Peanut CRSP 2012 Final Report for Project 127, 165 and 166

1. Final Summary

a. Brief statement of overall goal

The overall goal was to enhance incomes and employment opportunities of people through a strategy of improving agricultural producers' and processors' access to markets and stimulating new market demand, through activities that focus on improving post-harvest techniques, quality, peanut processing, peanut product development and access to market information and linkages. We proposed to address the global constraints with the developing/implementation of a model in peanut processing, marketing and utilization. Some peanut farmers are involved in post-harvest and processing activities, while others are successful entrepreneurs marketing peanut products. The approach was based on the existing Peanut Innovation Incubator Model (PIIM) conceptualized, developed and successfully implemented by the investigators while working in the Philippines, Thailand and Bulgaria. Using the PIIM, the investigators demonstrated commercialization or increased market-share of peanut products to a position of dominance. The model is appropriate for peanut processing activities by a village-based business or a larger business enterprise with nationwide distribution and exports. This project focused on processing aspect of peanut based products with emphasis on product development, consumer preferences and marketing. The proposed research was in line with the mission of USAID and the UN Millennium Development Goals (MDG) of poverty reduction, greater value of peanuts, improved public health and food security, gender equity, and development of partnerships.

b. Significant Technical Achievements-Host Country, US

The UGA GP3M team consisting of Drs. Manjeet Chinnan, Anna Resurreccion and Wojciech Florkowski identified opportunities for enhancing the peanut value chain, specifically development, processing and market development of peanuts and peanut products. The team worked with eight industrial partners in six project thrusts in Uganda and Ghana. There was cross-linking of project activities across host countries. A scientist from Uganda led an activity in a workshop in Ghana and similarly a scientist from FRI, Ghana led an activity in Uganda.

The following issues were identified and provided the basis of projects in Uganda and Ghana. 1) Aflatoxin in peanuts is a major issue that impacts a) producing high quality peanut products and b) public health. 2) Lack of stability of peanut pastes and butters leads to short-shelf life, reduced quality and negative consumer appeal (appearance and onset of rancidity resulting in off flavors). 3) Absence of diversity in peanut products in the market place despite consumer liking for peanut products. 4) Vitamin A deficiency that affects 40% of children in the Sub-Saharan regions of Africa and other countries; peanut butter has been demonstrated to be an excellent

delivery system for the nutrients. A total of six projects have been implemented (3 in Uganda, 2 in Ghana, and 1 in both countries), all processing and product development projects involved one or more industrial partner.

Seven products/processing technologies were developed by UGA.GP3M Team in collaboration with host country researchers and industry partners. One of these technologies, not in the list below, was the processing technology for producing aflatoxin free peanut products which was transferred to all existing and prospective industrial partners. This technology is an integral part in the development and commercialization of all peanut products as listed below:

a) Stabilized peanut butter (Makerere University; Food Engravers and SESACO);
b) Peanut-soy beverage (Makerere University; SESACO);
c) Peanut soup base (University of Ghana-Legon; Nkulenu Foods);
d) Natural chocolate peanut spread (FRI; CBA Foods);
e) Natural Vit-A fortified peanut butter (Makerere University; Food Engravers);
f) Nutritious peanut cookie (NARO; Hometech Foods).

Among the above product technologies three were commercialized. 1) Chocolate peanut spread was developed, optimized and commercialized by CBA Foods through collaboration with UGA.GP3M Team and FRI-Ghana. Product was launched at the 2012 Ghana International Fair. 2) Development and commercialization of a new natural Vit-A fortified peanut butter was completed. This work was done at Makerere University, Uganda in collaboration with UGA.GPM Team and the industry partner (Food Engravers). 3) Development and commercialization of nutritious peanut cookies was completed. This work was done at NARO, Uganda in collaboration with UGA.GPM Team and the industry partner (Hometech Foods). The remaining three technologies (a to c) are in the final stages of technology transfer prior to commercialization.

Two separate conference/workshops were held in Ghana and Uganda where our host country researchers gained valuable experience of organizing conference/workshop for regional and international attendees. Seventy eight (43 males and 35 females) individuals (32 from government; 30 from private sector; 16 from academic institutions) participated in hands-on training workshops and associated lectures.

Host Country Investigators prepared eight documents of their research findings in the area of process and product development and presented papers at national and international meetings. In addition, the host country PI gained experience in the application of appropriate statistical techniques to analyze household survey data and develop practical information for the use of public and private sector decision makers; the findings were presented in form of 8 papers at international meetings and one refereed journal article.

