FY 2011 Workplans

October 1, 2010-September 30, 2011

Dry Grain Pulses Collaborative Research Support Program (CRSP)

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For Further Information, Contact:
Dry Grain Pulses CRSP
321 Agriculture Hall
Michigan State University
East Lansing, MI 48824-1039, U.S.A.
Phone: (517) 355-4693
Fax: (517) 432-1073
Email: dgpcrsp@msu.edu
http://pulsecrsp.msu.edu

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Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda

Lead U.S. Principal Investigator
Robert Mazur – Iowa State University (ISU)

Collaborating Scientists
Dorothy Nakimbugwe, Makerere, Uganda
Henry Kizito Musoke, VEDCO, Uganda
Suzanne Hendrich, ISU, U.S.
Patricia Murphy, ISU, U.S.
Mark Westgate, ISU, U.S.
Gabriel Elepu, Makerere, Uganda
Michael Otim, NaCRRI, Uganda
Michael Ugen, NaCRRI, Uganda
Hilda Vasanthakaalam, KIST, Rwanda
Helen Jensen, ISU, U.S.
Manju Reddy, ISU, U.S.
Agnes Nakimuli, VEDCO, Uganda
Paul Kibwika, Makerere, Uganda

Project Problem Statement and Justification

Agriculture in East Africa is characterized by women and men working in small scale, rainfed production, averaging 2 hectares per household (FAO 2006). Erratic bimodal rainfall patterns in recent years further challenge cropping results (ARB 2007). Farmers have very limited access to extension, training, inputs (quality seeds, fertilizers, etc.), improved agronomic practices, new technologies, and credit (KDA 2004; Nkonya et al. 2004). Producers are not well linked with profitable markets, especially to emerging sectors of domestic and regional markets (Ehui & Pender 2005). Private traders operate on a small scale with limited investment capability. Availability and use of processed products at present remain very modest. As a result of low production levels, hunger is widespread (WFP 2006) and the vast majority of the rural population lives in absolute poverty (KDA 2004).

Our recent efforts to introduce new agronomic practices and technologies demonstrate encouraging progress (Butler & Mazur 2007). Ongoing collaboration since 2004 of Iowa State University (ISU), Makerere University (MAK), and Volunteer Efforts for Development Concerns (VEDCO) in Uganda's Kamuli District (Mazur et al. 2006; VEDCO 2006; Sseguya, Mazur & Masinde 2009) using a sustainable livelihoods approach has increased food security and market readiness from 9% to 77% among 800+ farm households in 2½ years (Sseguya 2007). The main crops grown in Kamuli district are maize, beans, sweet potatoes, cassava, bananas, rice and coffee (Sseguya & Masinde 2005). Most (90%) of participating households produce beans, but only 20% sold some in 2007. The SL approach focuses on understanding and supporting individual and community capabilities, assets (natural, physical, human, financial, social, cultural and political capital), goals, strategies and activities. Diversification of livelihood opportunities and activities is crucial to sustainability (Ellis 2000). In combination with SL approaches, scientific knowledge, improved technologies, financial assistance, and changes in government policies can have significant positive local impacts (Helmore &

Singh 2001). Participatory research methods can generate knowledge that people can apply to improve their individual and collective well-being (Selener 1997).

Beans provide a strategic opportunity to help meet the Millennium Development Goal targets of reducing hunger and poverty. Improved beans production in Uganda and Rwanda offers unique opportunities to address the deteriorating food security situation there and elsewhere in sub-Saharan Africa. The short growth period and two growing seasons offers great opportunities to contribute to rural poverty alleviation - playing an essential role in sustainable livelihoods of small scale farmers and their families, providing food security and income to the most vulnerable group, the women and children. Testing whether various management practices and technologies result in higher bean yield and quality at harvest and after storage (Objective 1), and which varieties, processing methods, and food combinations can increase consumption and nutritional value (Objective 2) are important under-researched issues in this region. Improved farmers's linkages to emerging markets and the food industry are also essential (Objective 3).

Central problems limiting production of quality beans and higher yields

- Declining soil fertility and inefficient cropping systems unable to utilize available resources effectively and efficiently
- Limited accessibility and affordability of quality seeds, non-seed inputs and other yield improving technologies
- Effects of drought and other weather related factors compromise productivity and quality
- Diseases (root rot, anthracnose, angular leaf spot, common bacterial blight, viruses, rust, ascochyta blight) and insect pests (aphids, thrips, bean stem maggots, weevils)

Central problems relating to nutritional value and processing of beans

Pre- and post-harvest losses for beans are very high throughout the value chain, mostly due to poor harvest and post-harvest practices and poor on-farm storage facilities. Poor pre- and post-harvest handling also results in the majority of beans on the market being characterized by mixed varieties and poor quality with high levels of foreign matter, rotten or shriveled beans, and infestation. The lack of value-added bean products having reduced preparation times makes bean preparation laborious with high fuel requirements; consumers also tire of monotonous flavor. As a result, an increasing number of people are abandoning or reducing their bean consumption despite its documented high nutrient content and health benefits.

The nutrition value of beans is negatively affected by anti-nutrients such as phytates, trypsin inhibitor, lectins, polyphenols, saponins, oligosaccharides and hemaglutinins (Kebede et al., 1995). However, treatments such as de-hulling, soaking, milling, fermentation and germination or malting and cooking enhance the digestibility and nutritional value (Matella 2005; Martín-Cabrejas 2006; Shimelis & Rakshit 2007; Nergiz & Gökgöz 2007; Cevdet & Gökgöz 2007).

Central problems inhibiting increased marketing of beans and derived food products
Prospects of marketing increased quantities of beans and new agro-processed bean products within the Ugandan and regional markets requires carefully examining production and marketing constraints (increased farm productivity, producer incentives, and access to better markets). Equally important is examining prospects for increasing demand for beans and agro-processed products (understanding consumers' tastes and preferences, increased consumer awareness of benefits of consuming beans and other value-added products, increasing consumer choices of value-added products, etc.).

Planned Project Activities

Objective 1: To Improve Harvested Bean Yield and Quality

Collaborators

National Crops Resources Research Institute (Kampala, Uganda)

Michael Ugen, Bean Programme, m.ugen@naro-ug.org, michaelugen@yahoo.com

Michael Otim, Entomology Department, otim_michael@yahoo.com

Volunteer Efforts for Development Concerns (Kampala, Uganda)

Henry Kizito Musoke, Executive Director, henrykizito@vedco.or.ug

Agnes Nakimuli, Eastern Region Program, anakimuli@yahoo.com

Iowa State University (Ames, Iowa)

Mark Westgate, Department of Agronomy, westgate@iastate.edu

Gerald Sebuwufu, Department of Agronomy, sebuwufu@iastate.edu

Makerere University (MAK-Kampala, Uganda)

Dorothy Nakimbugwe, Dept. of Food Science & Technology, dnakimbugwe@agric.mak.ac.ug, dnakimbugwe@gmail.com

Rationale

Results of Phase 1 research activities prompted several adjustments in research and development activities planned for Phase 2.

On-farm field trials revealed significant local variation in soil conditions that resulted in large genotype x environment interactions for the priority varieties evaluated. Although management techniques and farmer interest contributed to some extent, variation was largely due to variation in soil conditions and fertility. Bean production remained well below genetic potential and, in some cases, unresponsive to supplemental Nitrogen fertilizer. All soils in the test sites were depleted in phosphorous. Objective 1a will test the hypothesis that incorporating a small amount of inorganic phosphorous into the soil prior to planting will generate a profitable return on seed and N-fertilizer investment. Results of this objective will be compared to those of related studies to enhance Biological Nitrogen Fixation, in which phosphorous levels will be monitored as critical for profitable plant response.

Phase I results also confirmed the large potential for yield loss due to insect infestations during seed development. While chemical methods of insect control are available, their high cost and lack of information on effective and timely application renders chemical insecticides a luxury for most small-landholder farmers. Use of biological control agents, however, could prove to be an affordable and effective alternative. We will enlist the expertise of entomologists at Uganda's National Crops Resources Research Institute and elsewhere (University of Illinois, ICIPE) to identify and test biological control methods for two major insect pests in common beans - aphids and thrips. Controlled field trials will be conducted to determine specificity and effectiveness against these damaging pests.

Phase I analysis of farmer production levels and market requirements for consistent production levels and product quality required significant changes in seed management to effect a successful transition from household-based bean production to market-oriented production. A major priority is to establish a system for community-based production of quality seed. This will require establishment of farmer groups or associations committed to large-scale bean production, establishment and management of seed quality standards for all participating farmers to adopt, and development of bulk seed storage methods suitable for long-term (3-6 months) storage without loss of product quality. We will use proven participatory methods to engage farmers in this process and establish protocols for seed production, harvesting, and storage. We hypothesize that membership in an active farmer group and market forces will have a major impact on the success and sustainability of the production groups.

Numerous factors are known to affect the duration of seed quality in storage. Phase I studies on typical storage techniques revealed the need to improve bean post-harvest handling and storage to prevent post-harvest losses and avoid excessive time expenditure involved in re-sunning. Re-sunning is commonly used to limit damage to stored seeds caused by infesting bruchid larvae. While the actual control mechanism is not known, the movement of the seed is thought to be the controlling factor. If correct, periodically moving the seed could limit adult damage, but would have little impact on eggs or larvae. We will test to confirm a well-known technique of asphyxiation using air-tight bagging to eliminate living insects from the storage container. The triple bagging technique has numerous advantages including flexible storage volume, re-usable containers, and manageable volume of individual bags (50-100 kg) for transport. This flexible storage approach will be evaluated as a means to meet the emerging need for bulk storage on farm or at community collection sites as determined most appropriate and effective for collective marketing and increased farmer access to emerging markets.

These Phase II activities for Objective 1 build on the great potential for promoting improved practices and disseminating technologies in Kamuli, in other districts in Uganda, and in Rwanda that have similar yield and seed quality limitations. Key activities for Objective 1 include:

- Data on variety performance, fertility response, and pest/disease management will be analyzed.

- Exchange visits will be made to established seed production programs (e.g., Namulonge and western Uganda) to facilitate learning and sharing of practices and technologies.
- Drying and storage techniques will be evaluated in multiple periods to determine their effectiveness in keeping out/killing pests and maintaining seed germination viability.
- Bio-control strategies will be tested for two priority biotic pests.
- Refinements in practices and technologies (land preparation, soil nutrient management, pest and disease control, harvest and storage) will be evaluated, documented, and incorporated into materials for dissemination.

Approaches and Methods

Obj. 1a. Improve Yield and Quality through Evaluation of Better Production and Management Practices

1. Evaluate additional bean varieties with selected agronomic/nutritional traits under farmers' cropping system conditions (farmer selected and promising new NaCRRI varieties, high seed ferritin genotypes, early maturation, good yield, disease resistance). New varieties will be tested under conditions of monocropping and intercropping (with maize).
2. Evaluate practical methods to enhance nutrient management - organic fertilizers (adding compost and green manure to currently evaluated farm yard manure), adding phosphorous and nitrogen.
3. Evaluate appropriate biological and cultural/agronomic methods to control pests/diseases (intercropping, crop rotation, and possibly later trap cropping).
4. Promote adoption and use of key management practices and technologies.

Benchmarks

Oct. 2010 – Mar. 2011

- Variety performance and fertility response analyzed
- Biological and agronomic/cultural management control strategies for primary pests and diseases initiated

Apr. – Sept. 2011

- Variety performance, fertility response, and biological and agronomic/cultural controls analyzed
- Best performing farmer-selected and new bean varieties identified and reported to breeders
- Seeds provided for post-harvest storage studies

Obj. 1b. Support Community-Based Seed Production (CBSP) by Farmers Groups/Associations

1. Refine CBSP systems initiated in 2010 based on farmer group/stakeholder input

2. Document lessons learned in development of community based seed production systems
3. Scale up CBSP systems to other farmer groups in Kamuli District and explore approaches for doing so more widely

Benchmarks

Oct. 2010 – Mar. 2011

- Farmers' groups trained in management practices and group dynamics required for producing, storing and selling high quality seed
- Exchange visits conducted to established seed production programs
- Extension guide for bean CBSP initiated and tested with farmers

Apr. – Sept. 2011

- Linkages to breeders, seed processing and marketing companies established
- Seed storage facilities established

Obj. 1c. Evaluate Adoption of Improved Post-Harvest Handling and Storage Methods

1. Evaluate parameters of 'solarization' method (bean seed size, seed coat thickness, color, length of time exposed, heat accumulated by time of day, etc.), to achieve optimal moisture content and viability of bean seeds.
2. Train farmers in improved drying methods ('solarization') to achieve optimal moisture content and viability of bean seeds, and identify and address barriers to farmers' adoption.
3. Train farmers in improved threshing practices, identify and address barriers to farmers' adoption.
4. Train farmers in improved storage methods ('triple bagging' and 200 liter re-sealable plastic drums), and identify and address barriers to farmers' adoption.
5. Train farmers in management of bulking facilities (technical, organizational, and financial aspects)
6. Assess adoption of drying, threshing, and storage techniques through interviews and focus group discussions.

Benchmarks

Oct. 2010 – Mar. 2011

- Effect of solarization on germination and storage evaluated
- Farmers trained in effective use of solarization technique to preserve grain and seed
- Materials (polyethylene) for solarization procured and distributed to farmers' groups
- Barriers to adoption of solarization identified and resolved

Apr. – Sept. 2011

- Storage techniques evaluated for pest control and germination

- Farmers trained in new storage techniques
- Storage materials procured and distributed to farmers' groups
- Training of farmers' groups in managing bulking facilities completed

Obj. 1d. Strengthen Learning and Sharing of Innovative Practices

1. Share and disseminate information through farmer field days at research/demonstration sites, and develop materials and methods to promote improved management practices and technologies.
2. Review training materials by project farmers and RDEs / CNHWs, adapt, and translate
3. Develop materials for new farmer groups to utilize in adopting and utilizing new management practices and technologies (germination, moisture content, etc.)
4. Explore approaches to disseminate and promote management practices and technologies in other districts, and quantify the resource requirements.

Benchmarks

Oct. 2010 – Mar. 2011

- Exchange visits to other successful farmer groups outside the district conducted

Apr. – Sept. 2011

- Contacts with prospective districts to scale out technologies and practices initiated
- Stakeholder workshop held to review bean production training materials
- Extension materials translated and published

Target Outputs and Developmental Outcomes

We will document and publicize the contributions of production factors to increased yield, reduced lost due to pests and diseases, and improved quality after drying and storage, as well as successful strategies for profitable and sustainable community-based seed production. Farmers' indigenous knowledge combined with emerging research results and 'lessons learned' will be incorporated into revised training procedures and materials, and promotion protocols for use in VEDCO operations and NaCRRI demonstration projects in other areas of Uganda. The project will facilitate access to improved drying and storage techniques, and farmers' central roles in field days conducted for the public (farmers, farmer groups and associations, NGOs, researchers). We anticipate that dissemination of these technologies, management practices, and CBSP programs will benefit more than 2,000 VEDCO-assisted farmers and other farmers in Kamuli. Project researchers will actively explore the bases for dissemination of improved technologies and practices to other districts in Uganda and in Rwanda.

Objective 2: To Enhance Nutritional Value and Appeal of Beans through Appropriate Handling and Processing.

