The objective of the training is to improve the quality of peanut products from these villages to meet the FDA standard of less than 20 parts per billion (ppb) aflatoxin content. Most villagers were not aware of the aflatoxin problem in peanuts.

Dissemination of information on appropriate technology for post-harvest storage, processing, and shelf-life of peanut products continued through a website (http://peanut-crsp.kapi.ku.ac.th), which is accessible locally and internationally. Leaflets and CD containing similar information were prepared for areas that cannot be reached by internet services. The website is a significant contribution of this project since it facilitates the access of information about peanut to many people.

Peanut CRSP also contributed to facilities development at Kasetsart University. The program provided funds to procure small-scale laboratory equipment, such as blender, roaster, chopper, and modification of existing equipment at Kasetsart University, for use in the training courses.

Publications:

Peanut SATT, KU, Bkk, Thailand: 2003 International Training Program; Technology Transfer of Storage Handling, Processing, and Quality Measurement of Peanuts and Peanut Products [Publication type: OTHER] Record 2016
Peanut SATT, KU, Bkk, Thailand: 2003 Annual Report 2003 [Publication type: REPORT] Record 2017
Wongwithoonwid Y, Haruthaithanasan V, Chompreeda P and K Sriroth: 1990 Development of dog food from undersized peanut Proc. 28th Annu. Kasetsart Mtg. 29-31 Jan [Publication type: PROCEEDINGS] Record 2050

4 Demonstrated/Potential Impacts

There has been an increased capacity of researchers in Thailand and in the Asian region resulting from the training courses held in Thailand. A large number of villagers participated in the training workshops on post-harvest, processing, and packaging technologies. One of the main beneficiaries of training are Thai 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 of the training of Thai nationals is being carried out in collaboration with Kasetsart University partners, but this has not been completed. The results of the impact study will clarify the benefits derived by stakeholders from the training courses carried out by KU with support from Peanut CRSP in 2002.

A key impact is the leveraging of funds from the Thai Government that has provided substantial funding for the training of Thai nationals and villagers. The Thai Princess' project has supported village-level training.

Another impact was of a "community building" nature which the Peanut CRSP induced by building the multi entity collaboration around a single project in search of specific outcomes of improving local incomes and improving health by elimination of the aflatoxin risk and creating new products to increase peanut consumption and utilization.

Another easily overlooked impact is the building of connections between scientists and other individuals from several nations around common foci would lay the foundation for future technology transfer and collaboration though not necessarily pertaining to peanut or aflatoxin reduction.

5 United States/Host Country Beneficiaries and Benefits

Main beneficiaries of this training project are Thai villagers, both consumers and micro-processors, at the community level. They are mainly women involved in producing traditional peanut products and have learned new/improved, optimized and standardized peanut products from the training. They have benefited from the training on manual sorting technology to produce aflatoxin-free peanut products, and improved packaging. Their new enterprise has become a main source of cash income for the family.

Thai scientists, researchers, extension workers, and the private food industry representatives have benefited from the sustained training efforts since Phase I of the project. Many have become excellent trainers for the continuing international, national, and village-level training in Thailand.

Another group of beneficiaries are Southeast Asian scientists/researchers who have participated in the international courses funded partly by Peanut CRSP on Peanut Processing, Packaging, and Utilization Technologies held at Kasetsart University in Bangkok. Participants have ongoing projects or were expected to initiate food technology-related activities in their own countries after their training. The Thai training project has developed a cadre of peanut food technology scientists who continue to network to share information about peanut research and product development.

6 Building Partnerships

A key factor in the success of training and technology transfer activities in Thailand, especially at the village level, is the active partnership of Kasetsart University researchers with the Department of Agricultural Extension of the Ministry of Agriculture. Government extension workers were trained early on by the project and are now active trainers and facilitators at the village level. This strong linkage between research and extension, especially in training, should be considered in Peanut CRSP projects in other areas of the world. Since extension is a public service in most developing countries, training extension staff would ensure sustainability of the technology transfer support for peanut producers and processors especially in the rural areas, as in the case of Thailand.

Partnership in training with the Food and Agriculture Organization (FAO) was initiated in Phase I of the project, and is continuing. With FAO-Peanut CRSP-Kasetart University joint sponsorship, a technical consultation was held to discuss how to enhance the participation of men and women in peanut production and utilization.

7 Constraints and Recommended Solutions

The Host Country Project Investigators indicated that the main challenge for them and trainers is the limited time that they can allocate for visiting villages because they spent about 60% of their time in teaching and 30% for research. Hence, training is a minor activity of university professors. Further, there is no junior staff involved in peanut research. To solve the problem, the Project Investigators have trained graduate students who go to the villages to assist village trainers and extension workers in their activities.

8 Lessons Learned

The partners in Thailand, under the leadership of Kasetsart University scientists, have developed an excellent cadre of trainers who have good technical knowledge and training skills. They have developed team-work with local agricultural extension workers and farmers' and women's associations at the village-level to showcase the benefits derived from the adoption of Peanut CRSP technologies. The study tour portion of the training courses exposed the participants to actual field situations, including the constraints met by villages in developing their enterprise, and how these were solved.

The active involvement of extension workers and beneficiaries brought about a new dimension to training and technology transfer activities. The outputs went beyond research reports and papers. The project facilitated the production of extension materials such as brochures, leaflets, and posters, and the development of a Peanut CRSP website at KAPI in Kasetsart University, for general public access to peanut technology and training information.

There has been significant leveraging of funds from the Thai government, which has been fully committed to the successful implementation of the project since Phase 1. The Thai Princess's Royal Project has supported several poor, isolated villages that are now producing clean and healthy products that are generating cash for the family. Other donors who have provided funds for training like USAID and FAO. Opportunity for accessing training funds from Thai AID and the Ministry of Industry is being pursued by Kasetsart University to ensure sustainability of funding in the future. The Host Country Project Investigators indicated that the continued support of Peanut CRSP would allow them to continue to generate government funds for training.

With respect to engaging village level participants it was also learned that locations with need and strong organizational characteristics and which are the focused on National interests (Initiatives) might prove to be better positioned to realize successful project outcomes. Also the partnering with or the engagement of other NGO in supporting the local participants will likely raise the level of enthusiasm and involvement, necessary for fuller success.

9 Next Steps and Future Directions

Thailand has sponsored a well-organized International Peanut Conference in January 2005 in Bangkok, with Peanut CRSP. This international event was carried out successfully and was participated by about 150 peanut scientists and researchers and their partners from the U.S., Thailand, and other countries participating in Peanut CRSP, like Bulgaria, Philippines, etc.

The Industry Incubator Model that was developed in the Philippines could be transferred to Thailand to expand the commercialization of peanut products from village-level micro- and small-scale enterprises to medium- to large-scale food industry companies. Training of managers, factory workers, and other business groups is an important activity. The Ministry of Industry is providing funds to Kasetsart University, through its Small- and Medium-Enterprise Funds, to train private companies.

Thailand has been developed as a center for excellence in training of trainers and technology transfer and should continue this training project in the host country. The Thai project should continue to train Southeast Asian scientists, private food industry representatives, and extension workers on new/improved peanut products and methods to improve their quality and safety. It should expand its coverage to other regions **to train trainers on peanut technologies** based on the demand from other Peanut CRSP participating countries. The US could likely benefit by modeling the Thai approach to collaboration (between industry/universities/government) in the development of new peanut products and improved processing and packaging technologies.

10 General Observations

Strength: Thai scientists and researchers at Kasetsart University and their development partners have become proficient trainers on post-harvest, processing, and utilization technologies with appropriate methods to suit different groups of clientele. The Thai Project Team was able to build commitment from the government and other partners so the project has trained significant numbers of village-level processors in Phase 2. Training has involved whole communities, including extension staff, which would ensure sustainability at the village-level economic activities.