CBA Foods launched chocolate peanut spread at the Ghana International Fair leading to sales of all inventory manufactured for display. The strong demand led to the

decision by CBA Foods to invest in the large capacity grinding mill to expand production, likely leading to new job creation in the company. The nutritious peanut cookie technology by Hometech Foods generated one million Ugandan shillings of weekly sales by selling 1,000 packages of cookies produced by three employees. Given the currently limited distribution, there is a great potential for expansion of production, sales and employment. The vit-A fortified peanut spread manufactured by Food Engravers sold out all available inventory during the Uganda Manufacturers Association International Fair. The daily revenues of the company exceeded 150,000 Ugandan shillings and the company decided that a purchase of additional equipment to meet the strong demand was necessary.

Two innovations central to these projects contribute to their sustainability: 1) The technology for processing of aflatoxin free peanut products is the one and only effective technology, considering the limited resources of small and medium enterprises and the economies of scale at which they operate. The application of this technology to the manufacture of widely accepted peanut products delivers safety to local markets and breaks the barrier that, in the past, prevented viable exports for peanut products. 2) The partnership between the UGA GP3M Team and Host Country researchers with industry partners made possible the successful scale-up and commercialization of the developed food product/process technologies. These two factors increased the demand for domestic peanuts, created jobs in the food processing industry and enhanced revenues spurring economic development and growth.

c. Significant Issues/Challenges

The following issues have been identified and provides a basis of projects in Uganda and Ghana. 1) Aflatoxin in peanuts is a major issue that impacts a) producing high quality peanut products and b) public health. 2) Lack of stability of peanut pastes and butters lead to short-shelf life, reduced quality and negative consumer appeal (appearance and onset of rancidity resulting in off flavors). 3) Consumers like peanut products; however, there is a lack of diversity in peanut products in the market place. 4) Vitamin A deficiency affects 40% of children in the Sub-Saharan regions of Africa and other countries. Peanut butter has been demonstrated to be an excellent delivery system for the nutrients. 5) Diversity of foods varies by location and is considerably larger in Kampala than other surveyed cities to the north or north-east. 6) Frequency and the type of dishes that use peanut products as an ingredient vary across locations. 7) Little attention is being paid to maintain consistent quality of raw peanuts traded at the markets. 8) Budget constraint limits the purchase of processed peanut products for some households leading to the risk of aflatoxin-contaminated consumption of peanut products.

d. Capacity development, i.e. laboratory, field, equipment-Host Country, US

A commercial oven and infra-red temperature gauge were purchased with project funds for the cookie study in Uganda. Two temperature data loggers were purchased for peanut soup base research at Univ. of Ghana. Particle size distribution measuring devices were purchased both for Uganda and Ghana researchers. A pilot scale peanut mill was purchased for Ghana researchers; it is housed in the pilot plant of FRI (Food research Institute). The US PIs purchased three laptops (one for each PI) for research purposes; in addition, two Ipads were also acquired for field research.

e. Human Capacity/training – see attached Table 1

f. Key workshops/short-term trainings – see attached Table 2

g. Publications

Abstracts, Posters, Invited Presentations and Proceedings

16th World Congress of Food Science and Technology. International Union of Food Science and Technology (IUFoST), Foz do Iguaçu, Brazil. Pre-Congress Meeting. Aflatoxin Elimination in Peanut Products, for Food Security in Africa. Chinnan, Manjeet S., Anyebuno, George, Florkowski, Wojciech J., Resurreccion, Anna V. A.. August 4, 2012.

16th World Congress of Food Science and Technology. International Union of Food Science and Technology (IUFoST), Foz do Iguaçu, Brazil. Pre-Congress Meeting. Aflatoxin Elimination in Peanut Products, for Food Security in Africa. ***Processing for Elimination of Aflatoxin in Peanut Products*** Chinnan, Manjeet S. August 4, 2012.

16th World Congress of Food Science and Technology. International Union of Food Science and Technology (IUFoST), Foz do Iguaçu, Brazil. Pre-Congress Meeting. Aflatoxin Elimination in Peanut Products, for Food Security in Africa. ***Processing for Aflatoxin Reduction –a Philippine Case Study.*** Resurreccion, Anna V. A.. August 4, 2012.