Collaborators

Makerere University (MAK-Kampala, Uganda)

Dorothy Nakimbugwe, Dept. of Food Science & Technology, dnakimbugwe@agric.mak.ac.ug, dngabo@yahoo.co.uk

John Muyonga, Dept. of Food Science & Technology, muyongaj@agric.mak.ac.ug, hmuyonga@yahoo.com

Iowa State University (ISU-Ames, Iowa)

Suzanne Hendrich, Department of Food Science & Human Nutrition, shendric@iastate.edu

Patricia Murphy, Department of Food Science & Human Nutrition, pmurphy@iastate.edu

Manju Reddy, Department of Food Science & Human Nutrition, mbreddy@iastate.edu

Martin Mutambuka, Department of Food Science & Human Nutrition, mcmartin@iastate.edu

Kigali Institute of Science and Technology (KIST-Kigali, Rwanda)

Hilda Vasanthakaalam, Dept. of Food Science & Technology, hildajeya@hotmail.com, h.vasanthak@kist.ac.rw

Center for International Tropical Agriculture Research (CIAT-Africa)

Martha Nyagaya, Nutrition Programme – Harvest Plus, m.nyagaya@cgiar.org

Rationale

Phase 1 results indicate the need to promote increased bean consumption among farming communities and urban consumers to realize the nutritional and health benefits and address prevalent diet and nutritional imbalances, as well as the need to reduce cooking time and monotony in the diet. Doing so involves four core elements. The first is understanding and communicating consumer preferences regarding culinary properties and sensory characteristics of existing and improved bean varieties to national bean breeding programs and the private business sector. This leads to the second element - engaging the private business sector in value addition and commercialization of bean products to open up new markets for bean producers. Third, to enhance children's daily nutrient intake through increased consumption of beans and bean products, our emphasis will be on products that are practical, useful in school settings, and acceptable to students. Thus, institutional buyers such as schools, hospitals, and humanitarian agencies have been identified as potential markets for beans and bean products. Finally, complementary use of produce from home gardens to increase dietary iron content and bioavailability constitutes an important, new component of the project's next phase.

While beans have the potential to positively contribute to the nutritional and health status of both farming and urban communities, a number of constraints to consumption remain, including long cooking times, monotony of cooking methods and limited dietary complementation. During phase I, pre-processing methods that reduce cooking times to about 15 minutes, using a pre-processed bean flour were developed. Recipes utilizing the fast-cooking bean flour will be developed in a planned participatory, community based

competition and field day later in 2010. We hypothesize that availability of acceptable alternative ways of consuming beans will result in increased bean consumption. The central hypothesis regarding farmers' adoption, adaptation and sustainable (continuous) use is that a coordinated strategy of technological innovation to facilitate ease of utilization of bean foods for weaning and snacks and ongoing evidence of nutritional and economic benefits of beans are likely to create sustainable increased use of bean-based foods within communities.

To further enhance the nutritional benefits from beans, there is also need to evaluate the role of complementary foods on the nutritional and healthful contribution of beans, as well as promoting this knowledge and encouraging consumption of meal combinations that maximize balanced nutrient intake and enhance bioavailability. Key complementary foods commonly grown and consumed in Kamuli District (the study area in Uganda) have been identified as green vegetables, especially amaranth and citrus fruits. They are envisaged to enhance protein quality and mineral bioavailability of beans. This objective will seek to evaluate adoption and nutritional/health impact of practices aimed at maximizing nutritional contribution of beans, especially for nutritionally vulnerable populations. It is hypothesized that dietary complementation of beans with fruits and vegetables will improve the nutritional benefits to vulnerable individuals.

Phase I results indicate that new high yielding bean varieties were not necessarily of optimal nutrition, consumer acceptability and processability into high quality value added products. This clearly indicated a disparity between breeding for agronomic hardiness versus end user requirements. Thus, Phase II of this project will aim to bridge the gap between the breeder and the consumer by clearly defining consumers' sensory, culinary and processing requirements and informing national breeding programs. It is hypothesized that interfacing with bean breeders and providing critical information on expectations of end users (consumers and processors) will lead to development of sustainable and consumer acceptable varieties; and with potential for niche markets as high quality value added products.

Besides utilization by communities, the project will also partner with the private business sector to promote adoption of value addition to beans as a way of increasing consumption and creating market outlets. Bean varieties that are high yielding and stress resistant but have low consumer acceptability and are prone to being hard-to-cook were selected for value addition and product development in phase I. In phase II, processing protocols developed in phase I will be refined and up-scaled through the Technology Business Incubator (TBI) model, as a vehicle to promote technology transfer to the private sector. TBIs are effective frameworks for fostering industrial uptake of new technologies by providing 'seed' entrepreneurs with a supportive environment to help establish and develop their projects (Lalkaka 1996). It is hypothesized that by providing services (product refinement/optimization, marketing, access to funding/loans) on a 'one-stop-center' basis and enabling overhead costs to be reduced by sharing facilities, the TBI model will significantly improve the survival and growth prospects of bean processing enterprises in their early stages of development. Suitable private sector partners will be identified and linked to farmer organizations for maximum trickle down effect of value

addition returns. We will also test three additional hypotheses: (1) processing of beans significantly improves its acceptability and market potential; (2) promotion of bean processing can lead to increased beans consumption; and (3) there is no significant difference between the organoleptic property of bean based products made from hard-to-cook bean varieties and the varieties less prone to that phenomenon.

Initial publication outlets for this research include the Journal of Agricultural and Food Chemistry, and the Journal of Food Science.

Approaches and Methods

Obj. 2a. Address Nutritional and Health Problems among Vulnerable Individuals through Increased Consumption of Beans, Bean Products, and Complementary Foods

1. Document prevalence of diet-related health problems, both over and under-nutrition among vulnerable groups, which can be addressed through increased bean consumption.
2. Document consumer levels and trends of buying and using beans.
3. Identify accessible and affordable complementary foods (grain and vegetable amaranth, citrus, mango, etc.) to increase nutritional benefits of consuming beans.
4. Train rural populations (Rwanda, then Uganda) to utilize simple 'cold extrusion' technology (using hand-operated presses) at community level with processed (sprouted, fermented) beans and maize.
5. Determine acceptability and nutritional benefits (based on anthropometry and morbidity) from consuming bean based products by the nutritionally vulnerable, including bean based weaning foods and extruded snack products.
6. Develop and implement appropriate extension information education and communication (IEC) approaches (nutrition, processing of bean based products) for rural community nutrition and health workers to accelerate and multiply positive rural development impacts.

Benchmarks

Oct. 2010 – Mar. 2011

- Prevalence of diet-related health disorders in Uganda and Rwanda documented
- Consumer levels and trends of buying and using beans documented in Uganda and Rwanda
- Complementary foods to increase nutritional benefits of consuming beans identified
- Cold extruded bean products and cold extrusion process developed at KIST demonstrated in Rwanda and Uganda

Apr. – Sept. 2011

- Bean-based weaning foods developed for Uganda and Rwanda
- Extension approaches for popularization of bean products identified and content developed

- Farmers trained in bean cold extrusion processing
- Baseline nutritional status established for bean-based weaning food study in Uganda and Rwanda and extruded snack products

Obj. 2b. Analyze Culinary Properties, Sensory Characteristics, and Consumer Acceptability of Improved Varieties of Beans

1. Identify desirable culinary properties and sensory characteristics of beans in different regions
2. Analyze culinary properties of improved bean varieties in Uganda (NaCRRI) and Rwanda (ISAR)
3. Analyze sensory characteristics (color, texture, taste, flavor, etc.) and consumer acceptability of improved bean varieties in Uganda (NaCRRI) and in Rwanda (ISAR)
4. Liaise with national bean breeding programs to match consumer requirements with culinary and sensory characteristics of new varieties

Benchmarks

Oct. 2010 – Mar. 2011

- Analysis protocol for culinary properties obtained from the University of Pretoria
- Analysis of desirable culinary traits and sensory characteristics of current bean varieties initiated

Apr. – Sept. 2011

- Culinary traits and sensory characteristics of current bean varieties documented
- Analysis of desirable culinary traits and sensory characteristics of improved bean varieties initiated

Obj. 2c. Incorporate Insights from Analysis of Private Food Processing Industry regarding Development and Commercialization of Bean-based Products

1. Identify approaches and methods that enable farmers' associations to establish and strengthen links with the private food processing industry in Uganda, taking lessons from experiences in the U.S.
2. Engage private sector actors in developing protocols for value-added bean products (including utilizing the semi-processed bean flour).
3. Develop and evaluate marketing strategies regarding consumers' nutritional awareness and utilization, and work with private sector processors, distributors and retailers to promote bean products for purchase.
4. Support commercialization of bean products through technology and business incubation in the Makerere University, Department of Food Science, Technology and Business Incubation Centre.

Benchmarks

Oct. 2010 – Mar. 2011

- Successful technology incubation (and transfer) models identified and modified to suit unique characteristics of Uganda's and Rwanda's production/market economies
- Local and international industries as potential markets for beans and value added products identified
- Private industry interest in and conditions to adopt bean processing technology evaluated

Apr. – Sept. 2011

- Strong links created and fostered between farmers' associations and the private food processing industries in Uganda and Rwanda
- Development of protocols for value added bean products with private sector partners initiated

Target Outputs and Developmental Outcomes

Documentation and analysis of culinary properties and sensory characteristics of current and new bean varieties will be of great value to national bean breeding programs. We will document and publicize nutritional analysis of harvested beans and effects of processing methods, including the rural-based cold extrusion method. Our initial feeding trials will be evaluated in terms of participation and dietary impact, and the results published. In rural communities, we will conduct follow-up training and evaluation regarding adoption of promoted food preparation practices and use of complementary foods. Information on shelf-stability and consumer acceptability of the developed bean flour-based products and extruded products will be of interest to processors and retailers. Private sector processors will gain from the bean processing protocols that will be finalized and disseminated. Rural farmers will gain through project activities which will enable farmers' associations to establish and strengthen links with the private food processing industry.

Objective 3: To Identify Solutions for Constraints to Increased Marketing & Consumption.

Collaborators

Makerere University (MAK - Kampala, Uganda)

Paul Kibwika, Dept. of Agricultural Economics & Agribusiness, pkibwika@agric.mak.ac.ug

Gabriel Elepu, Dept. of Agricultural Economics & Agribusiness, elepu@agric.mak.ac.ug

Volunteer Efforts for Development Concerns (VEDCO - Kampala, Uganda)

Agnes Nakimuli, Eastern Region Program, anakimuli@yahoo.com

Iowa State University (ISU - Ames, Iowa)

Helen Jensen, Department of Economics, hhjensen@iastate.edu

Robert Mazur, Department of Sociology, rmazur@iastate.edu

Rationale

Although there has been an increase in bean market participation among households, bean production has tended to be for domestic consumption rather than for commercial purposes (currently 42%). Improved crop management practices and technologies stimulate market participation, as they effectively increase the quantity available for sale. Basic value addition activities such as proper drying, sorting, grading, storage, the absence damage or insect infestation, help improve quality and price. When farmers achieve higher prices, they increase marketing. The local village markets have been important concentration/assembly and dispersion points for beans, and where market prices become formalized. Still, most (79%) farmers who sell beans do so at farm gate rather than directly in markets. Transactions costs, costs associated with gathering information, travel, making sales or purchases, can impede the development of markets and marketing activities. Market participation by smallholder farmers is affected by transaction costs, especially distance and access to useful market information. Since households headed by women tend to market smaller quantities of beans, there is value in increasing program and policy support for women to participate in marketing. Our results to date suggest the value of increasing access to market information systems that are reliable and timely, improving transportation networks for marketing, strengthening farmer groups, and establishing associations that can effectively engage in collective marketing with various types of buyers, including industry.

To foster successful collective marketing activities as production increases, our Phase 2 activities focus on strengthening farmer groups and associations, and supporting development of value chain partnerships. These strategies reduce the costs of marketing transactions, including acquisition of market information. It is expected that these efforts will increase the number of farmers engaged in commercialization of beans, increase the quantity of beans sold, and increase the income and associated livelihoods benefits that small scale farmers derive from production and sale of beans. We expect that farmers participating in this project, as well as other VEDCO assisted farmers, will play important leadership roles in emerging associations.

Approaches and Methods

Obj. 3a. Assess capabilities and needs of farmer groups and associations

1. Assess institutional status of existing farmer groups and associations
2. Design strategies to build strong farmers' marketing associations

Benchmarks

Oct. 2010 – Mar. 2011

- Farmer groups' composition, roles, assets, and capabilities identified

Apr. – Sept. 2011

- Farmer groups' needs for profitability and sustainability determined and prioritized

Obj. 3b. Strengthen Farmers' Successful Engagement in Value Chain Development

1. Convene periodic value chain platform meetings

2. Establish product portfolio appropriate for target markets
3. Improve market information systems
4. Training farmers' associations in agri-business management skills

Benchmarks

Oct. 2010 – Mar. 2011

- Farmers trained in group / association dynamics and gender equity
- Partner meetings held in each of the two sub-counties
- Participatory market research groups formed

Apr. – Sept. 2011

- Participatory market chain analysis for the bean enterprises conducted
- Market information sources assessed

Target Outputs and Developmental Outcomes

Farmers will benefit significantly from improved market information systems, establishing small scale bulking centers, processing and extrusion as value addition income earning activities, and increased capabilities to engage with value chain actors regarding production, bulking, price negotiation, and targeting production. Consumer awareness and interest in bean products is expected to increase among households, students, and others. The private business sector will benefit by through product development, commercialization, and access to new markets.

Objective 4: Capacity Building

To Increase the Capacity, Effectiveness and Sustainability of Agriculture Research Institutions that Serve the Bean Sector in Uganda and Rwanda

Collaborators

Makerere University (MAK - Kampala, Uganda)

Dorothy Nakimbugwe, Dept. of Food Science & Technology, dnakimbugwe@agric.mak.ac.ug, dnakimbugwe@gmail.com

John Muyonga, Dept. of Food Science & Technology, muyongaj@agric.mak.ac.ug

Paul Kibwika, Dept. of Agricultural Economics & Agribusiness, pkibwika@agric.mak.ac.ug

Gabriel Elepu, Dept. of Agricultural Economics & Agribusiness, elepu@agric.mak.ac.ug

National Crops Resources Research Institute (NaCRRI - Kampala, Uganda)

Michael Ugen, Beans Programme, m.ugen@naro-ug.org, michaelugen@yahoo.com

Michael Otim, Entomology Department, otim_michael@yahoo.com

Kigali Institute of Science and Technology (KIST-Kigali, Rwanda)

Hilda Vasanthakaalam, Dept. of Food Science & Technology, hildajeya@hotmail.com, h.vasanthak@kist.ac.rw

Iowa State University (ISU - Ames, Iowa)

Robert Mazur, Center for Sustainable Rural Livelihoods, Iowa State University, rmazur@iastate.edu

Mark Westgate, Department of Agronomy, westgate@iastate.edu

Suzanne Hendrich, Department of Food Science & Human Nutrition, shendric@iastate.edu

Patricia Murphy, Department of Food Science & Human Nutrition, pmurphy@iastate.edu

Manju Reddy, Department of Food Science & Human Nutrition, mbreddy@iastate.edu

Helen Jensen, Department of Economics, hhjensen@iastate.edu

Approaches and Methods

- Engage students in learning appropriate theories and methods in discipline and multidisciplinary format, and applying them in their research activities
- Integrate students into research projects and research program development
- Guide development of students' research proposals and supervise their research

Benchmarks

Oct. 2010 – Mar. 2011

- Training M.S. students (Food Science & Technology, and Agricultural Economics and Agribusiness) at Makerere University on-going
- Training M.S. student in Food Science & Technology from Rwanda on-going
- Training Ph.D. students (Food Science & Human Nutrition, and Agronomy) at Iowa State University on-going

Apr. 2011 – Sept. 2011

- Training M.S. students at Makerere University on-going
- Training Ph.D. at Iowa State University on-going
- Inter-organizational learning fostered
- Preliminary results disseminated (conferences, publications, websites)

Degree Training

Trainee #1
First and Other Given Names: Gerald
Last Name: Sebuwufu
Citizenship: Ugandan
Gender: Male
Degree Program for training: Ph.D.
Program Areas or Discipline: Agronomy
Host Country Institution to Benefit from Training: National Crops Resources Research Institute, Uganda
University to provide training: Iowa State University
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Yes
Supervising CRSP PI: Mark Westgate
Start Date: August 2008
Projected Completion Date: August 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s)s of leveraged funds: Iowa State University
Amount Budgeted in Workplan, if providing full or partial support: $47,298
Direct cost: $39,106
Indirect cost: $8,192
U.S. or HC Institution to receive CRSP funding for training activity: Iowa State University

Trainee #2
First and Other Given Names: Martin
Last Name: Mutambuka
Citizenship: Ugandan
Gender: Male
Degree Program for training: Ph.D.
Program Areas or Discipline: Food Science and Human Nutrition
Host Country Institution to Benefit from Training: Makerere University, Uganda
University to provide training: Iowa State University
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Yes
Supervising CRSP PI: Suzanne Hendrich
Start Date: January 2009
Projected Completion Date: May 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s)s of leveraged funds: Iowa State University
Amount Budgeted in Workplan, if providing full or partial support: $43,114
Direct cost: $35,563
Indirect cost: $7,551
U.S. or HC Institution to receive CRSP funding for training activity: Iowa State University