Strength: Thai scientists and researchers have successfully involved extension workers in their training and technology transfer activities, especially at the village-level. Extension workers have day-to-day interactions with villagers and involving them as partners would ensure sustainability of technical advisory service to farmers and processors, which the university researchers cannot provide. They have influenced the conduct of field days and preparation of extension-type media materials, such as brochures and leaflets in Thai language. These materials have facilitated information dissemination and created greater public awareness.

Strength: Thailand shows examples of successful training courses for various client groups, including a strong training of trainers program. They can show to participants successful micro- and small-scale enterprises, which are operated mainly women, which are now producing improved peanut products in the local market.

11 Recommendations

Specific: Peanut CRSP to maintain its presence and use Thailand as a center for excellence in training of trainers for the Asian region and to show case successful technology transfer activities. The environment in the country is more open and Thai trainers are very willing to share information and their expertise to Asian and international collaborating scientists. There are examples of successful promotion and commercialization of Peanut CRSP technologies, especially at the village-level involving small-scale entrepreneurs who mainly women. The Thai government has provided consistent supports for this project for the past 10 years. The ongoing impact study of past training courses would provide ways to improve the training program. Thailand is already the focal point for training Asian scientists and there are active village-level technology transfer activities to show participants. Participating countries in other regions should consider sending participants for **training of trainers** to Thailand and to get experience in field application and benefits derived from Peanut CRSP technologies.

General: Peanut **CRSP to enhance technology transfer and beneficiaries training in all Peanut CRSP projects.** The experience in Thailand and the Philippines showed that active involvement of beneficiaries, through training and actual application, facilitated the promotion and commercialization of Peanut CRSP technologies. The experience in Thailand of involving extension workers as trainers and organizers of training activities facilitated the process of technology transfer and adoption.

Thailand became a "graduate country" economically as classified by USAID at the beginning of this 10-year Peanut CRSP grant period. The conversion of this project to a training program is an excellent example of the USAID intention of graduate countries continuing to extend technologies in a Region based on capabilities developed during the active project period.

Participants at and international workshop in Thailand held with CRSP and Thai Government support.

1 Project Title and Investigators

UGA38: Long and Short Term Training for Host Country Scientists

Deleted: Project Evaluations: EEP Members

U.S. Project Investigator	Dr. Jonathan Williams	Peanut CRSP Management Entity/Technical Committee, University of Georgia at Griffin, Georgia

1.1 Project Objectives

Objective	Goals	Status
1	Support post-graduate training of scientists from host countries.	Continuing
2	Support short-term training of scientists and researchers from host countries.	Continuing
3	Maintain technical liaison and competence through attendance of host country scientists and researchers to workshops, meetings, and seminars.	Continuing

1.2 Annual Budget:

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

The Peanut CRSP uses traditional methods for the education of graduate students. These include a combination of formal coursework and original research carried out under the direction of Project Investigators. Graduate students report that they are receiving an excellent education that has prepared them for a scientific career.

No information was available to the EEP regarding all the short-term training that has been conducted by the Peanut CRSP. International peanut meetings and conferences that involve Project Investigators are periodically convened. The most recent of these scientific meetings, the International Peanut Conference, was held in Thailand in January 2005. The Peanut CRSP has also been involved in joint USAID/CRSP retreats designed to improve the efficiency of CRSP operations.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Graduate students' projects are directed at host-country problems such as pest management, improved varieties, socio-economic issues, and additional utilization opportunities. These projects directly benefit one or more host countries.

3.2 Technical Outputs in United States

The research conducted by graduate students in participating U.S. universities is applicable to peanut production and utilization issues in the United States. The improvement of germplasm is especially important for U.S. producers.

3.3 United States Training and Capacity Development/Maintenance

The education of U.S. graduate students using Peanut CRSP funds is a significant accomplishment since these students become aware of the cultures and economics of developing countries. These students tend to become interested in helping developing countries and sometimes seek positions that are directed at this aim. In the very least, the students have a much broader perspective and become stronger scientists.

3.4 Host Country Training and Capacity Development/Maintenance

3.5 Technology Transfer (workshops, publications, patents)

Graduate student theses and dissertations are published and journal articles are derived from theses and dissertations. In some cases, research findings have been published in popular forms that are appropriate for producers.

Host country graduate students have the opportunity to observe the U.S. Cooperative Extension Service and programs. Hopefully, some of the education and technical transfer techniques are implemented in the host countries.

Publications:

Peterkin-Sagarra, DD: 2002 Mission Report for Training in Biological Control of Preharvest Aflatoxin Contamination of Peanuts

4 Demonstrated/Potential Impacts

The education of scientists is one of the most important accomplishments and impacts of the Peanut CRSP. The development of human capital is essential for both the U.S. and host countries. Workshops and conferences result in better informed Project Investigators and host country collaborating scientists and in better planned research projects.

5 United States/Host Country Beneficiaries and Benefits

Almost all stakeholders benefit from research conducted by graduate students since a wide variety of issues are being studied by the participants.

6 Building Partnerships

The education of graduate students represents a strong partnership between U.S. universities, Project Investigator mentors, and host countries research institutions and universities.

7 Constraints and Recommended Solutions

One host country graduate student reported difficulty in obtaining a visa to study in the U.S. Returning to the U.S. after visiting their home country has been a problem for a few students. Some universities have experienced difficulties in using the USAID TraiNet system for requesting visas. One U.S. graduate student experienced language difficulty when visiting a host country. A possible solution to the visa problem is for the Peanut CRSP Management Entity staff to become familiar with the TraiNet system for processing graduate student visa applications. This person could process the applications for all host country students. Advisors may suggest that their U.S. graduate students study the language of the host country in which they will work.

8 Lessons Learned

There is a high payoff for educating graduate students and contributes to sustainability of the initiatives introduced by Peanut CRSP in the host countries especially.

9 Next Steps and Future Directions

The Peanut CRSP should continue to provide funding for both host country and U.S. graduate student assistantships or fellowships.

10 General Observations

The Peanut CRSP graduate education program appears to be progressing well and the students are well satisfied with their educational experiences.

11. Recommendations

The project should be continued to provide funding for graduate students.

Transfer of technology – farmers participate in regular field days supported by the CRSP

A Sengalese field hand harvests peanuts from a plot in one of many variety trials.

1 Project Title and Investigators

UGA39: Program Support

U.S. Project Investigator	Dr. Jonathan Williams	Peanut CRSP Management Entity/Technical Committee, University of Georgia at Griffin, Georgia

1.1 Project Objectives

Objective	Goals	Status
1	To provide financial support for common items and activities not identified with individual projects.	Continuing
2	To provide a budgetary instrument for fiscal items not included in the Management Entity project.	Continuing

1.2 Annual Budget:

Budget for 2004-2006 is $8854.
This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

This project was established to provide financial support for common items and activities not identified with individual projects and to provide a budgetary instrument for fiscal items not included in the Management Entity project. Program Support permits funding of special publications, meetings and budget contingency adjustments that were not planned as part of the Management Entity budget. In addition, the costs associated with the External Evaluation Panel activities are paid from UGA39.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Not applicable

3.2 Technical Outputs in United States

Not applicable

3.3 United States Training and Capacity Development/Maintenance

Not applicable

3.4 Host Country Training and Capacity Development/Maintenance

Not applicable

3.5 Technology Transfer (workshops, publications, patents)

UGA39 is positioned to provide funding for short term technology transfer activities not planned as a part of another project. This provides flexibility necessary to respond to windows of opportunity.