16th World Congress of Food Science and Technology. International Union of Food Science and Technology (IUFoST), Foz do Iguaçu, Brazil. Pre-Congress Meeting. Aflatoxin Elimination in Peanut Products, for Food Security in Africa. ***Survey of Market Samples for Incidence of Aflatoxin in West Africa.*** Florkowski, Wojciech J. August 4, 2012.

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Processing for Aflatoxin Elimination in Peanut Products HACCP for the Peanut Processing Industry. SPONSORED BY USAID PEANUT CRSP (Collaborative Research Support Program)CO-SPONSORS; IUFOST (International Union of Food Science & Technology) UIRI (Uganda Industrial Research Institute), Kampala, Uganda "Collaborative Research, Transfer and Commercialization of a Processing Technology for Aflatoxin Elimination in Peanut Products in Southeast Asia – A Case Study ". Resurreccion, Anna V. A.. February 23, 2012.

Processing for Aflatoxin Elimination in Peanut Products. University of Georgia Peanut Product, Processing and Marketing Team, Accra, Ghana "Collaborative Research, Transfer and Commercialization of a Processing Technology for Aflatoxin Elimination in Peanut Products in Southeast Asia – A Case Study ". Resurreccion, Anna V. A.. January 23, 2012.

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Processing for Aflatoxin Elimination in Peanut Products. University of Georgia Peanut Product, Processing and Marketing Team, Accra, Ghana "PRODUCT DEVELOPMENT, PROCESSING AND MARKETING". Resurreccion, Anna V. A.. January 22, 2012.

IFT Annual Meeting. IFT - Institute of Food Technologists, Vegas, Nv. Development and Optimization of Peanut-Chocolate Spread for Ghanaian Consumers. (Poster & Abstract # 144-10). Diako, C., Buckman, S. E., Plahar, W. A., Saka, E., Florkowski, Wojciech J., Chinnan, Manjeet S., Resurreccion, Anna V. A.. June 27, 2012.

IFT Annual Meeting. IFT - Institute of Food Technologists, Vegas, Nv. Process Development and Product Quality Optimization of Precooked Peanut Soup Base. (Poster & Abstract # 231-02). Budu, A. S., Sakyi-Dawson, E., Afoakwa, E., Annor, G., Achilles, D. M., Florkowski, Wojciech J., Chinnan, Manjeet S., Resurreccion, Anna V. A.. June 27, 2012.

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2. Final Interpretation

a. Importance of Technical Achievements

i. Host Country

CBA Foods launched chocolate peanut spread at the Ghana International Fair leading to sales of all inventory manufactured for display. The strong demand led to the decision by CBA Foods to invest in the large capacity grinding mill to expand production, likely leading to new job creation in the company. The nutritious peanut cookie technology by Hometech Foods generated one million Ugandan shillings of weekly sales by selling 1,000 packages of cookies produced by three employees. Given the currently limited distribution, there is a great potential for expansion of production, sales and employment. The vit-A fortified peanut spread manufactured by Food Engravers sold out all available inventory during the Uganda Manufacturers Association International Fair. The daily revenues of the company exceeded 150,000 Ugandan shillings and the company decided that a purchase of additional equipment to meet the strong demand was necessary.

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enterprises and the economies of scale at which they operate. The application of this technology to the manufacture of widely accepted peanut products delivers safe products to local markets and breaks the barrier that, in the past, prevented viable exports for peanut products.

The partnership between the UGA GP3M Team and Host Country researchers with industry partners made possible the successful scale-up and commercialization of the developed food product/process technologies. These two factors increased the demand for domestic peanuts, created jobs in the food processing industry and enhanced revenues spurring economic development and growth.

b. Importance of physical and human capacity development-

i. Host Country

The UGA.GP3M Team brought global expertise to the researchers and industrial partners in the host countries. The approach used allowed small processors to access expertise of scientists in academic and government research institutions. The physical capacity has been notably enhanced by the purchase of certain instruments and equipment with projects' funds. Two particle size analyzers that were donated to the FRI-CSRI in Accra, Ghana and Makarere University in Kampala, Uganda. In the former institution, access to the analyzer was also assured to PIs from outside the FRI, primarily the Food Science Department of the University of Ghana-Legon. The UGA.GP3M team demonstrated the use of the analyzer using the locally produced and available on the market peanut paste and compared the results with the American-made peanut butter illustrating the desired level of particle size in peanut products. The demonstrations were followed by training HC PIs, students, where appropriate, and IPs in using the analyzer.