Trainee #3
First and Other Given Names: TBD
Last Name: TBD
Citizenship: TBD
Gender: TBD
Degree Program for training: Ph.D.
Program Areas or Discipline: Sociology or Economics
Host Country Institution to Benefit from Training: Makerere University, Uganda
University to provide training: Iowa State University
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Yes
Supervising CRSP PI: Robert Mazur
Start Date: August 2011
Projected Completion Date: August 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s)s of leveraged funds: Iowa State University
Amount Budgeted in Workplan, if providing full or partial support: $26,491
Direct cost: $22,012
Indirect cost: $4,479
U.S. or HC Institution to receive CRSP funding for training activity: Iowa State University

Trainee #4
First and Other Given Names: Marie Rose
Last Name: Kambabazi
Citizenship: Rwanda
Gender: Female
Degree: M.Sc.
Discipline: Food Science & Technology
Host Country Institution to Benefit from Training: Kigali Institute of Science and Technology - Rwanda
University to provide training: Makerere University
Supervising CRSP PI: Dorothy Nakimbugwe
Start Date: August 2010
Project Completion Date: August 2012
Training Status: Active
Type of CRSP Support (full, partial or indirect): Partial (Category 2b)

Trainee #5
First and given names: Catherine Tamale
Last name: Ndagire
Citizenship: Ugandan
Gender: Female
Degree program for training: M.Sc.
Program areas / Discipline: Food Science & Technology
Host Country Institution to benefit from training: Makerere University, Uganda
University to provide training: Makerere University
Supervising CRSP PI: Dorothy Nakimbugwe
Start date: August 2009
Project completion date: May 2011
Type of CRSP Support (full, partial or indirect): Partial

Trainee #6
First and given names: George
Last name: JJagwe
Citizenship: Ugandan
Gender: Male
Degree program for training: M.Sc.
Program areas / Discipline: Ag. Economics & Agribusiness *or* Ag. Extension & Education
Host Country Institution to benefit from training: Makerere University, Uganda
University to provide training: Makerere University
Supervising CRSP PI: Dorothy Nakimbugwe
Start date: August 2009
Project completion date: August 2011
Type of CRSP Support (full, partial or indirect): Partial

Contribution of Project to Target USAID Performance Indicators

- Six scientists will undergo degree training (two female, three male) during this budget cycle at Makerere University (three M.S.) and Iowa State University (three Ph.D.).
- We expect 67 farmers (56 female, 11 male) to participate in advanced training regarding production, harvesting, and post-harvest methods in Uganda.
- Important technologies and management practices that are under research or field testing are:
  - Protocols for matching bean varieties with agro-ecological regions and growing conditions (soil nutrients, amendments, and moisture) for optimum physiology (plant growth and development) and yield (seed number, size, and nutrient composition)
  - Post-harvest handling and storage training techniques being adapted and further development, incorporating results of project research
  - Protocols for producing bean flour, extruded bean snack and extruded instant bean flour
  - Recipes utilizing bean flour
  - Protocols for bean flour-based products
  - Improved market information system
  - Marketing plans for farmers and farmer organizations
- We expect these approaches to be at or near readiness for transfer for use by Host Country farmers or researchers during this phase of the project. We plan to demonstrate and disseminate these management practices and technologies to wider audiences.
- We expect that 67 households will benefit directly from our training and support program. The train-of-trainer approach utilized will ultimately benefit many more farm households.
- Two agricultural enterprises will benefit from the increased volume of product marketed and available for processing.
- We expect that all six participating producer organizations, two marketing associations, and an additional six producer organizations will receive useful and actionable technical assistance. All of these organizations have a significant or majority of women members.

- We expect that four Host Country partner organizations/institutions will benefit from these activities (two universities, one NARO, and one NGO).
- We anticipate that an additional 15 acres will be cultivated using improved technologies by during this phase of the project.

Target Outputs

- Reports regarding recommended practices for crop production, and both pre- and post-harvest management procedures to improve quality of harvested beans and increase yields
- Training manuals (for VEDCO's Rural Development Extensionists, farm group members, etc.)
- Stronger links between farmers groups and associations to diverse types of buyers, including the food processing industry
- Reports of superior processing methods to protect protein and carbohydrate digestibility
- Recipes for widespread use, including for nutritionally vulnerable people
- Protocol for bean flour processing promoted for commercialization
- New value-added bean products designed for identified consumer markets

Engagement of USAID Field Missions

USAID agricultural initiatives in Africa seek to build economies, establish and enhance partnerships, and harness science and technology to meet the needs of the vulnerable and impoverished. This project will help USAID meet its goals for improved well-being in Uganda and Rwanda through agricultural activities designed to promote best practices, develop and market nutritious bean-based value-added products, and successfully link farmers and producers to markets. We will meet periodically with Mission staff devoted to realization of their agriculture-related strategic objectives (SO 617-007 Economic Growth, Agriculture and Trade in Uganda) and SO 696-007 (Economic Growth, Agriculture and Trade) in Rwanda. We will also invite them to project-sponsored activities and share results of our research-development activities.

Networking Activities with Stakeholders

To realize project objectives and actively promote institutionalization of positive impacts of research project finds and impacts, we will effectively engage diverse key stakeholders throughout the project and in annual workshops:

- Work with farmers, groups and associations to understand local livelihoods, agronomic practices, their previous and current linkages with various types of institutions and service providers (governmental and non-governmental), private sector traders, and transporters
- Interact regularly with various types of institutions and service providers (governmental and non-governmental), private sector traders, transporters, small, medium and large scale processors and distributors etc., to gain and maintain appropriately broad perspectives on key issues in the value chain, benefit from their special expertise, and build consensus and collaborative relationships for high levels of continued success

- Hold periodic planning and review meetings to involve all partners so that challenges and constraints are discussed and strategies to deal with them developed together
- Facilitate broad involvement in research design, data collection instruments and processes, and data analysis
- Share results from various stages of the project to encourage constructive criticism and strengthen usefulness, impact and sustainability of intervention results
- Involve other developmental partners with similar interests for complementarily and dissemination of results to other areas and countries
- Project results will be shared with the research and developments communities in Uganda, Rwanda and the region through workshops and various types of publications

Leveraging of CRSP Resources

- In addition to the direct collaboration between food scientists in Uganda, Rwanda and the U.S. in this project, link work done by NaCRRI and ISU with ISAR (Institut des Sciences Agronomiques du Rwanda) and MSU through a linkage with the Pulse CRSP project directed by James D. Kelly
- Iowa State University is contributing to partial support for two Ph.D. students from Uganda
- Explore bases for possible collaboration with relevant USAID-funded projects in Uganda and Rwanda, as well as other relevant projects in these countries
- Identify, with Mission staff, the potential for an Associate Award
- Explore possibilities of funding from members of the bean producer and processor industry
- Work to identify agencies that may fund related research, training and outreach and prepare proposals as appropriate

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 - September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: **Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda**
Lead U.S. PI and University: **Robert Mazur, Iowa State University**
Host Country(s): **Uganda, Rwanda**

Output Indicators	2011 Target (Oct. 1, 2010 - Sept. 30, 2011)	2011 Actual (Oct. 1, 2010 - Sept. 30, 2011)
Degree Training: Number of individuals enrolled in degree training		
Number of women	2	
Number of men	3	
Short-term Training: Number of individuals who received short-term training		
Number of women	56	
Number of men	11	
Technologies and Policies		
Number of technologies and management practices under research	5	
Number of technologies and management practices under field testing	10	
Number of technologies and management practices made available for transfer	0	
Number of policy studies undertaken	0	
Beneficiaries:		
Number of rural households benefiting directly	67	
Number of agricultural firms/enterprises benefiting	2	
Number of producer and/or community-based organizations receiving technical assistance	16	
Number of women organizations receiving technical assistance	16	
Number of HC partner organizations/institutions benefiting	4	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	15	

Dry Grain Pulses CRSP : SECOND PERIOD (FY11)

Enhancing Nutritional Value and Marketability on Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda

	10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	ISU	0	Makerere U.	NaCRRI	VEDCO	Kigali Inst.
a. Personnel Cost						
Salaries	$3,790.00	$19,996.00	$18,300.00	$4,800.00	$14,400.00	$4,500.00
Fringe Benefits	$285.00	$2,639.00				
b. Travel	$9,150.00	$0.00	$9,560.00	$9,820.00	$2,500.00	$2,563.00
c. Equipment ($5000 Plus)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
d. Supplies	$4,500.00	$0.00	$9,750.00	$2,250.00	$15,502.00	$8,000.00
e. Training						
Degree	$1,855.00	$9,334.00	$8,750.00			
Non-Degree						
f. Other	$474.00	$0.00	$1,000.00	$900.00	$250.00	$750.00
g. Total Direct Cost	**$20,054.00**	**$31,969.00**	**$47,360.00**	**$17,770.00**	**$32,652.00**	**$15,813.00**
h. Indirect Cost	$4,732.00	$5,885.00	$4,736.00	$1,777.00	$3,265.00	$1,581.00
i. Indirect Cost on Subcontracts (First $25000)						
j. Total Indirect Cost	$4,732.00	$5,885.00	$4,736.00	$1,777.00	$3,265.00	$1,581.00
Total	**$24,786.00**	**$37,854.00**	**$52,096.00**	**$19,547.00**	**$35,917.00**	**$17,394.00**
Grand Total	$187,594.00					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$20,054.00	12.11%
Total direct cost budgeted for H.C institution(s)	$145,564.00	87.89%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$13,167.00						$ 13,167.00
Cash							$ -
Total	$ 13,167.00	$ -	$ -	$ -	$ -	$ -	$ 13,167.00
Attribution to Capacity Building							
Percentage of effort	86.98%	100.00%	88.81%	83.12%	81.62%		80.62%
Amount corresponding to effort	$21,553.91	$37,854.00	$46,266.46	$16,247.47	$29,315.46	$0.00	$151,237.29

U.S Institution PI: Dr. Robert Mazur, Professor of Sociology, Iowa State University

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

FY 2011 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: ***Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda***

	Abbreviated name of institutions											
	Iowa State		Makerere		NaCRRI		VEDCO		KIST			
Identify Benchmark Indicators by Objectives	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11
Objective 1	***Improve Bean Yield and Quality***											
1a. Variety performance and fertility responses analyzed	X				X							
1a. Biological & agronomic controls for pests & diseases initiated	X				X		X					
1a. Variety perform., fertility respon., bio. & agron. controls analyzed		X				X						
1a. Best performing bean varieties reported to breeders		X				X		X				
1a. Seeds provided for post-harvest storage studies						X		X				
1b. Training in group dynamics & mgmt. practices for quality seed					X		X					
1b. Exchange visits to established seed production programs					X		X					
1b. Extension guide for bean CBSP initiated and tested					X		X					
1b. Linkages establ. for breeders, seed processors, marketers						X		X				
1b. Seed storage facilities established						X		X				
1c. Effects of solarization on germination and storage evaluated	X				X		X					
1c. Farmers trained in effective use of solarization technique					X		X					
1c. Polyethylene for solarization distributed to farmers groups					X		X					
1c. Barriers to adoption of solarization identified and resolved	X				X		X					
1c. Storage techniques evaluated for pest control and germination		X				X		X				
1c. Farmers trained in new solar techniques						X		X				
1c. Storage materials produced and distributed to farmers						X		X				
1c. Training in mananging bulking facilities completed						X		X				
1d. Exchange visits of other farmer groups conducted					X		X					
1d. Contacts establ. w/ districts to scale technologies & practices						X		X				
1d. Stakeholder workshop to review bean prod. training materials		X				X		X				
1d. Extension materials translated and published						X		X				
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***											
2a. Documented diet-related health disorders in Uganda/Rwanda			X						X			
2a. Consumer levels & trends of buying & using beans documented			X						X			
2a. Identified complementary foods to increase nutritional benefits	X		X						X			
2a. Cold extruded bean products & process developed at KIST									X			
2a. Bean-based weaning foods developed for Uganda & Rwanda		X		X						X		
2a. Extension approaches indentifed and content developed		X		X				X		X		
2a. Farmers trained in bean cold extrusion processing										X		
2a. Baseline nutritional status established for feeding studies		X		X						X		
2b. Analysis protocol for culinary properties obtained			X						X			
2b. Analysis of desirable culinary traits of current varities initiated			X						X			
2b. Culinary traits & sensory char. of current varieties documented		X		X						X		
2b. Analysis of culinary traits & sensory char. of improv. var. initiated				X						X		
2c. Tech. incubation & transfer models identified and modified				X								
2c. Local & int'l industries as potential markets for beans identified				X								
2c. Private industry interest/conditions to adopt bean tech. evaluated				X								
2c. Links establ. btw. farmers' assoc. & private industries				X		X		X				
2c. Protocols for value-addition w/ private sector partners initiated				X								
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***											
3a. Farmer groups' composition, roles, assets, capabilites identified							X					
3a. Farmer groups' needs determined and prioritized		X						X				
3b. Farmers trained in group/assoc. dynamics and gender equity							X					
3b. Partner meetings held in two sub-counties			X				X					
3b. Participatory market research groups formed			X				X					
3b. Market chain analysis for bean enterprises conducted		X		X				X				
3b. Market information sources assessed		X		X				X				
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***											
4. Training M.S. (FST and AgEcon) at MAK on-going			X									
4. Training M.S. student in FST from Rwanda on-going			X						X			
4. Training M.S. students at Makerere University completed				X						X		
4. Training Ph.D. students at Iowa State University ongoing	X	X										
4. Inter-organizational learning fostered	X	X	X	X	X	X	X	X	X	X		
4. Prelim. results disseminated (conf., public., websites)		X		X		X		X		X		

Name of the PI responsible for reporting on benchmarks	**Robert Mazur**	**Dorothy Nakimbugwe**	**Michael Ugen**	**Henry Kizito Musoke**	**Hilda Vasanthakaalam**	
Signature/Initials:						

Date: _____

P2-MSU-1

Combining Conventional, Molecular and Farmer Participatory Breeding Approaches to Improve Andean Beans for Resistance to Biotic and Abiotic Stresses in Ecuador and Rwanda

Lead U.S. Principal Investigator
James D. Kelly, MSU

Collaborating Scientists
Cornell, INIAP-Ecuador, ISAR-Rwanda

Project Problem Statement and Justification
Common bean (*Phaseolus vulgaris* L.) is the most important grain legume (pulse) consumed in Ecuador, and the most important protein source in Rwandan diets. Around 120,000 hectares of beans are cultivated annually in Ecuador, and common bean is the most widely grown pulse in Rwanda on 300,000 hectares. Both bush and climbing beans constitute an important economic income for farmers, and staple food for thousands of Ecuadorian families, and the vast majority of small scale farmers in Rwanda. Improvement of bean genotypes for Ecuador environments has a potentially significant spinoff in terms of the high potential for adaptation to Rwanda upland farming systems, which is one of the most bean-dominated production areas in the world. Smallholder farmers, many of them widows supporting families, are keenly interested in rebuilding their bean genetic stocks and expanding into new market opportunities as stability has returned to their country. Building on international bean germplasm, but particularly on the Ecuador experience and germplasm, a tremendous opportunity is present to develop and deploy improved bean varieties in Rwanda, using the latest molecular and client-oriented plant improvement techniques. An improved understanding of plant traits and genotypes with resistance to multiple stresses from abiotic (e.g. drought) and biotic (root rot and foliar pathogens) sources should provide unique materials for small-scale farmers, while providing insights into plant tolerance mechanisms for enhanced plant breeding methods. Results of this project would contribute to improved yield, farm profitability and human resources in the host countries and indirect benefit to participating U.S. Institutions and bean producers.

Planned Project Activities

Objective 1: Develop through traditional breeding and marker-assisted selection (MAS) in a range of large-seeded Andean bean germplasm with differing combinations of resistance to major foliar and root diseases in contrasting bean growth habits for distribution and testing in the highlands of Ecuador, Rwanda and the Midwestern U.S.