Publications:

4 Demonstrated/Potential Impacts

Not applicable

5 United States/Host Country Beneficiaries and Benefits

6 Building Partnerships

Not applicable

7 Constraints and Recommended Solutions

Not applicable

8 Lessons Learned

Not applicable

9 Next Steps and Future Directions

UGA39 is necessary to allow the Management Entity to take advantages of opportunities for enhanced communication and technology transfer activities. In addition, the project permits the Management Entity to make budget contingency adjustments necessary to efficiently carry out the management functions.

10 General Observations

11 Recommendations

Continue UGA39 as a contingency project to give flexibility to program management.

1 Project Title and Investigators

UGA40: International Collaboration

U.S. Project Investigator	Dr. Jonathan Williams	Peanut CRSP Management Entity/Technical Committee, University of Georgia, Georgia

Host Country: Global

1.1 Project Objectives

Objective	Goals	Status
1	To publish and distribute newsletter and other technical information.	Continuing
2	To conduct joint workshops and training programs for developing country peanut scientists and technicians.	Continuing

1.2 Annual Budget:

The Budget for this project in 2004-2005 was $20,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

This project provides 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. UGA40 also allows collaborations with other CRSPs, international agricultural research centers, and non-governmental assistance organizations on research programs of mutual interest.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

Improvements in the newsletter have resulted in better communications throughout the Peanut CRSP network. Managing the program through web-based database modules has facilitated communications and reporting by host country collaborating scientists. The recently completed Georgia Peanut Tour resulted in host country scientists, researchers, and policy makers learning the latest technologies for peanut production and processing in the U.S.

3.2 Technical Outputs in United States

Better communication and simplification of program management has enabled the Project Investigators to devote more time to research and graduate student advising. As a result, significant technology development is continuing with individual research projects.

3.3 United States Training and Capacity Development/Maintenance

Not applicable

3.4 Host Country Training and Capacity Development/Maintenance

Study tours, seminars, and workshops have improved the host country collaborating scientists, researchers, and policy makers' understanding of the state-of-the-art of research in peanut production and processing. Of particular significance is the research on mitigation of the effects of aflatoxins on human health.

3.5 Technology Transfer (workshops, publications, patents)

Study tours and workshops are effective means of technology transfer to host country scientists and research administrators. Interactions of Peanut CRSP principal investigators and collaborators with other CRSP programs, international agricultural research centers, host country agricultural research organizations and non-governmental agencies are ways that newly developed technologies can be shared. In addition, most collaborators have interactions with host country extension organizations that demonstrate technologies and assist clientele with implementation.

Publicatons:

Ntare, B.R.; Williams, J.H.; Dougbedji, F.: 2001 Evaluation of groundnut genotypes for heat tolerance under field conditions in a Sahelian environment using a simple physiological model for yield. Journal of Agricultural Science [Publication type: JOURNAL] Record 1761
Pittman, J.W. Todd, A.K. Culbreath, D.W. Gorbet, and D.J. Zimet: An Interdisciplinary Approach for Selection of Peanuts for Multiple Insect and Disease Resistance Drived from Bolivian Germplasm. Proceedings American Peanut Research and Education Society, Inc. [Publication type: PROCEEDINGS] Record 2148
Pittman, R.N., D.W. Gorbet, D.J. Zimet, J.W. Todd, and D.E. Montenegro: Plant Introductions through the Peanut CRSP and the Use of Introductions by the Bolivian Project. Proceedings American Peanut Research and Education Society, Inc. [Publication type: PROCEEDINGS] Record 2147

4 Demonstrated/Potential Impacts

UGA40 is primarily a communications project. Impacts come from individual research projects although the relationships that the Management Entity builds with host countries are important in establishing the basis for technology transfer by host country collaborating scientists.

5 United States/Host Country Beneficiaries and Benefits

The primary direct beneficiaries are host country collaborating scientists and researchers as a result of improved communications and increased knowledge of peanut research through study tours, seminars, and workshops. The ultimate beneficiaries are peanut producers, processors, and consumers in host countries and the United States.

6 Building Partnerships

Not applicable

7 Constraints and Recommended Solutions

No constraints were identified. Additional study tours, workshops, seminars, and workshops would be helpful to host country collaborating scientists, if additional funds were available.

8 Lessons Learned

A communications project to link participating U.S. and host country research institutions would enhance networking and access to and sharing of information.

9 Next Steps and Future Directions

Continue efforts to improve communications and to support educational seminars, workshops, and study tours are needed. Upgrading the knowledge and skills of host country collaborating scientists is essential for continued progress of the Peanut CRSP.

10. General Observations

This communications project has contributed to enabling U.S. Project Investigators and host country collaborating scientists to network and keep in touch with each other and to share research results and information.

11. Recommendation

Continue supporting a similar communications project in the future.

A new peanut variety in Senegal - seed multiplication is a challenge for these technologies to impact producers.

Students and scientists from both Bolivia and the USA discuss breeding for improved varieties.

1 Project Title and Investigators

UGA41: Management of the Peanut CRSP

Deleted: Project Evaluations: EEP Members

U.S. Principal Investigator	Dr. Jonathan Williams	Peanut CRSP Management Entity/Technical Committee, University of Georgia, Georgia

Host Country: Global

1.1 Project Objectives

Objective	Goals	Status
1	To establish and maintain the legal and agreement framework needed for granting to participants of the Peanut CRSP Grant.	Continuing
2	To prepare and publish papers, presentation, research results and reports and exploit multiple media for information exchange.	Continuing
3	To successfully conduct of the following functions of governance: (1) Board meetings, (2) Technical Committee meetings, and (3) External Evaluations.	Continuing
4	To establish a set of records of Peanut CRSP activities and achievements.	Continuing

1.2 Annual Budget:

The Budget for this project in 2004-2005 was $405,000.00.

This evaluation covers the period from 1 August 2001 to the present.

2 Research Approaches

This project covers the management activities for the Peanut CRSP. The management model used is that of a hub (Management Entity) and spokes (24 research projects). This model increases the Peanut CRSP access to more universities and principal investigator expertise. Changing to the hub and spoke model resulted in increasing the number of projects from 9 (engaging 4 universities) to 24 (engaging 13 universities). 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 the principal investigators.

The Peanut CRSP is governed by a fourteen-member Board of Directors represented by the U.S. universities involved in the Peanut CRSP and one host country. A five-member Technical Committee elected from among the Principal Investigators provides guidance on programmatic direction and budget allocations to the Board of Directors. A modestly staffed Management Entity carries out Board of Directors and USAID policies and guidance on a day-to-day basis. The External Evaluation Panel provides periodic assessments of the effectiveness of the Peanut CRSP programs. The Board of Directors meets face-to-face once each year and are provided periodic programmatic updates through email. The Technical Committee examines the proposed work plans and principal investigator accomplishments on an annual basis to ensure that no serious problems are developing.

The Management Entity has developed a suite of web-based management tools to provide information regarding budgets, reports, and accomplishments. The electronic databases are utilized by the Principal Investigators to file trip reports and annual reports and to request budget adjustments and travel authorizations. Essentially all management activities are documented within the databases. Special utilities track reports and provide email prompts to principal investigators who are delinquent in submitting their reports. The databases permit reports to be generated for individual states, technical domains, geographic regions of world, etc. The software is simple to use; allows efficient tracking of financial, administrative and technical achievements; and encourage connections and collaborations across institutions.