The largest piece of equipment purchased under the project was the mill for grinding peanuts into paste that was donated to the FRI-CSRI in Accra, Ghana. The mill now allows to achieve the particle size comparable to that in American-made peanut butter removing the grittiness and assuring better solubility of paste in such dishes as the very popular peanut soup. The mill is accessible to IPs on the FRI premises and can be used to show the desired equipment for large processors, while small and micro enterprises can use the mill on the premises under the FRI policies. Capacity building through purchase of equipment allowed investigators to conduct investigations on problems important in peanut processing in Uganda and Ghana and the enhanced institutional capability will provide sustainability to future peanut and food research after the grant's termination.

A commercial oven and infra-red temperature gauge were purchased with project funds for the peanut cookie study led by NARO and HomeTech Foods in Uganda. The commercial oven was a key piece of equipment and allowed for the temperature control, which was necessary when testing various dough formulations. It replaced a charcoal heated oven, which caused uneven baking leading to high visual variability and inconsistent texture.

Two temperature data loggers were purchased for peanut soup base research led by the Food Science Department of the University of Ghana-Legon. The data-loggers allowed the monitoring of internal temperature in canned soup base assuring the product meets the standard international safety levels, while assuring the product eating quality.

Human capacity development included both academic PIs and industrial partners in Ghana and Uganda. Early engagement of industry partners facilitated developing technologies and fast tracking commercialization. The process/product technologies developed for markets were: 1) aflatoxin free quality peanut products, 2) shelf-stable high quality peanut paste and butter with high consumer appeal, 3) greater choices of peanut products (such as chocolate peanut spread by CBA Foods; peanut-soy beverage by SESACO; canned condensed peanut soup base by Nkulenu), 4) nutritious products delivering Vitamin-A (such as in Nutri-nut) and other nutrients (such as in Hometech's nutritious peanut cookie) to "at risk" population groups.

Host country researchers gained knowledge and experience in research methodologies on product development, quality measurement and processing of peanuts specifically and applicable to other foods. A wide variety of peanut products developed through new knowledge will be safer, nutritious and of higher quality. Host country collaborators also gained experience in preparing and presenting documents for disseminating knowledge to stake holders and the scientific community.

Host country personnel gained knowledge and experience in the preparation, verification and implementation of household surveys for the purpose of primary data collection when publicly available data sources lack project-relevant information as is typically the case with peanuts and peanut product consumption. The HC PIs were demonstrated the importance of debriefing after the pilot study implementation and the daily feedback to enumerators after the review of completed questionnaires in order to assure the high quality of collected data from face-to-face interviews. IPs also improved their experience in preparation of the descriptive statistical analysis of survey data and the quantitative analysis leading to the development of practical implications for the decision makers in private and public sectors. The analysis results showed, among others, the regional differences in consumer choices and purchase and consumption behavior that is indiscernible in the aggregate analyses.

The data collected from 500 consumers at the Ghana International Fair provided relevant market information about prices consumers paid for similar products prior to visiting the Fair and the willingness-to-pay for the displayed product and quality certification. The collection of consumer data at the Uganda Manufacturers Association Fair in Kampala proved to Hometech Foods that such events are a market information source and provide insights for the future decision making about the distribution, pricing and merchandizing the nutritious peanut cookies. Food Engravers obtained market and consumer insights from the summary of responses from 192 questionnaires about the Vit-A fortified chocolate peanut spread. The

summary of responses offers insights to company about consumers needed to make decisions about production expansion leading to an increase in the number of employees and investment in processing equipment. The peanut-soy beverage manufactured by SESACO was tested at the Uganda Manufacturers Association Fair in Kampala, providing feedback for making decisions about refining the attributes of the product and managing manufacturing costs and price.

A graduate student from the Department of Agribusiness Management was trained and involved in consumer information collection at the Ghana International Fair (short-term training).