Collaborators
Augustine Musoni, Louis Butare – Rwanda
Eduardo Peralta - Ecuador
George Abawi – Cornell
Sieg Snapp - MSU

Approaches and Methods

1. Continue to select parental breeding materials for crossing in Ecuador, Rwanda and U.S.
2. Expand group of lines from Rwandan breeding for crossing with new introduced differential lines from Ecuador, MSU, UPR and CIAT/PABRA.
3. Cross Rwandan sources of resistance for bean common mosaic virus (BCMV), angular leaf spot (ALS), rust, anthracnose, Fusarium wilt and Pythium and major foliar pathogens into large seeded lines with contrasting colors.
4. Confirm resistance of selected parental lines to target root pathogen(s) including Macrophomina in screenhouse/greenhouse tests, as needed in Rwanda or at Cornell.
5. Utilize markers in early-generation selection for major disease resistant traits in Ecuador and conduct inheritance studies in the greenhouse for anthracnose in Yunguilla and rust resistance in JE.MA.
6. Initiate marker-assisted selection at one central lab (Rubona) in Rwanda.
7. Yield evaluation of advanced lines in range of seed types in Ecuador, Rwanda and U.S. and continue to exchange most promising materials among the three breeding programs.
8. Initiate characterization of biofortified lines for Fe and Zn for use as parents in Ecuador.
9. Continue seed increase of most promising lines in all three countries.
10. Expand on farm trials with advanced lines in Rwanda and Ecuador.
11. Release elite climbing and bush beans bean varieties in different commercial types across agro-ecological zones in Rwanda; and a bush bean variety with broad disease resistance for production in Ecuador.

Objective 2: Develop inbred backcross lines in a range of commercial seed types for testing under drought and root rot pressure in Ecuador, Rwanda and the U.S.

Collaborators

Augustine Musoni, Louis Butare – Rwanda
Eduardo Peralta - Ecuador
George Abawi – Cornell
Sieg Snapp - MSU

Approaches and Methods

1. Evaluate specific populations developed at CIAT and MSU/Ecuador at two sites for reaction to drought and non-stress in Rwanda.
2. Continue with the selection of lines with tolerance to drought and root rots in Ecuador.
3. Evaluate sub-set of best drought tolerant lines from thesis study of Louis Butare at two locations in Rwanda; and those lines that become available from other sources (to be identified).
4. Continue characterization of new local traditional lines (bush, climbers) collected from growers in Ecuador to determine level of drought tolerance and root rot in Tumbaco.

5. Complete survey to identify field sites for root rot evaluation (Pythium, Fusarium wilt and Macrophomina), and initiate screening of promising germplasm in Rwanda. Field identification will be accomplished by surveys or bioassay of soil samples with beans (known to be susceptible to target pathogens) in greenhouse/screenhouse tests.
6. Field trials and greenhouse screening will be conducted to identify root rot resistance sources in Ecuador and Rwanda.
7. Characterize germplasm for reaction to individual root pathogens at Cornell using selected promising germplasm for Rwanda, Ecuador, MSU and TARS (UPR).

Objective 3: Collect and characterize pathogenic and genetic variability of isolates of root and foliar pathogens in Ecuador and Rwanda.

Collaborators
Augustine Musoni, Louis Butare – Rwanda
Eduardo Peralta - Ecuador
George Abawi – Cornell
Sieg Snapp - MSU

Approaches and Methods
1. Continue surveys to diagnose major root diseases in Rwanda and collect isolates of root pathogens for additional characterization.
2. Maintain the collection of root rot isolates previously collected in different production zones of Ecuador
3. Further characterization of root rot isolates collected previously in both Northern and Southern production regions of Ecuador at Cornell and/or Ecuador.
4. Phenotypic evaluation of Rwandan germplasm for resistance to local isolates of anthracnose, ALS and BCMV under field conditions.
5. Continue the collection of isolates of anthracnose, and ALS in Rwanda and Ecuador from diverse agro-ecological zones for race typing.
6. Increase seed of the differentials for anthracnose, ALS and rust in Rwanda; and continue characterization of ALS in Ecuador. Continue race characterization of Fusarium wilt pathogen and the aggressiveness of isolates of Macrophomina, Rhizoctonia, and F. solani will be conducted on selected bean germplasm.
7. In Rwanda, document and summarize past studies on mapping and/or variability of Fusarium wilt, Pythium, ALS, anthracnose by CIAT/ISAR and MS theses since many of the studies are in French.
8. Continue to document and publish results of recent and on-going breeding activities in Rwanda.

Objective 4: Employ participatory plant breeding and agroecological methods to assist the breeding process in Ecuador and Rwanda to enhance productivity and market quality of beans under development.

1. Design and validate sustainable farming practices including integrated crop management systems for smallholder farmers in Rwanda. Prepare and distribute a report on the cropping system survey and literature review outputs from prior

workplan, as a foundation for participatory on-farm bean cropping system assessment.

2. Compare and contrast advanced line selection practiced by breeders and farmers in high-altitude agroecological regions in Rwanda.
    - Plan genotype by environment farmer participatory assessment of advanced lines within intercrops and sole crops, and initiate trials in 2010.
    - On-farm assessment at pilot basis start during main growing season of 2009 with baseline and set up of one set of station and on-farm trials for second season in 2010, expanded on-farm trials in February 2011.
3. Evaluation of 17 tests with 17 CIALs each growing cycle in Ecuador.
4. Expand non-conventional and conventional seed production in Ecuador and Rwanda.
5. Release two bush beans and one climbing bean in Ecuador using farmer participatory approach.
6. Continue evaluation of advanced lines for canning quality in Ecuador.
7. Provide seed of elite and new varieties for post harvest quality evaluation at KIST in Rwanda.
8. Organize a visit of scientist(s) from Ecuador to Rwanda to interchange experiences on population management, germplasm bank, evaluation of early generation materials at different stations; interchange of experience on farmer participatory and seed production. (Depending on additional funding from CRSP).
9. Initiate interchange of experience in Rwanda on participatory methods and seed production for local community use with smallholder farmer members anticipated date August 2010. Training of trainers (extension, research technicians, NGO staff, expert farmers, seed company technicians) on seed and farming system production, and work with progressive farmers. This activity will be coordinated with root health workshop planned for late 2010.

Objective: Training

MSU Doctoral student, Gerardine Mukeshimana in plant breeding and genetics will conduct field research on drought resistance on genetic population(s) in Rwanda. A second doctoral, student Krista Isaacs from the US initiated field research on participatory research in Rwanda. A third student from Rwanda selected for training in participatory plant breeding and agroecology at MSU will start in 2011 – a suitable candidate is being identified by ISAR. Consideration will be given to short term training of a student from Rwanda in plant pathology if a suitable candidate a/o technician can be identified.

Degree Training

First and Other Given Names: Gerardine
Last Name: Mukeshimana
Citizenship: Rwandan
Gender: F
Degree Program for training: Doctorate
Program Areas or Discipline: Plant Breeding and Genetics
Host Country Institution to Benefit from Training: National Univ. Rwanda
University to provide training: MSU
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Yes
Supervising CRSP PI: James D. Kelly
Start Date: August 2008
Projected Completion Date: September 2011
Type of CRSP Support (full, partial or indirect): Full
If providing Indirect Support, identify source(s) of leveraged funds
Amount Budgeted in Workplan, if providing full or partial support:$30,000
Direct cost: $30,000
Indirect cost: $15,600
U.S. or HC Institution to receive CRSP funding for training activity: MSU

First and Other Given Names: Krista
Last Name: Isaacs
Citizenship: US
Gender: F
Degree Program for training: Doctorate
Program Areas or Discipline: Participatory plant breeding and nutrition
Host Country Institution to Benefit from Training: Indirect benefits for National Univ. Rwanda
University to provide training: MSU
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Not applicable
Supervising CRSP PI: Sieglinde Snapp
Start Date: January 2010, student was funded from other sources prior to this date
Projected Completion Date: May 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds: U. S. Department of Education's Fulbright-Hays Doctoral Dissertation Research Abroad (DDRA) Program.
Amount Budgeted in Workplan, if providing full or partial support: $30,000
Direct cost: $30,000
Indirect cost:$15,600
U.S. or HC Institution to receive CRSP funding for training activity: MSU

Short-term Training

Type of training: Workshop on Participatory plant breeding in Rwanda; Molecular marker-assisted selection – MAS workshop planned for 2010.
Description of training activity: Organize and conduct participatory plant breeding and hands-on root/soil health training workshops in Rwanda planned for third year in 2010, but may be offered in 2011 if not conducted in 2010. The root/soil health training will be planned as a train-the-trainer workshop for research, extension and NGO's personnel. The MAS workshop will depend on having trained scientists in Rwanda to conduct the workshop in addition to identifying suitable group of trainees from within ISAR, NGOs and NUR.

Location: Rubona, Rwanda
Duration 4-5 days
Scheduling of training activity
Participants/Beneficiaries of Training Activity
Anticipated numbers of Beneficiaries (male and female) 30
Amount Budgeted in Workplan $7,000
Direct cost: $7,000
Indirect cost:
If Leveraged Funding is to be used to Support this Training Activity, indicate the Source and Amount

Equipment: ISAR requests financial assistance ($15,000) to construct a new more spacious and modern screenhouse at Rubona. The one that is currently used is shared with other programs that were involved in sharing the costs for its rehabilitation, notably Sweetpotato program under CIP support. The new structure is intended to accommodate both crossing and diseases inoculation trials that can supplement/complement both conventional, FPVS and MAS. The ISAR technicians and intern students from collaborating universities (UNR, UPU, ISAE etc) that would be trained in pathology techniques would then regularly use the facility. This would greatly improve the selection efficiency in the breeding program.

Contribution of Project to Target USAID Performance Indicators

Two women are currently in doctoral degree training, and plans exist for short term training for other female technicians in the program. The scientific assistance provided to farmers is shared among men and women as both genders are active in bean production in both Ecuador and Rwanda. Completion of the project will also contribute to the increased sustainability of bean production in Rwanda and Ecuador.

Target Outputs

1. The development and release of locally adapted, acceptable and disease resistant bean cultivars for the major production regions in Rwanda, Ecuador and Michigan.

2. Increased sustainable productivity and profitability of bean production due to increased yield, improved understanding of agroecology diversity interactions with bean cropping system resilience, and reduced reliance on inputs.

3. Improved grower income and stability of bean production will contribute to better nutrition and health of farm families.

4. Increased awareness and knowledge of participatory breeding methods, nutrition, root and soil health issues will further improve bean productivity, long-term land management, environmental risk, thus contributing to sustainability of bean production and agricultural communities and improved dietary patterns.

5. Identification of germplasm sources that are of benefit in the improvement of selected bean traits for the U.S. market.

6. Enhanced human resource development, gender equity and improved infrastructure capacity of participating institutions in Rwanda and Ecuador.

Engagement of USAID Field Mission(s)
The PI and HC PI visited the USAID field mission in Kigali in May 08 and January 09 to describe the CRSP program and update them on status of the current work in Rwanda. Met with the Mission Director in Quito in April 2010.

Networking Activities with Stakeholders
ISAR, Government Extension, Farmers cooperatives and seed production agencies; increasing use of radio and television for the promotion of new bean varieties in Rwanda. NGO in Rwanda; World Vision, CARE, ADRA, CARITIUS, Catholic Relief Services, DERN; Cooperatives in Rwanda (COAMV in the North; RDO in the East; Rwanda Seed Company – RWASCO), Iterambere ry'Abahinzi Borozi Muhanga (IABM) (South), RADA (Development Authority- Country-wide), District and local Government Extention Agents (Country-wide), Musasu Watershed (south), Sogwe Watershed farmers Cooperatives (South), Gakiragi Watershed Cooperative (East), Umutara Polytechnic University (East), IMBARAGA (Umbrera farmer organization in the country), Government Prisons Services in East, South), Food Processing Industry in Butare (Huye), Kigali Institute of Technology (KIST), Higher Training Institute of Agriculture and Livestock (ISAE), Private farmers in different parts of the country, to mention a few.
NGO in Ecuador; PRODECI, FEPP-Forcafrejol, Technical Committee of Beans. Agricultural Organizations; Ecuadorian Cooperation of Legume Producers and Industry (Corporación Ecuatoriana de Productores y Comercializadores de Leguminosas), 17 CIALs, CORPOCIALs, (Chota, Mira, Salinas, Intag, Pallatanga), Grupo de Evaluadores de Frijol de Bolivar, Assoc. de Productores de Frejol de INTAG. Government Organizations; MAGAP, MIES, INIAP, Univ. Private companies: involve in purchase and sale of bean seed, companies involved in canning industry.

Leveraging of CRSP Resources
In Rwanda, funding was secured through AGRA – Alliance for a Green Revolution in Africa and PABRA network. Funding prospects from Harvest Plus and Kirkhouse Trust and the Nitrogen fixation CRSP project with Iowa State University to the bean breeding program are also at advanced stages in Rwanda. In Ecuador: Support from the National Government to the bean program in INIAP (Strengthening Research and Development) is very important. Economic help direct from NGOs projects of social reconversion of the external debt (Funds from Italy-Ecuadorian through local governments) to bean producer organizations in the northern zone is very important (threshers, post harvest equipment, help centers, seed production with CIALs, offer to purchase high quality commercial seed by Government Food Programs at Farmer/ Community Agricultural Shows).

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
October 1, 2010-- September 30, 2012)

PERFORMANCE INDICATORS/TARGETS
sistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title:
Lead U.S. PI and University:
Host Country(s):

Output Indicators	2011 Target (Oct 1 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals who have received degree training		
Number of women	2	
Number of men	1	
Short-term Training: Number of individuals who have received short-term training		
Number of women	4	
Number of men	4	
Technologies and Policies		
Number of technologies and management practices under research	17	
Number of technologies and management practices under field testing	14	
Number of technologies and management practices made available for transfer	16	
Number of policy studies undertaken		
Beneficiaries		
Number of rural households benefiting directly	5800	
Number of agricultural firms/enterprises benefiting	27	
Number of producer and/or community-based organizations receiving technical assistance	117	
Number of women organizations receiving technical assistance	51	
Number of HC partner organizations/institutions benefiti	40	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	20500	

Dry Grain Pulses CRSP FY2011 Budget

Combining Conventional, Molecular and Farmer Participatory Breeding Approaches to Improve Andean Beans

	10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	Mich. State Univ	Rwanda	Cornell Univ.	Ecuador	Rwanda	
a. Personnel Cost						
Salaries	$11,536	$18,888	$12,626.00	$8,000	$20,000	
Fringe Benefit	$2,815	$1,956	$5,934.00			
b. Travel	$8,196		$5,000.00	$5,000	$5,000	
c. Equipment ($5000 Plus)						
d. Supplies	$6,500		$3,440.00	$20,000	$10,000	
e. Training						
Degree		$10,005				
Non-Degree				$2,000	$5,000	
f. Other			$1,000.00			
g. Total Direct Cost	**$29,047**	**$30,849**	**$28,000.00**	**$35,000**	**$40,000**	**$0**
h. Indirect Cost	$15,104		$7,000.00			
i. Indirect Cost on Subcontracts (First $25000)						
j. Total Indirect Cost	$15,104	$0	$7,000.00	$0	$0	$0
Total	**$44,151**	**$30,849**	**$35,000.00**	**$35,000**	**$40,000**	**$0**
Grand Total	$185,000					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$59,896	36.77%
Total direct cost budgeted for H.C institution(s)	$103,000	63.23%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$10,000.00		$8,250.00	$5,000.00	$5,000.00		$ 28,250.00
Cash							$ -
Total	$ 10,000.00		$ 8,250.00	$ 5,000.00	$ 5,000.00	$ -	$ 28,250.00
Attribution to Capacity Building							
Percentage of effort	50.00%	100.00%	25.00%	25.00%	25.00%		43.47%
Amount corresponding to effort	$22,075.72	$30,849.00	$8,750.00	$8,750.00	$10,000.00	$0.00	$80,424.72

Name of PI & Institutional Affiliation: James D. Kelly, Michigan State University

Dry Grain Pulses CRSP

Report on the Achievement of "Semi-Annual Indicators of Progress"

(For the Period: September 1, 2010 -- September 30, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2011

Project Title:

	Abbreviated name of institutions											
	MSU			Cornell			Ecuador			Rwanda		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	10/1/11	Y	N*	10/1/11	Y	N*	10/1/11	Y	N*	10/1/11	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)											
Objective 1												
Review breeding program												
Andean bean nursery-Increase												
Plant Andean nursery												
Selection parental lines												
Selection elite lines	x											
Nursery evaluation							x			x		
crossing	x						x			x		
Marker assisted selection	x						x			x		
Advanced yield trials	x						x			x		
On farm trials	x						x			x		
Biofortification for Fe, Zn							x			x		
Canning and quality evaluation	x						x			x		
Variety Release	x						x			x		
Objective 2												
Advanced Population development	x						x					
Test Populations in Rwanda										x		
Other population development	x						x					
Characterize CIAT resistance sources										x		
Increase, characterize local germplasm							x					
Evaluation for drought and root rot				x			x			x		
Characterize germplasm to root pathogens	x			x			x			x		
Objective 3												
Survey root pathogens in Rwanda				x						x		
Characterize root rot isolates				x*			x			x		
Root Pathogen x germplasm interaction				x			x					
Collect foliar pathogens in Rwanda	x									x		
Race characterization	x			x			x			x		
Objective 4												
Visit of Rwandan scientists to Ecuador							x			x		
Workshop Participatory in Rwanda												
Evaluation of elite lines in CIALs							x			x		
Variety releases in Ecuador							x					
Farmer vs. Breeder Selection												
Evaluation of climbing beans				x			x			x		
Sustainable practices, nutrient mgt										x		
Name of the PI reporting on benchmarks by institution	James D. Kelly			George Abawi			Eduardo Peralta			Augustine Musoni		

Name of the U.S. Lead PI submitting this Report to the MO: James D. Kelly

James D. Kelly

Signature _____ Date _____

* *Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

* Assist and facilitate the characterization of root rot pathogens

P2-MSU-2

Expanding Pulse Supply and Demand in Africa and Latin America: Identifying Constraints and New Strategies

Lead U.S. Principal Investigator(s)

Richard H, Bernsten, Cynthia Donovan, and Eric Crawford Michigan State University

Collaborating Scientists

David Kiala, University Agostinho Neto, Angola
Feliciano Mazuze, Mozambican Institute for Agricultural Research (IIAM)
Juan Carlos Rosas, Escuela Agricola Panamericana (Zamorano, EAP), Honduras

Project Problem Statement and Justification:

Angola: Common beans and cowpeas are important crops for smallholder farmers in Angola, with approximately 36% of households in a recent survey indicating that common beans were the most important source of cash income from crops. About two-thirds of household production was sold, for those households growing beans. However, marketing constraints are clearly found in surveys in the Planalto region of the country. Looking more specifically at common beans, we find that many farmers sell into the local markets at harvest time simply because of convenience. Farmers who sell in more distant markets (27% of farmers in the region, based on survey estimates) indicate that they choose those markets in order to get higher prices, but they have transport expenses, as well as information constraints, making this marketing more costly. Some 28 percent of farmers determine when to sell their beans based on price, yet the information available to help guide this choice is limited to mostly friends, family and local traders.

A key question is whether or not there are areas for greater efficiency in the marketing system that would enable Angolan farmers to contribute greater amounts, substituting for imported beans as well as meeting unmet needs in the urban areas for the quality of beans demanded. Preliminary market research indicates a preference for local varieties, yet smalholder farmers in the Planalto region lack marketing strategies to reach those markets and trade organization appears weak, implying high transaction costs. There are three key marketing months for beans: January, February and June, and research is needed to track the beans through the marketing channels and identify the costs and margins at each transaction level.

Research conducted in the first phase of this project demonstrates the importance of bean marketing for farmers, highlights key aspects on how they market, and identifies the key marketing channels. Phase II of the research and training will identify the costs associated with the marketing channels, identify potential sources of information, and work with local organizations to ameliorate the information gaps which are reducing profitability and overall transactions for beans and cowpeas.

Mozambique: In Mozambique, both cowpeas and common beans are marketed by smallholder producers, and the local market information system (SIMA) shows high seasonality in prices for the common bean, whereas cowpeas tend to have less dramatic

variability, with more flexibility in planting seasons and locations. Cowpeas and common beans have different marketing channels, and the preliminary research on this with the market information system indicates that wholesale common bean traders often do not work with cowpeas or other legumes and prefer to specialize. Cowpea markets tend to be more localized, but recent developments suggest that new markets for processing may be arising. Research is needed to identify any new portions of the value chain for cowpeas, as well as track the costs occurring through the various channels, both for cowpeas and common beans. The formation of the bean task force was delayed from Phase I, but will be part of the efforts in the closing months of Phase I and then into Phase II of the MSU Pulse CRSP activities.

Some common bean traders have demonstrated innovations to gain efficiencies in their trading, using cell phones and automatic 24-hour banking machines. Understanding these innovations as well as traditional marketing channels for local markets will help to identify where farmers can improve their interactions with markets. Cowpeas tend to be more frequently traded in local markets, and research will focus more on these market channels as well.

Phase I research has identified the basic marketing channels, demonstrated differing seasonal price patterns for cowpeas and common beans, and evaluated where the beans and cowpeas of grown and marketed. Since cowpeas are generally grown in different agroecological zones than common beans, and cowpeas have a lower overall marketed volume, it will require additional time in markets outside the common bean markets. Phase II will also link the Pulse CRSP activities with those of other Pulse CRSP activities in Mozambique as well as with PABRA network activities to enhance farmer access to appropriate information on markets, including varietal choices and prices in different key markets. Cellphone technology is coming to SIMA and bean farmers will be among the first to be trained in using the technology once it is functioning.

Honduras: Small bean farmers in Honduras face rising input costs and lack access to profitable markets for selling their beans. During Phase 1, field trials identified promising organic production practices for reducing input costs; and a buyer (Whole Foods Market) was contacted who is interested in purchasing/importing fairtrade beans. During Phase 2, the project will continue to validate organic production practices, finalize third-party certification arrangements, and initiate exports of fair trade beans to the US.

Planned Project Activities

In all three countries, this research will seek to continue our work on markets and focus on identifying potential market enhancements for smallholders in Angola, Honduras and Mozambique. In Mozambique and Angola, a key aspect will be establishing a data bank with information on beans and cowpeas.

Angola and Mozambique: During Phase I of the Pulse CRSP, research in both Mozambique and Angola sought to describe and understand bean producers and their relationship to markets. There is substantial analytical work that will be completed in the next few months, but existing analysis for farmers and trading systems in Mozambique

and in Angola has highlighted some key features of bean production and marketing. Beans are seen as a cash crop by many farmers; trade networks are responsive to change; traders travel long distances and may specialize in beans; traders are adapting to new technologies and services (for example, cell phones and automatic teller machines at banks); and farmers make investments in improved varieties. Given what we are learning with this early work, we have identified the need to address efficiency concerns in marketing, both by traders and by farmers.

In both Mozambique and Angola, we will continue to provide training workshops and guidance on value chain research for common beans and cowpeas, including price analysis, partial budgeting on technologies, survey research methods, cost benefit analysis, and market cost structure. The two graduate students undertaking MS studies will finish their programs and return to their home countries in late-2011 to conduct outreach as well as additional research on pulses. Each will help to provide skills to their institutions. Two new IIAM staff will gain English language training for future graduate studies.

Objective 1: *Angola* 1.1 Identify efficiency in marketing channels and leverage points to increase farmer profits and trader volumes.

Collaborators
David Tunga, Food Security Department (DSA), MINAGRI
JJ Ivaska, World Vision PRORENDA project, Huambo

Approaches and Methods: Our Pulse CRSP efforts will focus on understanding the market efficiency within current bean markets, differentiating the beans purchased for local consumption in urban areas of Huambo and neighboring provinces and the beans purchased for sales in Luanda, by far the most concentrated urban market. Recent research demonstrates that farmers usually sell their beans either from their farms or in local markets for the ease of sales and to meet other needs for funds. Local beans are valued in the markets, yet it is critically important to track the costs and margins down with the value chain identified in early work.

Current research is working within Huambo province to identify the marketing channels, but Phase II will include diagnostics in Luanda as well as a greater focus on the costs and time associated with the various channels. The research methodology will be structured interviews with traders and other key informants in the various segments of the value chain, a method of rapid market appraisals that have been used successfully in Mozambique. Donovan will lead the market research, and both Kiala and Donovan will participate with an Angolan research assistant as well as collaborators in implementing the survey and analyzing the results.

Objective 2: *Mozambique* 2.1 Identify efficiency in marketing channels and leverage points to increase farmer profits and trader volumes

Using results from bean market research in 2008 and additional work in May-June 2010, an additional rapid appraisal of bean markets in 2011 will be able to capture greater detail on the costs and their variability over time. Donovan will lead the work with the Mozambican market information system team and with IIAM researcher. Identification of varieties will be included in this research.

Collaborators
Jill Findeis, Pennsylvania State University; Magalhaes Miguel and Celestina Jochua, IIAM, Mozambique; Arlindo Miguel and staff at the Agricultural Market Information System (SIMA), MINAG; Stephen Boahen, IITA (Mozambique);Alda Tomo, IIAM/CESE; Billy Mwiinga, WFP Mozambique P4P coordinator

Approaches and Methods: We propose action research with farmers and traders to improve their information systems, while enhancing our knowledge of the markets and potential for growth in bean markets. To complement the farmer-level research methods used in the Pulse CRSP project, this Phase 2 research makes use of trader interviews. The market rapid appraisal in Mozambique showed us that a single market visit was insufficient. Both cowpeas and common beans have markets that shift over time and space throughout the year. To ensure repeated market and more farmer visits across the major production and consumption zones, we include a request for a vehicle for the Northwest Zonal Research Center, for the IIAM/CESE activities, due to extreme transport constraints and dispersed production zones and markets.[1]

2.2 Develop cell phone-based information system for beans, to link farmers and traders to market prices and availability

Collaborators
Arlindo Miguel and staff at the Agricultural Market Information System (SIMA), MINAG; Helder Vicente, Provincial Directorate of Agriculture, Zambézia; Alda Tomo, IIAM/CESE; Billy Mwiinga, WFP Mozambique P4P coordinator; ADRA and World Vision (NGOs)

Approaches and Methods: This new work would link to developments in Zambezia Province to enable greater communication between farmers and markets. It entails additional field interviews with traders and with farmers, with repeated observations through time, through the linkage with the market information system. We will work to establish a link with selected bean traders as key informants on the research, using cellphones. This work will build on the PABRA 2009-2013 country work plan in Mozambique and World Food Programme's Purchase for Progress (P4P). Throughout this work, there will be a focus on market demand and assessment of varietal availability. Improving knowledge of availability of quality seeds for improved varieties through

[1] The MSU project with USAID has delivered 2 vehicles to IIAM/CESE zonal centers and they have been well used for three years, effectively enabling the CESE staff to conduct critical field research which would otherwise not be possible. The management of the vehicles under IIAM zonal directors has been a positive experience.

radio and cell phone may increase their use, and we will work with the Penn State CRSP project on this aspect.

Objective 3: *Honduras*
3. 1 Conduct on-farm trials to validated organic bean production practices, including organic fertilizers and pesticides based on extracts from local plants.

3.2 Provide technical assistance to farmer group interested in establishing commercial organic bean plots.

3.3 Assist farmer groups to obtain trade certification from FLO-Cert (the international fairtrade certifying agency) or another third-party certifier (e.g., Rainforest Alliance, IMO via Whole Foods Market).

3.4 Export fairtrade beans to a US retailer.

Collaborators
To facilitate fairtrade certification of a CIAL farmers association, farmers, the project will collaborate with FL0-Cert, the Rainforest Alliance, or IMO via Whole Foods Market. To produce fairtrade beans, the project will collaborate with CIAL farmers. To facilitate government permission to export, the project will collaborate with the Honduran Ministry of Agriculture through SAG/DICTA. To facilitate exports, the project will collaborate with a local transporter and exporter (e.g., Rojitos) and Whole Foods Market (i.e., US retailer interested in purchasing fairtrade beans).

Approaches and Methods: Initially, the goal of the project was to test organic practices for producing beans, which would be certified by a third-party and exported to US distributors/retailers. Certification options included USDA-certified (organic), Rainforest Alliance certified (sustainable produced), and Fairtrade Labeling Organization (FLO-CERT) certified. Field work and meetings with farmer groups carried out during Phase I identified four major constraints: 1) three years of chemical-free production is required to gain organic certification, during which farmers would not receive a premium for their crop, 2) the farmer groups had serious concerns about implementing all of the practices required for organic certification, given that they would receive a premium of only 10%, 3) Rainforest Alliance certification required farmers to implement several new practice (e.g., soil erosion control), but market recognition of Rainforest Alliance certification and the associated premium was uncertain, and 4) as FLO-CERT had not yet established standards and a fairtrade price for common beans, FLO certification was not possible.

In late 2009, we were told that FLO had recently established standards for fairtrade beans and had authorized FLO-Cert to certify bean producers. But, to receive fairtrade certification, the farmer group must meet an exhaustive list of requirements, including that producers receive a fair price, conform to fair labor practices, directly trade their product, create a democratic and transparent organization, have a plan for community development, and follow environmentally sustainable production practices. However, as a result of direct communications with FLO-CERT (Bonn, Germany) in early 2010 it

became unclear if FLO-CERT had actually established standards and a fair trade price for common beans. Currently, we are attempting to clarify if common beans qualify as a FLO-Certified commodity. Subsequently, our US market contacts at Whole Foods Markets advised that rather than seeking FLO certification, we should explore fair trade certification through the Rainforest Alliance or IMO—both of which are acceptable certifiers for products that Whole Foods Markets sells under its *Global Certified Trade Program*.

During Phase 2, the project will continued to implement on-farm trials to test/validate promising organic bean production practices--which (during Phase 1) gave good yields and reduced farmers' cash costs--and extend these practices to farmer groups. In addition, the project will 1) finalize which type of third-party certification to pursue, work with one or more farmers groups to implement the requirements to become fairtrade certified and 2) export the beans to a US retailer—most likely Whole Foods Market, which has expressed a strong interested in purchasing fairtrade- certified beans from small farmers in Honduras.

Objective 4: *Capacity Building*
Angola: Estevao Chaves, graduate of UAN, is expected to present his research proposal and conduct his field research in Angola in mid-2011.

Donovan with a CESE staff member from Mozambique will conduct training for students at UAN/Huambo as well as IIA concerning partial budgeting. Short-term training efforts are described below. The UAN research assistant and a UAN student will travel to Mozambique to work with Cynthia Donovan and SIMA/CESE colleagues, attending a training on price analysis, while learning about the MIS system in place.

A laptop computer will be purchased for UAN research assistant to facilitate the market research and ensure access at all times to a computer. Statistical software will be included along with other basic software.

Mozambique: CESE staff member Ana Lidia Gungulo continues with her MS program at the University of Pretoria. She is expected to develop her research proposal and conduct field research in mid-2011 after her field methodology course, and then is anticipated to finish her thesis by late 2011.

Staff members of the Center for Socio-Economic Studies (CESE) will receive additional training on survey research methods (R. Bernsten responsible) for CESE staff, and price analysis with SIMA data (C. Donovan). The price analysis course will include CESE, SIMA, and UAN (Angola) participants.

For IIAM/CESE, a vehicle is requested to be able to conduct the critical bean research out of the Northwest Zonal Research Center. The common bean productions zones are in three distinct parts of agroecological Region 10 (map attached).

Honduras: At least one short term training course on production and use of organic fertilizers and pesticides from plant extracts will be conducted with farmers of the organization involved and with technicians from the NGO assisting these farmers.

Contribution of Project to Target USAID Performance Indicators

Angola: With the links with the farmer associations, we expect to be able to highlight successful marketing strategies in the local markets. We will also be working to link these associations with buyers in these markets.

Mozambique: Through the market information system of MINAG, we hope to reach producer associations in one of the main bean production zones, while also reaching other associations in the area of research of the PSU Pulse CRSP project. The research system and the groups working with it will benefit from greater understanding of market channels to target for basic types of beans and cowpeas in the near future. The policy research will target trade and investment policy actions to improve the efficiency of bean trading, first through the value chain development work, especially the price work on spatial and seasonal variability.