Programmatic direction of the research effort is changed every five years as the Peanut CRSP achieves renewal from USAID. A Request for Proposals (RFP) is issued across a spectrum of peanut research topics as proposed in the plan of work presented to USAID as part of the renewal. This process assures that new research directions can be made and that new Principal Investigators can be brought into the Peanut CRSP. If a Principal Investigator leaves the university holding the subcontract with the Peanut CRSP, the institution may appoint an interim Principal Investigator for six months and then nominate a successor to continue the project if appropriate.

Department Heads or Chairs and senior administrators at participating U.S. universities are highly supportive of their faculty members involved in the Peanut CRSP. The results of a survey of university administrators are given in Attachment 1.

3 Outputs/Achievements

3.1 Technical Outputs in Host Country

The Management Entity, through the Principal Investigators, provides host country collaborating scientists with at least 50% of the project funds provided by the Peanut CRSP to carry out research programs. The host country collaborating scientists use the Peanut CRSP funds to address problems pertinent to their own countries. These funds have had significant impacts by preventing aflatoxin contamination of peanuts, improving peanut yields, developing new products made from peanuts, enhancing the nutritional value of peanut products, and managing pests of peanuts.

Some host country collaborating scientists have reported that peanut exports from their countries have increased as a result of Peanut CRSP research activities. Relationships between the Peanut CRSP and host countries are established and maintained through a series of Memoranda of Agreement that are negotiated with host country officials by the Management Entity. The host country collaborating scientists are delighted to be a part of the Peanut CRSP and are appreciative of the support that the Peanut CRSP Management Entity and the Principal Investigators provide to them. The results of a survey of host country collaborating scientists are provided in Attachment 2.

3.2 Technical Outputs in United States

The development of web-based management tools has streamlined reporting and improved the efficiency of budget management. Use of These tools results in excellent efficiency and a reduction in administrative costs for the Peanut CRSP (<17 % of the CRSP budget) that provides additional resources for research projects. By reducing the time devoted to management tasks, Dr. Williams has the opportunity for involvement in technical projects and for seeking supplemental funding for the Peanut CRSP from USAID Mission "buy ins" and other agency programs.

The Management Entity and Board of Directors' leadership has resulted in significant shifts in program emphasis during the last four years. There is a greater increased emphasis on food safety aimed at exploitation of the discovery that enterosorption of aflatoxin is a protective strategy. This research is critical for world health since it is estimated that 4.5 billion people are chronically exposed to aflatoxin. It appears that immune system suppression is occurring for the people most exposed to aflatoxin making them more susceptible to infectious diseases.

3.3 United States Training and Capacity Development/Maintenance

The Peanut CRSP continues to support a limited number of U.S. graduate students working on aspects of their mentors' Peanut CRSP project. Interactions of Principal Investigators with host country collaborating scientists and graduate students have strengthened internationalization of the Principal Investigator's campus and have added new dimensions to some graduate and undergraduate courses.

3.4 Host Country Training and Capacity Development/Maintenance

The Management Entity has facilitated host country graduate student educational programs through execution of a Memorandum of Agreement with host country organizations and by encouraging Principal Investigators to recruit host country students. Difficulties in using TraiNet has discouraged some Principal Investigators from utilizing Peanut CRSP funds for graduate research assistantships and has resulted in some host country graduate students being supported from state or other grant funds. Host country graduate students believe that they are receiving a quality education at U.S. universities and they appreciate the guidance and support from their mentors. The results of a survey of graduate students working on Peanut CRSP projects are given in Attachment 3.

The Management Entity has also facilitated workshops, conferences, and short-term visits for host country collaborating scientists and policy makers. These activities allow the collaborating scientists to present the results of their research to other scientists, network with other Peanut CRSP collaborating scientists and peanut researchers, and gain new research skills. The collaborating scientists are highly appreciative of these opportunities for networking and skill acquisition (see Attachment 2).

3.5 Technology Transfer (workshops, publications, patents)

The Management Entity has hosted workshops, conferences, and training sessions for the Principal Investigators and collaborating scientists. These activities have served to increase international technology transfer and impart new skills to participants. Host country collaborating scientists have variable relationships with their country's extension/technology transfer organizations. In some cases, the host country's system to disseminate new technology is well developed and effective, whereas in other countries there is little interaction between collaborators and extension/outreach agencies. A summary of host country collaborating scientists' involvement in technology transfer is given in Attachment 2.

The Management Entity is dedicated to effective transfer of new discoveries to researchers, producers, processors, consumers, and policy makers. There have been a number of significant technology transfer activities that have resulted in utilization of new peanut varieties, better methods for pest control and prevention of aflatoxicosis.

Publications:

ANAPO: 2005 VARIEDADES DE BUEN RENDIMIENTO
Awuah, R.T.;Ellis, W.O.: National Workshop on Groundnut and Groundnut Aflatoxins
David Cummins and JH 'Tim' Williams (Compiler): 2001 Peanut CRSP Annual Report 2001
David Cummins and JH 'Tim' Williams (Compiler): 2002 Peanut CRSP Annual Report 2002
Farid Waliyar and Moustapha Adomou: Summary Proceedings of the Seventh ICRISAT Regional Groundnut Meeting for Western and Central Africa (French)
Farid Waliyar and Moustapha Adomou: 2002 (English) Summary Proceedings of the Seventh ICRISAT Regional Groundnut Meeting for Western and Central Africa
Farid Waliyar et Moustapha Adomou: 2002 (French) Comptes rendus de la septiÃ©me rÃ©union rÃ©gionale de lÂ'ICRISAT sur lÂ'arachide en Afrique occidentale et centrale
Jonathan H. Williams , Timothy D. Phillips , Pauline E. Jolly , Jonathan K. Stiles , Curtis M. Jolly and Deepak Aggarwal: 2004 Human Aflatoxicosis in Developing Countries: A Review of Toxicology, Exposure,Potential Health Consequences and Interventions. American Journal Of Clinical Nutrition
Jordan, D L, C W Swann, J F Spears, R L Brandenburg, J E Bailey, and M R Tucker: Comparison of virginia and runner market type peanut (Arachis hypogaea) grown in the Virginia-Carolina produciton area. Peanut Science
Lustre, A. O.; Cariso, A. O.; Agustin, G. M.; Moxley, R. L.: Impact Assessment of the Vitamin A Fortification of Peanut Butter on an Industry Innovator: A Final Report
Marin Condori and Ruben Mostacedo: 2002 Resultados de Trabajos de Investigacion En El Cultivo De Mani (Arachis hypogaea L.)
Ntare, BR, Williams, JH and Dougbedji, F: Evaluation of groundnut genotypes for heat tolerance under field conditions in a Sahelian environment using a simple physiological model for yield. Journal of Agricultural Science, Cambridge
Ntare, BR, Williams, JH, and Dougbedji F: 2001 Evaluation of groundnut genotypes for heat tolerance under field conditions in A Sahelian environment using a simple physiological model for yield. Journal of Agricultural Science (Cambridge)
Peterkin-Sagarra, D.D.: Mission Report for Training in Biological Control of Preharvest Aflatoxin Contamination of Peanuts.
Phillips, T.D.; Williams, J.H.: Human Aflatoxicosis: Achieving Health through Agriculture Poster at the Africa USAID Economic Development Officers Meeting ; Johannesburg
Pittman, J.W. Todd, A.K. Culbreath, and D.W. Gorbet: Yield and Pest Resistance in a Bolivian Landrace Peanut Variety, "Bayo Grande" and Five Similar Bolivian Plant Introductions of Arachis hypogaea from the USDA Arachis Germplasm Collection. Proceedings American Peanut Research and Education Society, Inc.
Sarun Wattanutchariya and Robert Moxley: Technology Transfer and Impact of Peanut CRSP Funded Research in Thailand. Final Report
TW Crawford,Jr; Yohe, JM; Begrekidan,B; Williams,JH; Neely,CL; Barnes-McConnell,PW; Egna,HS; Demment,MW: Collaborative Research Support Programs: Vital Links.
Van der Merwe, PJA, Subrahmanyam, P, Hildebrand, GL, Reddy, LJ, Nigam, SN, Chiyembekeza, AJ, Busolo-Bulafu, CM, and Kapewa, T: Registration of groundnut Cultivar ICGV-SM 90704 with Resistance to Groundnut Rosette. International Arachis Newsletter
Williams JH: 2003 Human Aflatoxicosis : Health Through Agriculture. APRES Proceedings 2003