Two staffers from Food Engravers, two from Hometech Foods, and one from Sesaco were trained in the collection of data through implementation of a consumer survey using the convenience sample.

ii. US

Graduate students in the Department of Agricultural and Applied economics, University of Georgia, participated in the analysis of data from the household surveys in Ghana and Uganda. While performing the analysis, the students learned about household behavior in Sub-Saharan African countries with regard to the preference and choice of peanut products and how to model various aspects of consumer behavior in food consumption and peanut product consumption in particular. Several selected papers and posters were prepared and presented at various national and international meetings. The analysis, manuscript preparation and presentations made a major contribution to the professional development of graduate students. In addition, one undergraduate student was also involved in assisting in paper preparation and has become acquainted with the specifics of household behavior and the functioning of the Ghanaian economy.

c. Heritage left from workshops and short-term training-

i. Host Country

Issues related to expanding markets for peanuts were identified and research strategies for intervention were developed. Aflatoxin content of peanut products is a major constraint to exports and a threat to public health. An appropriate intervention processing step was implemented. The problem of stability of peanut pastes and its resulting negative effect on product quality, shelf-stability and consumer acceptability was researched by Host Country investigators in Uganda. Using peanut product technologies developed by US Investigators in Asia and Eastern Europe, considerable effort by researchers in Uganda and Ghana was devoted to development of various value-added peanut products that not only delight consumers, but also address the nutritional needs of children in Africa.

ii. US

Written materials have been developed for the presentation at workshops and collected into a publication by IUoFST (International Union of Fodd Science and Technology) expanding the focus on the issue of aflatoxin and other mycotoxins in food. The data sets obtained from household surveys in Ghana and Uganda created a base of information that continues to be utilized in applied economic studies past the project duration. Since the project completion several more papers have already been presented or are scheduled to be presented at five international, national and regional meetings and two Ph.D. dissertations are being prepared using the survey data. Moreover, three data sets from surveying consumers during the tasting of commercial products in Ghana (July-August 2012) and Uganda (October 2012) await advanced analysis after the summary of responses was already evaluated.

d. Heritage left in publications

Host Country Investigators prepared eight documents of their research findings in the area of process and product development and presented papers at national and international meetings. In addition, the host country PI gained experience in the application of appropriate statistical techniques to analyze house hold survey data and develop practical information for the use of public and private sector decision makers; the findings were presented in form of 8 papers at international meetings and one refereed journal article.

In addition, despite the termination of the project, the HC PIs continue to work on manuscripts using the data generated during the project. Several such manuscripts led to the submission of papers for review and presentation at international professional meetings and for submission to peer-refereed journals.

The presentations and meetings, published abstracts and journal articles enhance the visibility of the PIs at home and abroad. They also are essential in the promotion system at PIs academic or research institutions.

3. Final Summary of Accomplishments by Objective

Objective 1:
We developed excellent working relationships with research institutions having capable staff and facilities, research collaborators and industry partners on industry constraints for improved peanut products and processes.

Institutions in Uganda - Makerere University and NARO (National Agricultural Research Organization).
IPs in Uganda – Food Engravers, SESACO Foods, and Hometech Foods

Institutions in Ghana – Food Research Institute of CSIR (Council for Scientific and Industrial Research); and University of Ghana-Legon
IP’s in Ghana – Nkulenu Foods, CBA Foods, and Selasie Foods

Objective 2:
Market and consumer surveys were implemented in Uganda and Ghana providing baseline information on consumer food purchase and consumption for strategic product development effort. The Ghana household survey data summary and analysis strongly support the development of the peanut soup base in collaboration with the University of Ghana and Nkulenu, the Industrial Partner. Peanut soup is the common dish using paste as an ingredient and the results support the training of paste producers (including Nkulenu manufacturing peanut soup base) in sorting and removal of potentially aflatoxin-contaminated peanuts. The manufacturing of the peanut soup base from safe peanuts meets the domestic and international regulatory safety regulations and offers opportunities for exporting the product.

In Uganda, the household survey results confirm wide preference for cookies making the nutritious peanut cookies a balanced, nutritious food product that is convenient, shelf-stable and portable, while allowing production by small entrepreneurs. The nutritious peanut cookie has become available to consumers in various size packages allowing consumers to choose the amount. Given that the primary buyers are parents the intended consumers are school-age children, the product fills the needs for liked, nutritious, safe and portable product.

The consumption of bread at breakfast and lunch in combination of using peanut spread on bread opens market opportunities for the stabilized chocolate peanut spread. The chocolate peanut spread fits the market niche and meets expectations of the urban consumer in Uganda. The product is nutritious and of high value and fills the need for the product that is potentially fits the urban lifestyle.