Honduras: The project will contribute to USAID's foreign assistance framework by providing short term training to male and female bean farmers and NGO staff, validating organic bean-production technologies/management practices, and identify new markets for fairtrade beans—which will increase farmers'/rural households' incomes.

Target Outputs

Mozambique

1) Farmers and traders in Mozambique will be better connected, ensuring market surpluses are absorbed at competitive prices, according to quality demands in the markets
2) Availability of improved seeds and their use will be enhanced through improved communications

Angola

1) In Angola, farmers will be able to market their crops to marketing channels that offer better returns

Honduras

The Project will lead to development outcomes by:

1) Testing/validating organic bean production practices,
2) Extending the organic bean production practices to farmers,
3) Assisting one or more farmer groups to become fairtrade certified,
4) Exporting fair trade-certified bean to US distributors/retailers, and
5) Completing a research paper summarizing strategies constraints and opportunities for producing and marketing organic/fair trade beans.

Engagement of USAID Field Mission(s)

Angola: The host country and US PI will meet with staff at USAID/Angola mission to update them on project activities. We will also ensure that research reports are distributed to mission staff.

Mozambique: The host country and US PI will meet with staff at USAID/Angola mission to update them on project activities. Given MSU's long term project with USAID/Mozambique, we will be able to ensure that mission staff are invited to outreach events and receive all reports produced under the Pulse CRSP activities.

Honduras: The project's host country and US PI will meet with staff at the USAID/Honduras mission to update them on project activities.

Networking Activities with Stakeholders

Angola: The project PIs will meet in Huambo with the development agencies involved in farmer productivity and market extension activities, including World Vision/Angola with its ProRenda project. The links of this work with that project enable also outreach directly to farmer associations in the Planalto Region of Angola.

Mozambique: The links with both IIAM researchers in the field and with the market information system SIMA will enable us to conduct outreach both through mass media (internet, TV, and radio) as well as to meet with farmers organizations in the regions in which beans and cowpeas are being promoted. With the research output from Phase I, it is hoped to enter Phase II with a "Feijao"[2] Task Force moving forward to help develop knowledge on the supply and demand of beans and cowpeas.

Honduras: The Project's PIs will meet periodically with staff of various HC institutions (e.g., Ministry of Agriculture and Animal Husbandry, EAP, NGOs, processors/packers, transporters, exporters, third-party certifiers) to update them regarding the actions taken by the research project and solicit their suggestions for implementation.

Leveraging of CRSP Resources

Angola: UAN is providing all salary support for Dr. Kiala. In addition, it provides vehicles for all research and work environment for Donovan while in Angola. Donovan will be able to leverage some travel to Angola with other work under a contract with World Vision in Angola. Thus, trips will be proportionately charged each time depending on work requirements and timing.

Mozambique: IIAM/CESE supports the project in various ways. Salary support for Mazuze and CESE analysts is provided through the government budget, as is work space for the activities. It provides vehicles for some of the research. For the new vehicle at the Northwest Zonal Research Center, IIAM/CESE will provide a driver, maintain the vehicle, and cover many of the other operational costs for the vehicle. The Mozambique Food Security project with USAID covers some market research costs in its support of the market information system, and where possible, costs are shared. By combining travel

[2] The word Feijão in Portuguese covers both beans and peas.

between FSG and Pulse CRSP, Donovan is often able to stretch the travel dollar to cover more trips. Alda Tomo research on beans will also have costs shared with the PABRA network activities, as we leverage those funds.

Honduras: EAP, a private university, will support the project by providing salary support for the HC-PI's participation in the project and provides access to vehicles for carrying out fieldwork. In addition, the PIs will contact several organizations to solicit leveraged funds, including the Agrobiodiversity project funded by the Norwegian Development Fund which include similar actions on organic production of beans with small farmers.

Training/Capacity Building Workplan Format

Degree Training

First Names: Ana Lidia
Last Name: Gungulo
Nationality: Mozambican
Sex: Female
Institution: University of Pretoria, South Africa
Supervising CRSP PI: Cynthia Donovan
Degree Program for training: MS
Program Areas or Discipline: Agricultural Economic
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Not applicable
Host Country Institution to Benefit from Training: IIAM
Thesis Title/Research Area: Bean and Cowpea marketing in Mozambique
Start Date: January 2009
Projected Completion Date: December 2011
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full CRSP support

First Names: Estevao
Last Name: Chaves
Nationality: Angolan
Sex: Male
Institution: Federal University of Vicosa, Brazil
Supervising CRSP PI: Cynthia Donovan
Degree Program for training: MS
Program Areas or Discipline: Agricultural Economics
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Not applicable.
Host Country Institution to Benefit from Training: University of Agostinho Neto, Angola
Thesis Title/Research Area: Bean and Cowpea marketing in Angola
Start Date: January 2009
Projected Completion Date: December 2011
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full CRSP support

Short-term Training:

Type of training: Analysis of market price data
Description of training activity: Participants will work with data from SIMA and complete analysis to understand analytical methods and research issues related to market prices
Location: Maputo, Mozambique
Duration: 1 week
When will it occur? November 2011

Participants/Beneficiaries of Training Activity: 12 (2 from UAN/Angola, 5 from IIAM, and 5 from Directorate of Economics/MINAG, which includes SIMA)
Anticipated numbers of Beneficiaries (male and female) 6 women and 6 men
PI/Collaborator responsible for this training activity: Donovan with SIMA Arlindo Miguel
List other funding sources that will be sought (if any): MSU USAID/Mozambique Food Security Project
Training justification: the training will enable researchers to use the available price information to look at markets and understand dynamics of the markets, including seasonality and spatial variability. It will provide empirical methods that can also be used by students in the UAN Program in Angola, using new price data.

Type of training: Analysis of market price data
Description of training activity: Participants will work with data from DSA or elsewhere and complete analysis to understand analytical methods and research issues related to market prices
Location: Luanda, Angola
Duration: 1 week
When will it occur? November 2011
Participants/Beneficiaries of Training Activity: 15 (10 from UAN/Angola, 5 possible DSA participants)
Anticipated numbers of Beneficiaries (male and female) 8 women and 12 men
PI/Collaborator responsible for this training activity: Donovan with SIMA/CESE staff
List other funding sources that will be sought (if any):
Training justification: The training will enable students and analysts to use the available price information to look at markets and understand dynamics of the markets, including seasonality and spatial variability. It will provide empirical methods that can also be used by students in the UAN Program in Angola, using new price data.

Type of training: Survey research methods
Description of training activity: Participants will attend sessions specific aspects of survey methods and evaluate existing survey instruments and methods in exercises
Location: Maputo, Mozambique
Duration: 2 weeks
When will it occur? March 2011
Participants/Beneficiaries of Training Activity: 15 (9 CESE analysts and 6 DAP analysts)
Anticipated numbers of Beneficiaries (male and female) 6 women and 9 men
PI/Collaborator responsible for this training activity: Bernsten and Mazuze
List other funding sources that will be sought (if any):
Training justification: The training will enable analysts to develop and evaluate survey methods for agricultural research and adoption evaluation

Type of training: Intensive English Course
Description of training activity: One CESE analyst will live with a family in South Africa and study English intensively, with 30 sessions per week
Location: Capetown, South Africa
Duration: 8 weeks
When will it occur? February 2011
Participants/Beneficiaries of Training Activity: 1 Anticipated numbers of Beneficiaries (male and female) 1 male
PI/Collaborator responsible for this training activity: Mazuze
List other funding sources that will be sought (if any):
Training justification: In order to gain from regional interactions and research, as well as compete for graduate studies, CESE analysts need to have excellent English skills.

Equipment (costing >$5,000)**:**

MOZAMBIQUE

Four wheel drive, double cabin pickup truck

Given the multiple foci of bean production and the lack of transport at the Northwestern Zonal Research Center, market and farmer research requires transport facilities. Note with earlier research, vehicles from other zonal research centers were made available, but it has become a major limiting factor.

IIAM/CESE would buy, own the vehicle, and pay operational costs.

$40,000 has been budgeted for the purchase.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Expanding Bean Supply & Demand in Africa & Latin America: Identifying Constraints & New Opportunities
Lead U.S. PI and University: Rick Bernsten, MSU
Host Country(s): Angola, Mozambique, Honduras

Output Indicators	2011 Target (October 1, 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women	1	
Number of men	1	
Short-term Training: Number of individuals who received short-term training		
Number of women	24	
Number of men	34	
Technologies and Policies		
Number of technologies and management practices under research	6	
Number of technologies and management practices under field testing	3	
Number of technologies and management practices made available for transfer	2	
Number of policy studies undertaken	2	
Beneficiaries:		
Number of rural households benefiting directly	50	
Number of agricultural firms/enterprises benefiting	3	
Number of producer and/or community-based organizations receiving technical assistance	6	
Number of women organizations receiving technical assistance	2	
Number of HC partner organizations/institutions benefiting	5	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	100	

Dry Grain Pulses CRSP : FIRST PERIOD

Project Title: Expanding Bean Supply & Demand in Africa & Latin America

	10/01/10 - 09/30/11						
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)
Institution Name	MSU	MSU	UAN	IIAM	EAP	U Pretoria	U Vicosa
a. Personnel Cost							
Salaries	$9,815		$12,000	$6,000	$5,500		
Fringe Benefits + Allowances	$12,262		$2,000	$1,500	$2,225		
b. Travel	$14,636	$3,500	$16,064	$8,000	$12,525		
c. Equipment ($5000 Plus)				$40,000			
d. Supplies	$1,071	$3,000	$3,000	$3,000	$3,675		
e. Training							
Degree						$22,476	$16,152
Non-Degree			$7,660	$18,800	$500		
f. Other		$2,000					
g. Total Direct Cost	**$37,784**	**$8,500**	**$40,724**	**$77,300**	**$24,425**	**$22,476**	**$16,152**
h. Indirect Cost	$19,648	$4,420					
i. Indirect Cost on Subcontracts (First $25000)			$515	$0	$0	$0	$0
j. Total Indirect Cost	$19,648	$4,420	$515	$0	$0	$0	$0
Total	**$57,432**	**$12,920**	**$41,239**	**$77,300**	**$24,425**	**$22,476**	**$16,152**
Grand Total				$251,943			

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$46,284	20.4%
Total direct cost budgeted for H.C institution(s)	$181,077	79.6%

Cost Share (25% MSU)	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	Total
In-kind	$14,358							$14,358
Cash								$0
Total	$14,358	$ -	$ -	$ -	$ -	$ -	$ -	$14,358

Attribution to Capacity Building								
Percentage of effort	10.0%	41.0%	20.0%	27.0%	10.0%	100.0%	100.0%	32.2%
Amount corresponding to effort	$5,743	$5,297	$8,248	$20,871	$2,443	$22,476	$16,152	$81,230

U.S Institution PI:

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 – September 30, 2011)

FY 2011 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: *Expanding Pulse Supply and Demand in Africa & Latin America: Identifying Constraints & New Opportunities*

	Abbreviated name of institutions							
	MSU		UAN		IIAM		EAP	
Identify Benchmark Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**
Objective 1: Angola								
1. Identify efficiency in marketing channels & leverage points to increase farmer profits & trader volumes								
Outreach on marketing report (Phase I) for smallholders and other stakeholders	X		X					
Database on bean production and marketing documented and established	X							
Focus groups with farmer associations held on marketing analysis				X				
Objective 2: Mozambique								
1. Identify efficiency in marketing channels & leverage points to increase farmer profits & trader volumes								
Database on bean production and marketing documented and established	X							
Outreach for Report on Bean Value Chain (output from Phase I)						X		
Farmer focus groups to discuss results and identify opportunities	X					X		
Meeting of National Bean Task Force						X		
Summary report on two windshield surveys and bean results	X							
Conduct additional field research with Windshield Survey 2011		X				X		
2. Develop cellphone-based information system for beans, to link farmers & traders to market prices & availability								
Launching of cell platform in at least one bean production zone	X							
Database on bean prices available through website		X						
Focus groups with farmers to ensure usefulness of cell phone system						X		
Objective 3: Honduras								
1. Conduct on-farm trials to validate organic bean-production practices, including organic fertilizer and pesticide from plant extracts								
On-farm trials using organic fertilizer and plant extracts							X	X
Conduct commercial organic plots							X	X

	Abbreviated name of institutions							
	MSU		UAN		IIAM		EAP	
Identify Benchmark Indicators by Objectives	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11
2.Provide technical assistance to farmer group interested in establishing commercial organic bean plots								
Collaborate with NGO on assisting CIAL							X	X
Conduct training course							X	
3. Assist farmer groups to obtain fairtrade certification								
Prepare request with farmer organization	X							
Submit request for certification	X							
4. Export fairtrade beans to a US retailer								
Negotiate export contract	X							
Finalize export of beans		X						
5. Research papers summarizing constraints & opportunities for exporting fair trade beans		X						
Objective 4: Capacity Building								
Angola								
MS Thesis proposal		X		X				
MS thesis field research designed and conducted		X		X				
Students trained on use of market price data	X							
Mozambique								
MS thesis proposal for Univ. of Pretoria		X				X		
MS thesis field research designed and conducted		X				X		
CESE staff trained in Price data analysis	X							
CESE staff trained in Survey Research methods	X							
CESE staff member completes Intensive English course					X			
Honduras								
Training course for organic bean production							X	

Name of the PI responsible for reporting on benchmarks	Bernsten-Donovan	Donovan-Kiala	Donovan-Mazuze	Rosas
Signature/Initials: Richard F. Bernsten				

Date: May 21, 2010

P2-PSU-1

Improving Bean Production in Drought-Prone, Low Fertility Soils of Africa and Latin America – An Integrated Approach

Lead U.S. Principle Investigator
Jonathan Lynch, PSU, USA

Collaborating Scientists
Kathleen Brown, PSU, USA
Roland Chirwa, CIAT, Malawi
Jill Findeis, PSU, USA
Celestina Jochua, IIAM, Mozambique
Magalhaes Miguel, IIAM, Mozambique
Juan Carlos Rosas, EAP, Honduras
Soares Almeida Xerinda, IIAM, Mozambique

Project Problem Statement and Justification

This proposal is premised on four well-established facts:

1) *Drought and low soil fertility are principal constraints to bean production in Latin America and Africa.*
2) *Most bean producers in poor countries cannot afford irrigation and intensive fertilization.*
3) *Bean genotypes vary substantially for root traits that determine their tolerance to drought and low soil fertility, making it feasible to increase yields in low-input systems through genetic improvement.*
4) *To exploit the potential of this approach, we need intelligent deployment of root traits in bean breeding programs, and better understanding of the socioeconomic and agroecological factors determining the adoption and impact of stress tolerant crops and cropping systems.*

Drought and low soil fertility are primary constraints to bean production throughout the developing world. Phosphorus limitation is the most important nutrient constraint to bean production. What is needed is *integrated nutrient management*, consisting of judicious use of fertility inputs as available, management practices to conserve and enhance soil fertility, and adapted germplasm capable of superior yield in low fertility soil.

We have shown substantial variation in bean P efficiency that is stable across soil environments. P-efficient genotypes possess root traits that enhance P acquisition. Genetic variation for these traits is associated with large variation in growth and P uptake among related genotypes in field studies. Several of these traits can be evaluated in rapid screens with young plants, greatly facilitating breeding and selection.

Drought is a primary yield constraint to bean production throughout Latin America and Eastern and Southern Africa. Beans vary substantially in drought tolerance, due primarily to variation in root depth and thereby access to soil water, earliness (drought escape), and

secondarily to seed filling capacity. Drought tolerance has been identified in several races of common bean, but is complex and associated with local adaptation. Utilization of specific traits in drought breeding, through direct phenotypic evaluation or genetic markers (eg QTL) would be useful.

We need a better understanding of how stress tolerant genotypes affect the sustainability of their cropping systems. One concern is that P-efficient genotypes will 'mine the soil', although we have recently reported that P-efficient genotypes actually protect soil fertility by reducing erosion. Another concern is that more vigorous bean root systems may affect the performance of maize or other intercrops.

Genotypes that are more responsive to inputs may promote the use of locally available inputs such as sparingly soluble rock P. Similarly, bean genotypes with deeper root systems may be synergistic with soil management techniques to conserve residual moisture.