Williams JH (Compiler): 1998 Annual Report. Peanut CRSP, University of Georgia, Griffin GA USA	
Williams JH (Compiler): 1999 Annual Report: Peanut CRSP, University of Georgia, Griffin GA USA	

4 Demonstrated/Potential Impacts

The impacts associated with the Peanut CRSP are largely those associated with individual projects and with development of human capital. The Management Entity plays a significant role in these activities by providing overall leadership and management for the program. From a direct impact standpoint, the development the web-based management tools by the Management Entity stands out. These databases have reduced transaction costs for management of projects and have allowed the Management Entity quickly generate required reports. The use of web-based management tools has kept administrative costs as low as possible and permits more funds to be invested in research projects.

5 United States/Host Country Beneficiaries and Benefits

The new technologies generated by projects benefit producers, processors, and consumers in both the United States and host countries. The Management Entity provides overall leadership and management of the program and plays a major role in determining the focus of the research project portfolio. The shift in emphasis during the past four years from development of new peanut varieties to prevention of aflatoxicosis was very significant this moves the program into the area of human health. Obviously, improving the health of people in host countries is a major goal of USAID and many donor countries. The finding that exposure to aflatoxins suppress the immune system is highly significant since infectious diseases are a major problem in many developing countries.

6 Building Partnerships

The Management Entity has effectively developed partnerships with a wide range of organizations that include the U.S. universities, host country universities/Ministries of Agriculture, other CRSP programs, non-governmental organizations, USAID Missions, and U.S. peanut grower associations. In general, these partnerships are functioning and effective. It appears that there are few additional opportunities for partnerships, such as those with technology transfer and extension institutions and farmers' associations in host countries.

7 Constraints and Recommended Solutions

No serious constraints to the effective functioning of the Peanut CRSP are apparent. The difficulty that U.S. universities have with TraiNet suggests that the Management Entity could hire and train a part-time employee to be trained on this system. This individual would then process all of the visa applications for host country graduate students that have been recruited by Peanut CRSP Principal Investigators. Other CRSPs have found that this approach is highly effective and minimizes frustration for Principal Investigators and clerical employees at U.S. universities who are attempting to use the system. A more efficient way of processing U.S. visas (i.e., TraiNet) was identified as an issue by the Management Entity, Principal Investigators, and host country graduate students.

Some Principal Investigators and host country collaborating scientists reported that fund transfers from U.S. universities to host country research institutions were not timely because administrative personnel at the universities were not familiar with processes used for fund transfers to other countries. The Management Entity should consider making all fund transfers to host country institutions directly from the University of Georgia. If this suggestion is not feasible, Principal Investigators responsible for transferring project funds to host countries should become more proactive in ensuring that their universities accomplish the transfer in a timely manner.

8 Lessons Learned

The primary lesson learned is that a Management Entity can function with limited staffing and low administrative costs if a web-based management system is utilized. It is recommended that other CRSP programs consider adopting the management tools developed by Dr. Williams.

9 Next Steps and Future Directions

Continued innovation within the Management Entity is expected and desired. The current Program Director should assess if refinement of the web based management tools is a priority for the next five years.

The Peanut CRSP needs to focus on matching production technology changes to market development and opportunities. The importance of market, nutritional qualities and food safety to preserve and develop value should remain a focus over the next phase. The importance of health benefits to market and economic development is important for the future of this commodity, and should have impacts that reach well beyond the commodity.

10 General Observations

The Management Entity is providing excellent leadership and administration for the Peanut CRSP with limited staffing. The Management Entity is to be commended for forward thinking in regards to programmatic direction, utilization of modern management tools and expansion of the geographic areas served by the program. The communications efforts carried out by the Management Entity are strong as is the leadership for human capacity development and technology transfer. The Management Entity works effectively with the Technical Committee and the Board of Directors as well as with numerous partner organizations. Efforts underway to capture the history, accomplishments, and impacts of the Peanut CRSP are commendable.

11 Recommendations

UGA41 should be continued with appropriate funding.

Attachment 1

Summary of Responses from U.S. University Administrators

- All respondents supported their faculty being Principal Investigators of Peanut CRSP projects. They believe that participation in the Peanut CRSP helps faculty grow professionally as global scholars. Administrators feel that involvement with Peanut CRSP enhances internationalism on their campus, strengthens courses, promotes interaction with faculty at cooperating universities, and increases scholarly outputs such as publications and presentations. The Peanut CRSP is the major outreach/international activity of some departments. Having host country graduate students is viewed as a major plus for involvement in the Peanut CRSP.

- U.S. university involvement in the Peanut CRSP results in minimal problems relating to fund management. Some problems were noted with timely allocation of funds from USAID through the Management Entity. Fund management is viewed as more complicated than grants from other federal agencies and the flow of funds is often late and unpredictable which make continuity of research projects difficult.

- Participation in the Peanut CRSP is viewed as enhancing graduate education programs. However, difficulties with TraiNet software discourages some Principal Investigators from paying host country graduate student assistantship stipends on USAID funds. Graduate student education is viewed as the most important benefit resulting from Principal Investigators' participation in the Peanut CRSP.

- Peanut CRSP affiliated graduate students do not pose any additional administrative or logistical difficulty except for the problems with using TraiNet.

Attachment 2

Summary of Responses from Host Country Collaborating Scientists

- Relationships between the U.S. Principal Investigators and host country collaborating scientists are collegial and cordial. Joint project planning is the norm and there is a good exchange of ideas regarding the approach to be used for research. In some cases, a mentor relationship with the principal investigator continues after the collaborator receives his/her graduate degree. The relationship can be described as a professional team working collaboratively.

- Collaborating scientists feel like an important part of the Peanut CRSP. They believe that involvement in the Peanut CRSP has strengthened their careers and believe that they are part of an important team of equals. Participation requires joint research planning and host country collaborators are delighted to supply much of the raw data and samples for the projects. Collaborating scientists truly appreciate visits to Principal Investigators' institutions for research training, project planning, seminars, conferences, and other information exchange activities.

- Host country collaborating scientists have relationships with their country's extension programs that vary from none to strong ties. In some host countries, universities carry out technology transfer whereas in other countries the relationship is through the extension arm of the Ministry of Agriculture or Ministry of Health. Some collaborating scientists have a direct role in technology transfer. In Ghana, a Peanut CRSP collaborating scientist designed on farm trials that are carried out by extension staff.

- The Peanut CRSP supports technical training and education for host country scientists. Skills development workshops are provided to students and collaborating scientists by the Peanut CRSP. The Peanut CRSP supports advanced degree studies for host country students and organizes many seminars, conferences, and workshops that are both international and directed at a specific country. Short-term training on specific research techniques and statistical procedures is highly valued by collaborating scientists.

- Collaborating scientists believe that Peanut CRSP funding has resulted in many accomplishments that benefited host countries. These include increased export of peanut products free of aflatoxins, improved peanut products with better nutritional characteristics, a peanut grading system, research publications, new research equipment, enhanced human capital, greater awareness of the dangers of ingesting aflatoxins, increased peanut yields, and a simple means for controlling fungal diseases. Impact assessment research has been initiated in the Philippines to determine the economic, health and social benefits of Peanut CRSP supported research.