The consumption frequency, eating occasions and form of eating peanuts in Uganda stresses the relevance and importance of the availability of safe peanuts supply through the training in sorting peanuts removing the potentially aflatoxin-contaminated kernels. The analysis of the Uganda household survey shopping outlet information provides the Industrial Partners with information about the type and visits by shopping outlet assisting in the decision about the distribution of their peanut products developed and commercialized as the result of the project.

Objective 3:
The following issues were identified and provided a basis of projects in Uganda and Ghana. 1) Aflatoxin in peanuts is a major issue that impacts a) producing high quality peanut products and b) public health. 2) Lack of stability of peanut pastes and butters lead to short-shelf life, reduced quality and negative consumer appeal (appearance and onset of rancidity resulting in off flavors). 3) Consumers like peanut products; however, there is a lack of diversity in peanut products in the market place. 4) Vitamin A deficiency affects 40% of children in the Sub-Saharan regions of Africa

and other countries. Peanut butter has been demonstrated to be an excellent delivery system for the nutrients.

Projects carried out in Uganda and Ghana that addressed the above mentioned issues/constraints are:

UGANDA- Funded -Proposals – Title	**HC-Institution***	**PI**	**Industry Partners**
a) Development of a stable peanut butter (Study 1and 2)	MU	Kaaya	5
b) Technology transfer and training of individuals/company representatives in the processing technology for reduction of aflatoxin in peanut products to below regulatory limits	MU	Kaaya	5
c) Formulation, development and processing of a new Natural Vitamin A fortified Peanut butter (Initially handled by UIRI investigator who was unable to identify and engage an industry Partner)	MU	Kaaya	1 - Food Engravers
d) Formulation, process development, scale-up, and commercialization of Flavored Peanut Soy Beverage for Ugandan Markets (New activity – initiated in this fiscal year).	MU	Kaaya	1 - SESACO
a) Optimization, evaluation and commercialization of nutritious peanut cookies.	NARO	Masette	1
a) Formulation, development and processing of high quality peanut butter (Terminated upon request of Host Country PI due to inability to identify and engage an Industrial partner during the initial stages.)	UIRI	Rubalema	
b) Formulation, development and processing of Vitamin A fortified	UIRI	Rubalema	

Peanut butter (Terminated upon request of Host Country PI due to inability to identify and engage an Industrial partner during the initial stages. This project was subsequently conducted by Makerere University Investigators)			

GHANA- Funded -Proposals – Title	**HC-Institution***	**PI**	**Industry Partners**
Natural Chocolate peanut spread Stabilized peanut butter (Terminated due to Industry Partner's lack of agreement on IP's contribution to collaborative research project)	FRI FRI	Diako Diako	1- CBA Foods 1- Marilyn and Victor Nwusu
Completed formulation development of a canned, condensed peanut soup base, Process development, Consumer sensory testing. Continuing research on shelf-life determination. Technology transfer and commercialization.	UGL	Budu	1-Nkulenu Food
Processing technology for producing peanut products that meet regulatory limits for Aflatoxin. Technology transfer of processing technology to host country investigators (2) and industry/government and academic representatives.	FRI	Anyebuno	2- CBA Foods and Nkulenu Foods

* MU – Makerere University
NARO – National Agricultural Research Organization
FRI – Food Research Institute
UGL – University of Ghana-Legon
UIRI – Uganda Industrial Research Institute

Issues related to expanding markets for peanuts were identified. Research strategies for intervention were developed. To reduce aflatoxin content of peanut products, a major constraint to exports and a threat to public health, Host country investigators from Ghana verified Peanut CRSP technologies previously developed by the US PIs and worked on transferring the technology to peanut processing industries in Ghana, Uganda and neighboring countries. The problem of stability of peanut pastes and its resulting negative effect on product quality, shelf-stability and consumer acceptability was researched by Host country investigators in Uganda. Using peanut product technologies developed by US Investigators in Asia and Eastern Europe, considerable effort by researchers in Uganda and Ghana was devoted to development of value-added peanut products that not only delight consumers, but also address the nutritional needs of children in Africa.

The intervention strategies that address the major issues and constraints identified in utilization of peanuts in East (Uganda) and West Africa (Ghana) are developed through public-private partnerships involving US Investigators, Host country investigators from academic and Government research institutes; together with Industry Partners. These partnerships provide a mechanism for Industry to access research and development expertise in public research institutions that opens avenues for successful technology transfer and adoption, with a high probability for commercialization of new and/or improved products and processes for local and export markets. The market pull creates opportunities for the smallholder farmers, who supply the raw materials.