We need a better understanding of socioeconomic factors determining adoption of stress tolerant bean germplasm and the likely effects such adoption may have on household income and nutrition. Our team has observed that factors such as family structure may play a large role in determining whether the introduction of more productive germplasm is likely to have positive or even negative effects on household income and nutrition.

Drought and poor soil fertility are primary constraints to pulse production in developing countries. Recent developments in our understanding of root biology make it possible to breed crops with greater nutrient efficiency and drought tolerance. Such crops will improve productivity, enhance economic returns to fertility inputs, and may enhance overall soil fertility and system sustainability, without requiring additional inputs. The overall goal of this project is to realize the promise of this opportunity to substantially improve bean production in Africa and Latin America.

Planned Project Activities

Objectives

Objective 1: Develop bean genotypes with improved tolerance to drought and low P.
Objective 2: Develop integrated crop management systems for stress tolerant bean genotypes.
Objective 3: Understand constraints to adoption of new bean technologies, income and nutrition potential, and intra-household effects and impacts.
Objective 4: Capacity building.

Objective 1: Breeding

Collaborators

Kathleen Brown, PSU, USA
Roland Chirwa, CIAT, Malawi
Celestina Jochua, IIAM, Mozambique
Jonathan Lynch, PSU, USA

Magalhaes Miguel, IIAM, Mozambique
Juan Carlos Rosas, EAP, Honduras

Approaches and Methods

Honduras The activities in Central America (mainly Honduras and Nicaragua) will include continuation of objective 1 as in the previous two years including the testing of a set of small red inbred backcross (IB) lines (Amadeus 77 background) in farmer´s fields, to study the value of specific root traits under low fertility and drought conditions. This set will include 10-12 IB lines which have similar shoot growth habit, days to flowering and maturity, and seed type, but differ on their root characteristics and response to diverse levels of drought and low fertility stress. The results of these field trials will be used to determine if multilines will provide better yield stability than single lines under a varying drought/low fertility conditions encountered by small farmers in Central America.

This set of IB lines will be also tested for BNF in a low fertility soil at Zamorano. The BNF trial will include two *Rhizobium* inoculated treatment s with strains CIAT 899 (*R. tropici*) and CIAT 632 (*R. etli*), and an uninoculated treatment, and five replicates. This research will help to determine if there is a relationship of specific root traits with greater nodulation and nitrogen fixation under stressed field conditions.

During FY11, advanced lines developed from crosses between drought and low fertility tolerant parents (previously identified by the project in collaboration with CIAT and the DGPC-UPR/Beaver breeding project) with disease resistant cultivars, will be distributed for testing to at least five countries members of the Central America and the Caribbean (CA/C) Bean Research Network. In addition, promising tolerant lines identified in previous years, will be validated and considered for release in Honduras and at least one additional country.

A set of advanced lines and cultivars, mainly small reds and blacks and red mottled from the DGPC-UPR/Beaver project, will be sent to IIA researchers for field testing and root phenotyping. The set of IB small red lines with Amadeus type developed for Central America, will be sent to IIAM researchers during this year for testing of the multiline approach on FY12, whilst a set of IB lines is developed using a Mozambique commercial cultivar as the recurrent parent, to determine if the approach is proven to be useful under representative farmer conditions.

EAP will assist IIAM to develop breeding populations to improve commercial cultivars using disease resistance, stress tolerant Mesoamerican lines. At IIAM development of IB populations will continue, as will evaluation of single lines and multilines from genotypes identified as promising in phase one at multiple locations in northern Mozambique. PVS approaches will be initiated in Mozambique, with guidance from JCR at EAP.

Since the EAP is part of the UPR/Beaver DGPC breeding project team and its collaboration with CIAT bean breeder (S. Beebe) and physiologist (I. Rao) has been increased significantly during the last five years, interaction with these breeding groups

will continue to be emphasized under this project . EAP, UPR and CIAT are involved in the distribution and exchange of improved germplasm thru the CA/C Bean Research Network under EAP leadership. More specifically, partnership with CIAT during recent years includes the bean biofortification project supported by CIDA in Latin America (2005-10) and the drought/low fertility breeding project supported by Red SICTA/IICA/SDC (2007-09) in Honduras and Nicaragua. Recently EAP and CIAT, in collaboration with CIMMYT and the national research programs, have prepared and submitted a proposal to IDRC for conducting a collaborative regional research project.

Mozambique

1) Seed increase

The objective of this activity is to increase seed of several genotypes identified in phase 1 and material that we will have received from our collaborators to be available for on-station and on-farm trials. We also do seed increase to maintain existing germplasm. Seed of P efficient and drought tolerant bean genotypes that were selected in phase 1 will be increase for future evaluations.

2) Testing and selection of bean genotypes

Several bean genotypes identified in Phase 1 will continue to be tested in on-station and on-farm to select genotypes tolerant to drought and low P conditions and adapted to Mozambique. During phase I of this project and the Mcknight project we identified bean genotypes with root traits suitable for low P conditions, and other genotypes with root traits adapted to drought tolerance. These genotypes will be evaluated in Sussundenga, Lichinga, Gurue under Phosphorus stress and in Chokwe under drought stress for yield performance. Promising genotypes will be selected for advanced trials. In parallel, we will be evaluating small red and back beans from Central America that will be received from in Honduras with sources of disease resistance and tolerance to drought and low P.

We will evaluate the performance and adaptability of red mottled bean lines with bc3 that performed well in Angola and Rwanda. Other bean lines to be evaluated in different sites in Mozambique include black bean lines that were screened for low N environment. These genotypes will be provided through collaboration with other DGP projects from Angola/Puerto Rico and Ecuador. The PVS approach will be used in on-farm evaluations so that the farmers can have the opportunity of selecting the varieties they prefer starting from the vegetative stage.

3) Phenotyping and screening bean genotypes for Low P and drought tolerance

Several bean genotypes will be screened in the greenhouse/field to identify genotypes with root traits suitable for drought and low P conditions. The root traits to be evaluated include root whorl number, basal root angle, adventitious and basal root number and length, and primary root length. Root branching is also another trait that will be evaluated. Genotypes with superior root traits will be selected for testing yield performance in Sussundenga, Lichinga and Chokwe. The other potential bean growing site for evaluations is Gurue. During the screening we will also be identifying sources of drought and low P tolerance that can be used as parents.

4) Testing F5 families developed previously

F5 families developed in previous project will be tested for adaptability and yield performance in different bean growing sites and superior lines will be selected for advanced yield trials. Currently we have more than 600 F4 lines and seed of F3 generations from different crosses that were developed using parents contrasting in root hair traits. These lines are being evaluated for root traits in the laboratory and lines with superior root traits will be identified. Seed of these lines will be increased for advanced trials for identification of superior lines adapted to Mozambique. These lines will be candidates to be released and new varieties after testing in farmer's conditions. The evaluations of the genotypes in farmer's conditions will be in collaboration with extension services and NGOs working in the selected sites (Sussundenga, Lichinga, Gurue, Angonia, Chokwe). We will focus more on working with farmer that are organized in groups or associations. Some of NGOs collaborators include World Vision, Save the Children and CLUSA.

5) Development of bean genotypes and introgression of root traits suitable for low P and drought conditions

Crosses involving introgression of basal root whorl number and total number of basal root using genotypes identified from local germplasm and other root traits will be conducted. From our previous screening we have identified bean genotypes with high number of whorl and total basal roots that will be used as parents to develop bean genotypes adapted to low P soils. In addition, deeper-rooted genotypes were also identified previously that confer tolerance to drought. These genotypes will be used as parents to develop drought tolerant beans. Several early maturity genotypes and genotypes developed for drought conditions at CIAT were also preliminarily evaluated for adaptability in Mozambique. Promising genotypes will be submitted to advanced trials.

Objective 2: Integrated Crop Management

Collaborators
Jonathan Lynch, PSU, USA
Magalhaes Miguel, IIAM, Mozambique
Soares Almeida Xerinda, IIAM, Mozambique

Approaches and Methods: Activities will extend and expand on approaches employed in phase one, gaining greater reliability from evaluation at multiple locations and seasons, and with new lines as identified in objective one. Activities will continue to focus on agroecological impacts and management synergies of new genetic materials, including effects on erosion, intercropped maize, and synergism with local sources of phosphate rock. In 2010 IIAM will obtain and prepare rock phosphate (RP) and lime; conduct in Chókwe a drought screening experiment to determine moisture deficit effects on yield of P-efficient, P-inefficient and selected lines; and conduct in Chókwe an experiment to determine moisture conservation techniques (mulch, no-till, microbasins) effects on growth and yield of P-efficient genotypes. In 2011 and 2012 activities from 2010 will continue, in addition, IIAM will establish, in Sussundega, Gurue and Lichinga, on-farm demonstration plots of drought tolerant, and P efficient common bean genotypes with

moisture conservation techniques; establish, in Sussundega, Gurue and Lichinga, on farm demonstration plots of drought tolerant and P efficient common bean genotypes with moisture conservation techniques; conduct, in Chókwe and Sussundenga or Lichinga, a multiple-season pot experiment to determine available P release from rock P and liming effects on this, and incubation time effects on beans growth and yield; and in Gurue, Lichinga or Sussundenga, conduct experiments to determine the effect of rock P and lime application on growth and yield of P-efficient genotypes.
The specific activities are detailed below:

2.1 Obtain in Nampula, and grind local rock phosphate (RP) and lime to use for the project activities. This activity is consists of manual grinding of RP, which has low productivity but is necessary to acquire enough material for the pot and field trials. Some areas of Mozambique have huge RP unexploited shallow reserves, which would make the mining profitable as cheaper P fertilizer. Although RP usually has no immediate impact in increase of yield as compared to commercial inorganic fertilizer, it has been reported to increase yields in the 2nd and 3rd years after application, especially in acid soils which are common in bean growing areas of Mozambique. Commercial inorganic fertilizer is both too expensive and also unavailable in remote areas of Mozambique mainly due to poor infrastructure. The outcome of our research on use of RP may become a driving force for private sector investment on small scale mining of RP which would make this fertilizer available to small scale farmers.

2.2 Conduct, in Chókwe, an experiment to determine potential synergy between moisture conservation techniques (mulch, no-till, microbasins) and drought tolerant bean genotypes. This research is a follow-up of identification of P-efficient common beans which are more susceptible to drought because of having shallow roots. To minimize susceptibility to drought some ‘best bet’ technologies for moisture conservation are good options for adoption by farmers in order to reduce yield losses in years of lower rainfall. In this study we hypothesize that moisture conservation techniques will significantly reduce yield loss of P-efficient and/or drought tolerant genotypes under water deficit taking full advantage of better growth in low fertility soils. The genotypes to be used are selected from drought screening trials conducted under the breeding activities of this project. The moisture conservation techniques are ‘best bet’ technologies that have been promoted for adoption by farmers in other projects. Therefore, we anticipate that they will be easily scaled up for use by bean producing farmers.

2.3 Establish, in Sussundega, Gurue and Lichinga, on farm demonstration plots of drought tolerant, and P efficient common bean genotypes with moisture conservation techniques. Drought tolerant genotypes that are outstanding in the drought screening trials conducted at Chokwe Research Station will be used in these sites. The priority will to install the demo plots at farmers associations’ fields to maximize the exposure of moisture conservation techniques, and the drought tolerant as well as P-efficient new genotypes. Other important strategies to maximize the exposure and adoption of moisture conservation techniques and the new genotypes are the links with NGO’s and local public extension who will be our collaborators and, as more genotypes are selected by farmers, can help to multiply them and extend these technologies beyond the area and time frame of our project.

2.4 Conduct, in Chókwe or Sussundenga, a multiple-season pot experiment to determine available P release, from rock P and lime effects, and incubation time effects on beans growth and yield. It is well known that the RP effects on crop growth and yield is not immediate. It is a result of P mining which gradually make the P more available for uptake by plants. Therefore, the research on use of RP involves multiple season trials. Although the P-efficient genotypes can grow better and attain higher grain yield under low P, some very poor soils impair the growth of beans due to limited minimal P substrate. The RP appears to be a local P source that can be alternative for P amendment to improve yields. However, we are not aware of previous research ion the utility of RP for bean fertilization in African soils, hence the need for this study. The results of our work may create business opportunities for rock P mining and marketing since refined fertilizers are not available in remote areas due to poor infrastructure.

2.5 Write and submit reports.

Objective 3: Socioeconomics

Collaborators
Jill L. Findeis, PSU, USA
Rachel Smith, PSU, USA
Bayou Demeke, CIMMYT-Nairobi
Maria da Luz Quinhentos, IIAM. Mozambique

Approaches and Methods: Phase II project activities will build on phase I survey research to understand constraints to adoption, income and nutrition potential for households, and intra-household impacts. Activities will include 1) engagement of farm households in PVS at our research sites, 2) on-farm testing followed by a farm household survey to determine critical constraints hindering adoption or reducing the diffusion of improved seed, including access to seed systems, 3) inclusion of survey questions specifically focused on disposition of newly-adopted beans (sales in alternative markets across supply chains, household consumption) by households, and 4) inclusion of both male and female perspectives in the survey to estimate intra-household impacts. The economic network approach used in phase I will be used to estimate the village-wide impacts of stress tolerant germplasm. The use of this approach in phase II allows for a short run *ex ante/ex post* comparison, focusing on adoption constraints and impacts.

Participatory Variety Selection (PVS) activities will be carried out at research sites in Gurue, Angonia, Lichinga, and Sussundenga in years 1 and 2 of phase II. Local farmers (male and female) will be included in the PVS, to understand farmer acceptance/resistance to selected characteristics of the beans. This activity will be used -- in concert with phase I survey results focused on stated preferences for particular bean characteristics -- to inform the larger research project on preferred characteristics and to identify most promising stress tolerant beans. At least 10 PVS participants will be included at each research site in both years 1 and 2, and gender balance will be maintained. We will assess differences, if any, in preferences across the 4 regions.

On-farm testing of the most promising stress tolerant beans will be conducted. In addition, a farm household survey will be conducted among farms participating in on-farm testing at the research sites. The survey protocol will be developed in year 1 of phase II, be translated into Portuguese, undergo Penn State Human Subjects clearance, be pretested locally among farmers, and be conducted across the research sites at Gurue, Angonia, Lichinga, and Sussundenga. The survey will include sections on constraints (*agro-ecological, economic, social*) to adoption and greater diffusion; assessment of yield and input cost impacts; impacts on household income versus household nutrition attributable to beans; and intra-household impacts. If possible, we will include questions on the survey focusing on rock phosphate.

IIAM staff at the sites will conduct the household survey, in collaboration with interviewers/translators, after being trained by PSU collaborators. Training will take place in Sussundenga Fall 2010. Statistical analyses of the data will be conducted and adoption/diffusion models estimated. Simulations based on the *ex ante* and *ex post* data will conducted to estimate the overall impact of the new technology on the bean-growing regions of Mozambique, under different market scenarios.

Finally, we will collaborate closely with the Michigan State CRSP team in Mozambique to assure that both teams benefit from the other's activities. Since both teams work collaboratively with IIAM, a PSU/MSU collaboration will provide an even greater benefit to our in-country hosts.

3.1 Train IIAM staff in PVS.

3.2 Conduct PVS among selected farm households at the research sites. Identify positive and negative characteristics, based on male and female preferences. Compare to stated preferences from *ex ante* surveys.

3.3 Develop farm household survey, translate into Portuguese, obtain Human Subjects clearance, pretest survey instrument. Train IIAM staff to conduct survey; IIAM staff will train additional interviewers.

Objective 4: Capacity Building

Collaborators
Kathleen Brown, PSU, USA
Jill Findeis, PSU, USA
Celestina Jochua, IIAM, Mozambique
Jonathan Lynch, PSU, USA
Magalhaes Miguel, IIAM, Mozambique
Juan Carlos Rosas, EAP, Honduras
Soares Almeida Xerinda, IIAM, Mozambique

Approaches and Methods
Training IIAM (Mozambique) researchers at Penn State

In this phase of the project we plan to train two IIAM researchers at Penn State. Samuel Camillo will receive formal graduate training in plant biology. We will request from IIAM that Venancio Salagua receive nondegree training in socioeconomics. EAP will provide training in PVS and MAS for African and/or Central American trainees.