- More than half of the respondents reported no problems with fund transfers from United States universities. Some collaborating scientists stated that fund transfers were delayed due to internal procedures at the universities of principal investigators and problems in accessing funds after transfer to host countries because of bureaucracy. Some respondents reported difficulty in moving research equipment and supplies through the custom services in host countries.

- **Attachment 3**

Summary of Responses from Host Country Graduate Students

- Almost all graduate students reported that they had no problems in being admitted to their U.S. universities. One student reported that his acceptance was delayed because of difficulties in obtaining undergraduate certificates and transcripts from the host country university from which he graduated. One student reported a difficulty connected with his scores on the Graduate Record Exam (GRE).

- Graduate students were highly satisfied with the quality of their graduate program. They appreciate the excellent library and information technology available to them. Graduate students believe that the U.S. graduate education system stresses independent thinking and problem solving. The courses are helpful in ensuring that students achieve their career goals. Graduate students appreciate the mentoring/advising from their major professors and enjoy the multi-cultural environment present in most departments. They also appreciate the opportunity to conduct original research and the fact that principal investigators have a genuine concern for students.

- Graduate students enjoy their research because the projects address meaningful issues, are interesting, and relevant to their home country. Students are thankful that they are able to present research results at conferences, that they gained new research skills, and that some of their research can be patented.

- Only one respondent experienced a problem in obtaining a U.S. visa. Most reported no difficulty except that a visit to a consulate their home country was necessary to obtain the visa. One student indicated that the start of their studies was delayed because of problems with TraiNet.

- Only one international student experienced difficulty in communicating in English. This individual knew formal English but had difficulty in understanding "American English". Most of the students responding to the survey had extensive English language courses in primary, secondary and college courses in their home countries.

A simple peanut sheller used by small scale processors.

The Peanut Collaborative Research Support Program

External Evaluation Panel 2005 Report

Annex 6

Peanut CRSP Host Country Benefits and Impacts

The lead author for this section of the Report was Dr. Dely Gapasin (World Bank Consultant for Development and Gender Issues).

The section is based on the observations made by External Evaluation Panel members in their respective projects and clusters of programs.

In 2001-2005, 20 host countries participated in Peanut CRSP implementation. The regional focus for Phase 2 is Africa, with 10 countries implementing 24 research projects (some projects are multi-country). The other host countries are in South/Southeast Asia (4), Latin America/Caribbean (2), and Eastern Europe (2). The shift to an African focus was in response to the recommendation by the 1996 EEP, and is deemed a good decision by this EEP.

1. Human capital development in research.

A very important achievement of the Peanut CRSP in Phase 2, and one with a widespread impact in the host countries, is the development of capacity of research scientists, researchers, and policy makers. Improved human capital is a sustainability factor that would ensure continuity of the key initiatives supported by the Peanut CRSP over the years. Improved research capacity resulted from graduate degree programs, non-degree training (post-doctoral fellowships, internships, etc.), and short-term visits of host country and U.S. scientists and researchers. Thailand has become a center for excellence in training of trainers for the Asian region (UGA37), but also benefiting host county scientists from other regions. UGA40 also provides flexible support for additional degree and short-term training by the Management Entity (ME).

Peanut CRSP scientists interact in Bolivia.

In 2001-2005, 32 scientists and researchers completed M. S. degrees and 13 completed Ph.D. degrees (-38-% male and -62% female overall), Annex Table 9a. Thirty one (69%) of the graduates are from the host countries and 14 (31%) are from the United States (Annex Table 9b). There is high pay-off for educating graduate students and Peanut CRSP should continue the graduate programs in the future. Graduate students are well satisfied with their educational experience, although there have been problems with English language proficiency (TOEFL requirement), and delays in processing visas to the U.S. which could be minimized by better support for the use of USAID's TrainNet system.

Non-degree training, post-doctoral fellowships, study visits to the U.S., and participation in international and regional conferences, provided opportunities for host country scientists and policy makers to learn new research methods and share information. In 2001-2005, about 136 researchers and policy makers (125 from host countries and 11 from the U.S.A.) participated in these events (Annex Table 10a and 10b). These training events allowed the scientists and researchers to acquire skills and apply these techniques and technologies under their own country-specific situations, to carry out good scientific research, and initiate networking.

2. Socio-economic, Gender and Policy Benefits and Impact.

The beneficiaries of Peanut CRSP technologies in the host countries are varied including researchers, policy makers, extension staff, men and women farmers, private sector companies, NGOs, etc. In response to the 2000 EEP recommendation, five socio-economic, and policy studies were implemented (4 continuing and 1 new start) in Phase 2 with significant implications to the host countries. These studies documented impacts of: peanut products in Philippines and variety releases and training in Thailand (NCS07), peanut marketing systems in Senegal (UCN36), production efficiency and market development in Haiti, Dominican Republic, and Jamaica (AUB30), aflatoxin reduction in Ghana and Benin (AUB30), and policy analyses in Malawi, Senegal, and Uganda (VT09). VT54 is tapping into women's associations to create awareness of villagers of the health effects of aflatoxin and how it could be managed. The studies provided data on the impact of Peanut CRSP technologies in the host countries and build socio-economic research capacity that is much needed in the collaborating research institutions. The socio-economic studies should be continued in the future.

3. Technology Benefits and Impact.

One of the strengths of the Peanut CRSP is its support for germplasm exchange between U.S. and the host countries, breeding to produce improved genotypes, and variety testing in the U.S. and host countries for location-specific adaptation. Examples are breeding for tolerances to drought in India and Bangladesh (FAM51), resistance to Tomato spotted wilt virus (TSWV), leaf spot, and *A. flavus* in Bolivia (UFL16), resistance to thrips, potato leafhopper, Southern corn rootworm, and TSWV in Ghana and Benin (NCS19), etc. The current effort on resistance work is commendable, as this activity is a critical concern especially in the host countries.

Peanut farmers in Ghana meet with Peanut CRSP scientists.

U.S. and host countries for location-specific adaptation. Examples are breeding for tolerances to drought in India and Bangladesh (FAM51), resistance to Tomato spotted wilt virus (TSWV), leaf spot, and *A. flavus* in Bolivia (UFL16), resistance to thrips, potato leafhopper, Southern corn rootworm, and TSWV in Ghana and Benin (NCS19), etc. The current effort on resistance work is commendable, as this activity is a critical concern especially in the host countries.

Release and eventual adoption of new peanut varieties developed by Peanut CRSP and host country scientists have high potential impact. Some examples of varieties are: Mairana variety in Bolivia (UFL16), two short-duration, rosette-resistant varieties in Uganda (UGA28), a rosette-resistant variety in Malawi (UGA28), rosette-resistant variety in Ghana (UFL13, NCS19), and leaf spot-resistant varieties in Senegal and Burkina Faso (TAM17). An economic study showed that the adoption of rosette-resistant peanut varieties in Uganda and Malawi are expected to save US$47 million annually.

Multi-disciplinary teams in the U.S. and host country research institutions have developed crop management technologies that would complement resistant varieties that would require low or minimum input use. These

In Uganda and Malawi rosette virus resistant varieties of peanut provide farmers with 2-3 times the yield of traditionally susceptible lines.

technologies would be appropriate for smallholder and resource-poor farmers in developing countries. There have been some successful cases of increased peanut production and productivity using Peanut CRSP developed technologies. Examples are: Crop modeling using PNUTGRO in Ghana and Benin (UFL13), and improvement of CROPGRO and release of a new Windows version (UFL13), with potential application in other countries (i.e., Guyana, Bolivia).