Objective 4:

Working sessions between US and Host Country investigators built on the knowledge-base on peanut product and processing technologies brought to the table by the research teams. These maximized the efficiency of the research plans by minimizing time and expense of the research and development phases of product commercialization. The UGA.GP3M Team brought global expertise to the researchers and industrial partners in the host countries. The approach used allowed small processors to access expertise of scientists in academic and government research institutions. The strategy of identifying and planning for early engagement, frequent interaction and requests for input from collaborating industries increased the probability of early adoption and commercialization.

The technologies developed should lead to: 1) aflatoxin free quality peanut products, 2) shelf-stable high quality peanut paste and butter with high consumer appeal, 3) availability of greater choices of peanut products (such as chocolate peanut spread by CBA Foods; peanut-soy beverage by SESACO; canned condensed peanut soup base by Nkulenu) in the market place, 4) delivery of Vitamin-A (such as in Nutri-nut) and other nutrients (such as in Hometech Foods' nutritious peanut cookie) to “at risk” population groups through peanut products.

Objective 5:
All industry partners were engaged to collaborate on new technologies for manufacturing aflatoxin free high quality new or improved peanut products. The partnerships between the researchers and industry significantly increased the success of technology transfer. The employed approach facilitated fast tracking product commercialization.

Objective 6:
Two separate conference/workshops were held in Ghana and Uganda where host country researchers gained valuable experience of organizing conference/workshop for regional and international attendees. Seventy eight (43 males and 35 females) individuals (32 from government; 30 from the private sector; 16 from academic institutions) participated in hands-on training workshops and associated lectures.

Host Country Investigators prepared eight documents on their research findings and presented papers at national and international meetings such as IFT – Institute of Food Technologists in Las Vegas, NV, IUFoST – International Union of Food Science and Technology in Iguassu Falls, Brazil and USAID Peanut CRSP Planning Conference in Malta.

Host country researchers gained knowledge and experience in research methodologies on product development, quality measurement and processing of peanuts, specifically, and applicable to other foods. A wide variety of peanut products developed through new knowledge will be safer, nutritious and of higher quality. Host country collaborators also gained experience in preparing and presenting documents for disseminating knowledge to stake holders and the scientific community.

Host country personnel gained knowledge and experience in the preparation of the descriptive statistical analysis of survey data and the quantitative analysis leading to the development of practical implications for the decision makers in private and public sectors. The analysis results showed, among others, the regional differences in consumer choices and purchase and consumption behavior that is indiscernible in the aggregate analyses.

Objective 7:
A commercial oven and infra-red temperature gauge were purchased with project funds for cookie study in Uganda. Two temperature data loggers were purchased for peanut soup base research. Particle size distribution measuring devices were purchased both for Uganda and Ghana researcher. The equipment allows investigators to conduct investigations on problems important in peanut processing in Uganda and Ghana. In addition, enhanced institutional capability will provide sustainability to future peanut and food research after the grant has ended.

Objective 8:
The economic benefits from the development and commercialization of chocolate, stabilized peanut spread by CBA Foods on Ghana have been demonstrated at the Ghana International Fair in Accra July 23-August 4, 2012. The displayed product sold well and all inventory prepared for the Fair was depleted. In addition, 500 questionnaires were completed by visitors providing information about the perception of the product attributes, willingness to pay, product quality certification and socio-demographic information that will allow generating additional knowledge about the target consumer segment to the collaborators and the Industrial Partner after the data are fully analyzed. The jar of chocolate peanut spread sold by CBA Foods was priced at 5 cedis and the demand was so large that the company decided to purchase a peanut butter mill to process and supply approximately one ton of the product per batch.

In Uganda, Hometech Foods that commercialized the nutritious peanut cookie technology developed and transferred under the collaborative project has been selling 1,000 packets of cookies per week at the price of 1,000 Uganda shillings per packet. The company produces the cookies using three employees and sells them to three buyers leaving plenty of room for growth in sales if it expands the production. During the recent Uganda Manufacturers Association Fair in Kampala, the product was highly accepted and was selling well (two package sizes priced at 1,000 and 3,500 Uganda shillings, respectively) nearly exhausting the available inventory. More than 230 questionnaires were collected from the visitors who tasted the product, evaluated it, and then provided additional information about their willingness to pay for the product and quality assurance.