Women in the Sahel winnowing peanuts. In many parts peanuts are the primary source of income for women.

4. Post-harvest and Utilization Research Benefits and Impact.

Another area where Peanut CRSP has significant impact in some host countries is the development and utilization of peanut and peanut-based products in partnership with the private sector and the collaborating research institution. The vertical integration of production to post-harvest and utilization would require strong linkages to food science research institutions (UGA04, UGA11), and the local food industry. A key achievement is the industry incubator model developed in the Philippines with the private food industry (UGA04) that has potential application in other countries (Bolivia, Guyana, Bulagria, Ghana, etc.). Socio-economic impact of adoption of peanut CRSP developed food technologies in the Philippines (NCS07) are: (i) Vitamin A-fortified peanut butter was commercialized with 37% increase in production; (ii) aflatoxin-free, better quality peanut products became available in local stores and supermarkets; and (iii) a company has started to export aflatoxin-free peanut sauces for the first time to the U.S.

Peanut butter on sale in a Philippines kiosk.

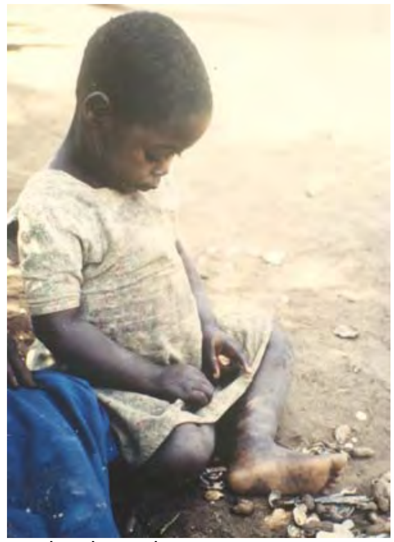
A complementary area is the development of micro- and small-scale, village-level peanut processing enterprises in Thailand (UGA37), the Philippines (UGA04), and in Guyana (UFL52). In Thailand, Kasetsart University trained over 250 villagers (mainly women) on peanut processing and sorting technology. Trained villagers initiated village-level enterprises that are producing aflatoxin-free peanut products with better packaging. These enterprises have provided the main cash income of women in these villages. Similar experience occurred in the Philippines involving women peanut processors with support from Leyte State University scientists (UGA04).

A field day demonstration of the peanut butter manufacturing process for women's groups in Guyana.

5. Health-related Research Benefits and Impact.

The focus on aflatoxin and health-related research was added in the Peanut CRSP agenda in Phase 2. Ten projects focus on aflatoxin-related issues: detection and forecasting (UWI49), preventing contamination (UGA22 and FAM51), decontamination (UGA01, UGA04, NCA32), preventing exposure (TAM50, OKS55), socio-economics (AUB30, VT54), and human consequences (UAB56). Results of Peanut CRSP research would have significant impact in the host countries where the problem is pressing but awareness of the effect of aflatoxin on human health is quite low. Surveys on farming, post-harvest, processing, and marketing practices and aflatoxin levels and awareness in Ghana (AUB30), in Senegal and Uganda (VT54), Bulgaria (UGA11), and the Philippines (UGA04), have been carried out. Data generated by these projects are important in understanding the socio-economic, health, and nutritional effects of aflatoxin in humans, especially for awareness building among policy makers and health workers. Peanut CRSP could continue to play a critical role in bridging agricultural concerns and human health issues, related to peanut, as shown in this program.

A high potential impact area for Peanut CRSP is reducing dietary exposure to aflatoxin with its human health implications. Several projects have demonstrated the effectiveness of using clay in human diet to reduce bioavailability of aflatoxins, done mainly in the U.S. (UAB56 and TAM50).



Aflatoxin has been shown to suppress immunity in people and cause underweight in children..

A study is planned in Ghana to use Novosil clay in human diet in capsule form (TAM50); there was no adverse effect of Novosil clay in rats. Also in Ghana (OKS55), traditional peanut products were reformulated to incorporate Novosil clay (at 0.5-1.0%) without adverse effect on consumer acceptance.

6. Strengthening Linkages to Extension, Farmers, and Entrepreneurs.

To facilitate the adoption of Peanut CRSP developed technologies, many projects have linked with extension institutions and producers/farmers' associations, mainly through host country initiatives. Examples are: (1) the Princess Sirinthorn' development project in poor villages in Thailand with Kasetsart University and extension service providing training and guidance to villagers (mostly women) on using Peanut CRSP technologies (UGA37); and (2) ANAPO, a progressive farmers' association, has developed a Peanut Seed Program in Bolivia, and linked with farmers' associations (UFL16).

A farmers' field-school for IPM technologies in Ghana. Most attendees are women

A significant effort of technology transfer has benefited a large number of men and women farmers and entrepreneurs and other stakeholders. Many projects have supported farmers' field days, workshops, study tours, and other extension activities. Farmers' training received emphasis in several host countries using farmers as trainers (i.e., farmers' field schools) such as in Ghana and Benin (UFL13 and NCS19), in Bolivia (UFL16), and in Guyana (UFL52). A summary of field days, workshops, and farmers' training is shown in Annex Table 11 and 11b.

Participants at a field day in Guyana

The Peanut Industry Incubator in the Philippines has established a mechanism for researchers to interact with entrepreneurs to solve market or product related problems through research.

7. Institutional Development and Sustainability.

Some host countries benefited from funding assistance to develop/improve research facilities and provision of critical research equipment. Examples are: four research and sensory testing laboratories in Bulgaria (UGA01), greenhouse facilities and equipment in Bolivia (UFL16), pilot food laboratory and facilities in the Philippines (UGA04), equipment such as digital camera, GPS, and others in Ghana and Benin (UFL13 and NCS19), and training equipment in Thailand (UGA37). Improvement of research facilities and human capital development would ensure sustainability of the research initiatives supported by Peanut CRSP in the host countries.

There has been leveraging of funding from host country governments and others resulting from Peanut CRSP commitment, another sustainability factor. Examples are: the Thai Government has provided cash equivalent of US$27,500 in 2003-2004 to train Thai nationals, farmers, and villagers (UGA37); USAID GEM project supports farmers' associations in developing Peanut Collection Stations in the Philippines (UGA04); and a technology transfer project of IADB has contracted ANAPO in Bolivia to provide extension services to farmers (UFL16). Documentation of fund leveraging by national research institutions from the government, private sector partners, and donors needs improvement in the future.

The Peanut Collaborative Research Support Program

External Evaluation Panel

2005 Report
Annex 7

U.S. Benefits and Impacts

This section of the report was prepared by Mr. Howard Valentine, Executive Director of the Peanut Foundation the research wing of the American Peanut Council, using contributions from all the other panelists.

Title XII of the Freedom From Hunger Act which authorizes the CRSP programs requires that there are benefits to US farmers and industry from the program. This section of the report examines the performance of the Peanut CRSP in regards to the benefits accrued to the USA from this international cooperation.

The impact of the Peanut CRSP on the USA has been significant. Much of the early investment initiated projects in areas that have led the peanut industry into expanded research to improved consumption. Secondly the funds have stimulated development of new and innovative varieties with disease resistance. Thirdly the Peanut CRSP has fostered the development of a product that will render aflatoxin less of a health hazard. Finally the program has encouraged collaboration among scientist from many disciplines around the world to work together in partnerships that would be unthinkable without encouragement from the Peanut CRSP. The overall impact has been positive and has acted as a catalyst for expanding peanut research into new areas years before other funding entities have committed funds. Much of this technology is available in the 'World Geography of Peanut' web site supported by the Peanut CRSP http://lanra.anthro.uga.edu/peanut/knowledgebase/

Overview of Areas of Impacts

Food Safety

Aspergillus infected peanuts.