Another company that has commercialized a peanut product in Uganda is Food Engravers. In collaboration with the Makerere University and the GP3M Team, Food Engravers have been selling the stabilized chocolate peanut spread. At the recent Uganda Manufacturers Association Fair in Kampala, Food Engravers displayed, allowed consumer to taste and purchase their product. The product was readily accepted and the company sold their available supply daily. The small production scale of Food Engravers will have to be expanded to take advantage of the very strong demand despite the relatively high price of the product (5,000 Uganda shillings per 450g jar).

A product with great market potential that has been commercialized in Uganda is peanut-soy beverage named PNUTSOY by the medium size food manufacturer, SESACO. The product, which expands the company's soy-based beverages, is produced in three flavors (strawberry, vanilla, and ginger). Given SESACO's processing capacity and well developed distribution network, the product will soon be widely available to consumers in the greater Kampala area. The expansion of production will increase the demand for domestic peanuts and soybeans and offer opportunities for additional employment.

The participation in the Ghana International Fair provided the opportunity to collect relevant market information using the convenience sample consisting of opinions

gathered from 500 consumers. The data is currently being analyzed and will provide invaluable information about prices consumers paid for similar products prior to visiting the Fair and the willingness-to-pay for the displayed product and quality certification.

The participation of Hometech Foods in the Uganda Manufacturers Association Fair in Kampala proved that such events are a valuable tool for collecting relevant market and consumer information. Once analyzed, the summary of the data collected during the Fair will provide insights for the decision making about the distribution, pricing and merchandizing the nutritious peanut cookies. The microenterprise such as Food Engravers will benefit from the summary of responses by 192 consumers who returned the questionnaires after tasting and evaluating the chocolate peanut spread. The summary of response will offer insights needed to make decisions about the expansion of production scale and the target consumer population. It is expected that the production expansion will require increasing the number of employees and investment in the processing equipment. The feedback provided by the socio-economic survey for peanut-soy beverage will be used in making decisions about refining the attributes of the product and managing manufacturing costs.

TABLE 1: Human Capacity/training

Workshop name	Location	Training type	Female participants	Male participants	Comments
Enumerator training for the Uganda household survey	UIRI, Kampala; October 2010	Interview skill development, and pilot test	9	9	Included role-playing and debriefing after the pilot survey
PROCESSING FOR AFLATOXIN ELIMINATION IN PEANUT PRODUCTS	FRI-CSRI, Accra; January 24-25, 2012	Presentations and hands-on lab	15	21	Included sorting, blanching, skin removal and aflatoxin presence testing
PROCESSING FOR AFLATOXIN ELIMINATION IN PEANUT PRODUCTS AND HACCAP PROCEDURES	Makarere University, pilot plant, Kampala, Uganda; February 21-23, 2012	Presentations and hands-on lab	20	22	Included sorting, blanching, skin removal and aflatoxin presence testing
Results from the urban household survey in Ghana	University of Ghana-Legon; June 6, 2012	Presentations and commercial American peanut product display and tasting	8	8	Included discussion by USAID representatives, PIs and IPs
Global mycotoxin issues	Foz de Iguacu, Brazil; August 4, 2012	Presentations and discussion	18	17	Pre-conference workshop, IUof FS triennial meeting
Enhancing the peanut value chain, from processing to marketing peanuts and peanut products" - Closing Conference	FRI-CSRI, Accra; December 5, 2012	Presentations and discussion; product tasting	14	10	Presentation of selected household survey results, peanut product development and presentation of commercialized products

Table 2: Human capacity development and training – students trained with the help of Peanut CRSP grant funding

Name	Gender	Country	Degree program	Completion date	Training location	Significant employment
Victoria Yoo	F	USA	MS	August 2011	UGA	Company in Atlanta
Padmanan Nambiar	M	USA	MS	July 2010	UGA	Ph. D. program at UGA
Ghanna Sheremenko	F	USA	MS	December 2011	UGA	Ph. D. program at UGA
Padmanan Nambiar	M	USA	Ph. D.	2015	UGA	Not applicable
Ghanna Sheremenko	F	USA	Ph. D.	2015	UGA	Not applicable
Ting Tina Meng	F	USA	Ph. D.	2014	UGA	Not applicable
Andrew Mata-Leclerc	M	USA	BS	2014	UGA	Not applicable
Achilles Dongdem	M	Ghana	M Phil	December 2012	University of Ghana-Legon	Nkulenu Industries
Diane	F	Uganda	BS	?	Makarere University	SESACO