This is an area that the Peanut CRSP has made one of its long-term impacts. The development of an aflatoxin absorbing food additive that can be ingested with or prior to eating peanuts or peanut butter and thus render the toxin unavailable will improve the safety of peanut products worldwide. It is estimated that the USA peanut industry spends in excess of $25 million a year in attempting to manage (reduce to safe levels) this toxin in the diet of peanut consumers. The ability to incorporate the consumer into this process will significantly reduce the cost now incurred by the industry. It is hoped that eventually the clay can be incorporated into peanut products so that the clay won't have to be ingested separately.

Similar products are already being used on many animal feeds in the USA, providing livestock producers with greater profits. This product will allow an increased value for peanut meal also once it passes regulatory approval. Much of the meal is currently sold at a significant discount and has to be blended with other lower aflatoxin containing meals.

Dr. Tim Phillips being awarded the BIFAD Award for his discovery of safe aflatoxin neutralizing food additives.

The CRSP is leading the Center for Disease Control and the World Health Organization into the realization that aflatoxin is a solvable issue critical to USA and world infectious diseases. This effort ultimately could save millions of lives and provide important security and diplomatic benefits to the USA through increased good will.

Nutrition Benefits

Peanut CRSP lead the industry to study health benefits associated with peanut allowing a FDA health claim that has increased sales 10% a year.

This is an area of early inventiveness by the Peanut CRSP. The Peanut CRSP was funding peanut nutrition research long before many in the peanut industry thought about heralding the nutrition benefits of peanuts. The peanut consumption suffered double digit decline in the late Eighties and early Nineties due to the perception that peanuts were not healthy on account of their high content of oil. Early studies funded by the Peanut CRSP developed new information on the vitamin, mineral, and trace element content of peanuts. Much of the existing information was over 40 years old and outdated. This new data coupled with studies that showed that peanut did not contribute to people getting fatter when peanut was added to the diet has catapulted the consumption of peanuts in the last 8 years.

Now according to AARP peanuts are considered one of the healthiest foods we consume. Advertising by many of the major food manufacturers in the USA tout the many health benefits of eating peanuts. Now seen as healthy and part of a low carbohydrate diet peanuts have seen double digit increases in each of the last 5 years. Additionally with advertising from the National Peanut Board and the State grower organizations, using much of the research data funded by the Peanut CRSP, we are now seeing generic programs adding other dimensions to the health message. One of the peanut economists showed that the largest portion of the consumption increase came from this healthy food message. Another industry leader said, "This Peanut CRSP data was the key element to the overall health and nutrition perception. That's what turned around the consumption of peanuts in the last 5 years".

Many major manufacturers of peanut products report record sales for the last 5 years. It has been estimated that the impact of this increased consumption has been as much as $500 million annually. Peanut consumption in all products has increased on average over 10 percent in the last 5 years. Consumption in the current partial year already shows an increase of 9 percent.

Production Efficiency Benefits

The single largest expenditure for a USA peanut grower is fungicides. The estimated cost per acre is from $15-$30 per acre or over $50 million dollars a year. The Peanut CRSP has been a leader in funding peanut seed breeders to develop varieties that are resistant to many fungal diseases.

The CRSP funded research that has developed a released runner variety that is resistant to nematodes. This variety was developed with the use of molecular markers a developing breeding tool for peanuts. The variety has been planted commercially in Texas and Oklahoma in the last several years and is expected to see a significant increase with the 2005 plantings. This variety is particularly helpful where no alternate nitrogen-using crops are available. Additionally the breeders in Texas released a Spanish variety developed with the help of the Peanut CRSP that now represents over 60 percent of that market. It has multiple disease resistance and increased yield. Work also continues in New Mexico on new varieties with increased yields using a Bulgarian Valencia introduction.


High yielding Valencia varieties in New Mexico

The same effort with CRSP funding has produced seed varieties in the North Carolina-Virginia area that represent almost 70 percent of the varieties planted. Many of these new cultivars have resistance to cyclindrocladium black rot (CBR) a disease that the growers of this area have no other tool to manage economically.

The Southeastern production area will soon benefit from this CRSP effort as well. Two varieties developed using Bolivian germplasm will soon be released. These new varieties have resistance to leafspot, blight, and rust. This rust resistance could be effective in soybean breeding as well. All these diseases have a significant economic impact on the growing of peanuts in the area.

Additional CRSP funded research in disease and insect forecasting in North Carolina will have tremendous impact on farm cost. The forecasting systems will also allow for the reduction of pesticides by early intervention in fields. Both weather advisors and key disease advisory indexes are already in place and adding profitability to peanut farming through the management of tomato spotted wilt disease.

Value-adding Benefits

Peanuts were always seen by the industry as a commodity. The development of a peanut with improved oil chemistry is changing all that in one area. Almost all the runner peanuts planted in Texas will have this new oil chemistry. The CRSP program has been funding research with Texas breeders for many years helping to develop this high Oleic/low Linoleic peanut. This trait will find itself into the other two areas of peanut production shortly.

This trait creates a healthier peanut with higher levels of monounsaturated oil. The oil profile of this new peanut has oil almost identical with olive oil, considered the "Gold Standard" in plant oils. There are many published research studies (including those supported by the CRSP) showing the heart-healthiness of high monounsaturated oils.

Shelf life of peanuts after shelling can be genetically improved.

Additionally this trait increases the shelf life of the peanut products produced from high oleic peanuts. Several studies have indicated a ten-fold increase in shelf life. This will reduce packaging cost, reduce the volume of product destroyed due to expired user dates, and prevents the early occurrence of off flavors due to oil oxidation. The R&D director for a major peanut brand says, "This is the greatest development in peanut consumer traits in my career."

Another value-added product developed with funding from the Peanut CRSP is a peanut butter high in resveratrol. Resveratrol is component of foods shown to assist in the reduction of heart disease. This product is under development by researchers in the USA for distribution in the next couple of years, and can help increase peanut consumption world-wide.

Training and Capacity Building

Many university deans have commented that the Peanut CRSP funds have enabled them to expand the amount of research facilities they have for peanut research. The seed money from the CRSP combined with other university resources has enabled these deans to expand facilities in times of shrinking state funding. The ability to hire superior students from around the globe has added to the technical expertise of their research labs. Additionally the experience gained by research leaders in traveling to other peanut producing countries has added to the abilities of their staffs. Dean Gale Buchanan of the University of Georgia comments, "The CRSP adds approximately $2 million to the peanut research fund pool. This helps maintain interest by researchers in peanut research."

A US student discussing her research with a Bolivian at a field day.

Future Directions and Improvements

Nutrition information will continue to drive peanut consumption and improve the health of the USA population. New information being developed on peanut consumption lowering the risk of cardiac disease, improving the blood sugar control for diabetics, and lowering the risk of several forms of cancer will drive increased consumption.

CRSP funding has been ahead of the curve in food safety, cost reduction for producers, value-added traits, and nutrition. The tools needed to keep this advancement moving may be different in the future. Peanut genomics will be the driver in the future according to Dr Joe Jen of the USDA-ARS. The Peanut CRSP should take a leadership position in this area by helping to sequence gene rich regions in the peanut genome and funding development of molecular markers for natural disease resistance in the wild species as well as improved nutritional attributes.

Additional development of non-destructive screening devices for aflatoxin will improve health and reduce cost for the USA industry. Technology is the only tool to help the USA industry to stay competitive in the US and world markets. The CRSP must continue its leadership position in driving peanut research.

Drying Peanuts in the USA