Strengthening research infrastructure at IIAM

Many IIAM researchers are posted in regional research centers, which encourages interaction with farmers in production zones, but limits research possibilities, since the zonal centers do not have effective internet access or lab facilities. In our current Penn State-IIAM project funded by the McKnight Foundation we have invested in strengthening research infrastructure at the Sussundenga research center, which is the base of Magalhaes Miguel and is located near a main bean production zone. We installed a satellite dish for direct internet access and constructed a lab for soil and plant analysis. Internet access has been critical in maintaining communication between Mozambique and the USA, and in the ability of IIAM scientists to access research literature and other internet resources. The soil and plant analysis lab will be an important resource for the entire central region of Mozambique. Our proposed Pulse CRSP project would expand this effort by providing internet access for the Chokwe research station, the base of Celestina Jochua and Soares Xerinda, and adding additional capacity to the analytical lab at Sussundenga. During the phase I of the DGP CRSP project, we were able to purchase several lab equipment crucial for tissue analysis at Sussundenga research station. In the next phase, we plan to acquire several lab equipment ans supplies, still in need for full operation of the Lab. We also need to physical expand the facilities housing the lab to accommodate more equipment. Funds from phase II would help us to improve the working space of the Lab.

Strengthening research and training capacity of Zamorano

Zamorano serves undergraduate students from most Latin American countries. Dr. Rosas offers courses in Genetics, Plant Breeding and Crop Production, and guides thesis research projects utilizing field plots, greenhouse and laboratory facilities of the Bean Research Program. Traditionally, some Zamorano graduates become research assistants in the Bean Program; this experience has helped more than 20 graduates go to graduate school in the USA and abroad. The Bean Program at Zamorano has trained many researchers from the national bean programs of Central America, the Caribbean and Ecuador, as part of the previous Bean/Cowpea CRSP. Training in the Bean Program is offered in areas such as breeding and selection, field plot management, techniques for managing bean pathogens in the field and laboratory, marker assisted selection, and Rhizobium and mycorrhiza production technologies. Also, several graduate students from U.S. universities involved in CRSP collaborations with Zamorano have conducted their M.S. and doctoral field research in Honduras. Recently, the program has developed capability for root phenotyping to characterize and select genotypes with superior root traits associated with tolerance to drought and low soil fertility. Capabilities in this area will be upgraded as part of this project. In the proposed project, Bean Program facilities and expertise at Zamorano will be used in formal training of undergraduate students; in-service training of technical personnel from Central America, Caribbean and African; graduate research of doctoral and master science candidates from collaborating countries

and the U.S.; and to organize and conduct short courses, workshops and project related events. In addition, the project would have access for conducting on site studies and research trials with CIAL and other farmer organizations which are involved in participatory plant breeding and seed production.

Multilingual web-based delivery of research methods for root traits
We have established a web site that describes research methods for root traits in English, Spanish, French, and Portuguese (http://roots.psu.edu). This site has been widely used, having received an average of 600 visitors, 3600 pages downloaded, and 8400 files downloaded per day over the first three months of 2010. Continued support for this web site in the proposed project will be a resource for agricultural researchers throughout Africa and Latin America.

Contribution of Project to Target USAID Performance Indicators
Research capacity of host country institutions will be enhanced by training and infrastructure development. The development of new bean genotypes with enhanced yield in stressful environments will enhance rural livelihoods and improve food availability in urban and rural areas. Socioeconomic research will permit improvement of technology targeting and dissemination strategies.

Target Outputs
Breeding:
Honduras: A set of IB lines with Amadeus plant and seed type will be available for testing the multiline approach in farmer fields in Honduras and elsewhere.

At least 10 drought /low fertility tolerant advanced lines developed for the project in collaboration with UPR/Beaver and CIAT, will be included in the regional VIDAC and ECAR trials and distributed to Central American and Caribbean national programs and research organizations.

At least 40 promising lines and germplasm from EAP, PSU, UPR/Beaver and CIAT, will be sent to researchers of IIAM for testing in Mozambique

Mozambique: Seed of several bean genotypes will be multiplied and made available for evaluations.

At least 20 lines with root traits adapted to low P conditions will be selected from F6 generations for advanced evaluations.

At least 100 bean genotypes or lines will be evaluated for root traits, and at least 20 genotypes will be selected. Parents with good root traits for drought and low P adaptability will be identified.

Seed of F1 generations from different crossed of parents contrasting in root traits will be increased.

Integrated Crop Management: At least two moisture conservation technologies to reduce drought susceptibility of P-efficient (shallow rooted) genotypes will be identified. In the following growing season will be exposed to farmers, through demonstration plots conducted with our partners (farmers associations, public extension and NGO's).

From rock P trials will be identified minimal and optimal application PR application rates. These results will be used for field trials in the subsequent growing season. The field trial results will be shared with the socioeconomic unit of IIAM to integrate feasibility studies of RP use.

Socioeconomics:
PVS conducted across research sites.
Ex post survey developed.
Penn State Human Subjects clearance of *ex post* survey.
Field testing of survey instrument complete.

Capacity Building:
Degree training of an IIAM researcher in Plant Biology at Penn State.
Nondegree training of an IIAM researcher in socioeconomics at Penn State.

Engagement of USAID Field Mission(s)
When project staff are in Maputo we will attempt to meet with AID staff to brief them of our activities and progress, annually if their availability and interest permits.

Networking Activities with Stakeholders
Outreach/Impact in Honduras: The project will work in collaboration with at least 20 CIAL (farmer local agricultural research committees)) which are currently active in Honduras. These CIALs are composed of men and women interested in the introduction and testing of technological alternatives to improve the productivity and sustainability of the cropping systems in their communities. Although most CIAL members are male, it is quite common to find CIALs led by women and others composed only of women; also, many young farmers are members of several CIALs. Zamorano is currently collaborating with CIALs in four regions of Honduras, as part of participatory plant breeding activities started in 2000, to improve local landraces of beans and maize with specific agro-ecological adaptation and consumer preferences. So far, 11 bean (including three IB lines developed by the project from crosses of landrace x improved cultivars) and four maize cultivars have been released through these partnerships for conducting participatory plant breeding (PPB) activities with CIALs of Honduras. Several other breeding lines are under validation in communities of the regions of Yorito, Vallecillo, Yojoa Lake and the Yeguare river basin, and some will be released as cultivars by 2011.

The project will also collaborate with the main NGOs of Honduras, especially those organizations that have been collaborating with Zamorano for more than 10 years (FIPAH, PRR, etc.), as well as with the National Bean Research programs from Honduras, Nicaragua and other Central American and Caribbean countries members of the Bean Research Network. This regional bean research network will be the mechanism

to be used for the testing, validation and dissemination of novel bean lines and multilines developed by our project. The regional bean network has been coordinated by Zamorano since 1996.. The bean network has facilitated the testing of breeding lines and germplasm for nearly 20 years, and its members (the national bean programs) have been involved in the release of improved bean cultivars developed by Zamorano which are currently the main cultivars used by farmers in the region.

Foundation seed of released cultivars will be produced by Zamorano to assist certified and artisanal seed production and distribution projects supported by governmental and NGO organizations, such as the technological bonus in Honduras, which is reaching over 75,000 farmers every year with high quality seed of improved bean cultivars. Similar seed production and distribution projects have been implemented in Nicaragua and El Salvador in recent years, to assist small farmers with seed and fertilizer, as part of a policy for food security in rural areas and urban low-income sectors. These seed production and distribution projects will be assisted with foundation seed of improved cultivars developed by the project through our collaborators from the national bean programs and NGOs who are also involved in these seed projects.

The Zamorano bean program has been involved in training courses and in-service training in several aspects of bean research and seed production. The program has the required field, greenhouse and laboratory facilities to train technical personnel of our Central American and Africa collaborators in germplasm evaluation, breeding and selection, field plot management, marker assisted selection, participatory plant breeding, seed production and BNF tecnologies. Also, in collaboration with CIALs and NGOs, we can train technical personnel and farmers in on-farm innovation, participatory plant breeding and artisan seed production, focusing it from the perspective and needs of the small farmers.

<u>Outreach/Impact in Mozambique:</u> In Mozambique we will be working with NGOs, namely World Vision International (WVI), Care International and the Cooperative League of the United States (CLUSA), with involvement of small scale farmers in several regions in Manica, , Tete , Zambezia and Niassa provinces in central and northern Mozambique. The proposed project will continue our collaborative work with World Vision International, which has been conducting activities in agricultural extension, variety testing, human nutrition and on-job training, involving thousands of farmers in Gurue, and Milange districts in Zambezia province; Malema and Mutuali, in Nampula province.

To maximize impact, the project will be working with farmers that have been organized themselves in organizations formed by several farmers associations and work with them in plant variety testing and evaluation. Currently, in almost all village communities in Mozambique farmers are organized in associations and sometimes, a number of farmers associations in a community form a cooperative, ending up with an organization with a large number of farmers. This is being encouraged by the CLUSA in Lioma, Gurue, which enables them to empower the farmers for acquisition of more expensive farming facilities and equipment, such as animal traction, tractors, implements, warehouses, etc.,

and better market access for their produce. We will be working with CLUSA to ensure that innovative technologies generated by the project can reach a large number of farmers capable of selling their increased production.

A major focus of WVI is the training of extensionists and then of the farmers in a community. Currently, extensionists lack training materials and useful information to deliver. In this project, we will, in parallel with the research activities, conducting training of extensionists, both from the public sector and NGOs, in relevant subjects like diagnosis of nutritional disorders, soil water conservation and techniques in participatory technology testing and dissemination. Since the farming systems vary among the regions where the project is going to be implemented, we will be developing training materials appropriate to each of the sites. For example, in Angonia farmers use ridges during land preparation, while in Gurue, and Sussundenga, farmers use flat red soils and/or in declined terrain susceptible to erosion, for planting, and as a result water and nutrient status of the soils in these locations vary. Our project will develop technologies (plant materials and soil management techniques) adequate to these specific crop systems across targeted research and technology delivery sites.

Under this project we will be working with the above mentioned NGOs, and farmers associations in Sussundenga, Manica province, Angonia, Tete province, Gurue, Lioma, Milange in Zambazia province, and Malela, Molocue and Mutuali, Nampula province, reaching several thousand small-scale farmers growing beans in the region. The planned activities can be summarized as: a) genotype evaluation and testing using participatory approach, b) technology dissemination for adoption, and c) training for extensionists in relevant subjects such as diagnosis for nutritional disorders and techniques for soil water use conservation.

Leveraging of CRSP Resources

This project is highly leveraged with other ongoing projects and investments, including:

- a project funded by the McKnight Foundation Collaborative Crop Research Program entitled *Increasing Bean Productivity and Household Food Security in Stressful Environments in Mozambique Through the Use of Phosphorus-efficient Seeds by Farm Households* for $435,175 for 4 years to IIAM, PSU, and EAP
- a project funded by the Generation Challenge Program entitled *Basal Root Architecture and Drought Tolerance in Common Bean* for $900,000 for 4 years to PSU and CIAT
- a project funded by the Howard G Buffett Foundation entitled *Roots of the second green revolution* for $1,426,000 plus ca. $500,000 in capital investments for 5 years to PSU, with support from IIAM and CIAT
- a project funded by the International Atomic Energy Agency entitled *Characterization of root traits contributing to enhanced phosphorus acquisition from low fertility soil* for $40,000 for 4 years to PSU
- a project funded by the Norwegian Development Fund entitled *Participatory Plant Breeding for Mesoamerica: Promoting the management, conservation and development of Agrobiodiversity* for $ 250,000 for 5 years to EAP

- a project funded by the International Science and Education Program of the U.S Department of Agriculture entitled *Ag 2 Africa: Development of an International-US Learning Laboratory* for $149,993 for 4 years to PSU.
- a project entitled *Investigating the Social Influences Underlying Agricultural and Malaria Practices in Mozambique in Order to Diffuse Innovations in Beans and Malaria Vector-control* funded by the Clinical and Translational Sciences Institute (CTSI) for one year for $50,000.
- a pilot project funded by the Social Science Research Institute (SSRI) to explore the potential for developing cell phone technologies for widespread dissemination of information on improved bean seed, legume pests, and new seed access to illiterate farmers in Mozambique and East Africa. Total pilot project funding is one year for $20,000.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 20010 -- September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Improving Bean Production in Drought-Prone, Low Fertility Soils of Africa and Latin America – An Integrated Approach
Lead U.S. PI and University: JP Lynch, Penn State
Host Country(s): Mozambique, Honduras

Output Indicators	2011 Target (October 1, 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women		
Number of men	1	
Short-term Training: Number of individuals who received short-term training		
Number of women	2	
Number of men	1	
Technologies and Policies		
Number of technologies and management practices under research	10	
Number of technologies and management practices under field testing	5	
Number of technologies and management practices made available for transfer	2	
Number of policy studies undertaken	Jill?	
Beneficiaries:		
Number of rural households benefiting directly	LA/C:200, Moz:500	
Number of agricultural firms/enterprises benefiting	LA/C:1,Moz:5	
Number of producer and/or community-based organizations receiving technical assistance	LA/C:10, Moz:50	
Number of women organizations receiving technical assistance	LA/C:1, Moz:5	
Number of HC partner organizations/institutions benefiting	2 (EAP, IIAM)	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	LA/C:1000, Moz:5	

Dry Grain Pulses CRSP Budget

Project Title: Improving Bean Production in drought-Prone, Low Fertility Soils of Africa and Latin America – An Integrated Approach

	10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	EAP	IIAM	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name						
a. Personnel Cost						
Salaries	$13,500.00	$0.00	$8,000.00	$0.00		
Fringe Benefit	$2,740.50	$0.00	$2,000.00	$0.00		
b. Travel	$6,000.00	$6,500.00	$5,000.00	$12,000.00		
c. Equipment ($5000 Plus)	$0.00	$0.00	$0.00	$0.00		
d. Supplies	$10,000.00	$15,500.00	$6,000.00	$14,300.00		
e. Training						
Degree		$3,199.18	$2,000.00			
Non-Degree		$10,830.00	$3,000.00			
f. Other				$1,200.00		
g. Total Direct Cost	**$32,240.50**	**$36,029.18**	**$26,000.00**	**$27,500.00**	**$0.00**	**$0.00**
h. Indirect Cost	$15,475.44	$17,294.01	$4,000.00	$0.00		
i. Indirect Cost on Subcontracts (First $25000)		$24,000.00				
j. Total Indirect Cost	$15,475.44	$41,294.01	$4,000.00	$0.00	$0.00	$0.00
Total	**$47,715.94**	**$77,323.19**	**$30,000.00**	**$27,500.00**	**$0.00**	**$0.00**
Grand Total	$182,539.13					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$32,240.50	19.30%
Total direct cost budgeted for H.C institution(s)	$134,823.19	80.70%

Cost Share	U.S. Institution	U.S. for Host Country	EAP	IIAM	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$30,820.00						$ 30,820.00
Cash	$0.00						$ -
Total	$ 30,820.00	$ -	$ -	$ -	$ -	$ -	$ 30,820.00
Attribution to Capacity Building							
Percentage of effort	80.00%	100.00%	50.00%	50.00%			79.02%
Amount corresponding to effort	$38,172.75	$77,323.19	$15,000.00	$13,750.00	$0.00	$0.00	$144,245.94

U.S Institution PI: Jonathan P. Lynch Authorized Institutional Approval:

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

FY 2011 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: **P2-PSU-1**

	Abbreviated name of institutions					
Identify Benchmark	EAP		IIAM		PSU	
Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**
Objective 1: Breeding						
testing small red IB lines	x					
BNF in small reds	x					
drought/low P advanced lines	x					
lines sent to IIA	x					
seed increase				x		
selection				x		
phenotyping				x		
testing F5 families				x		
introgression				x		
Objective 2: ICM						
prepare RP			x			
water conservation/genotype				x		
on farm demos				x		
RP pot study				x		
Objective 3: Socioeconomics						
train IIAM staff in PVS/survey					X	
develop PVS & HH surveys/translate					X	
Human Subjects clearance					X	
pretest HH survey in field				X		
interviewer training - HH survey				X		
conduct PVS/brief PVS survey			X	X		
Objective 4: Capacity Building						
MS training of IIAM plant biologist					X	X
nondegree training of IIAM social scientist					x	x

Name of the PI responsible fo reporting on benchmarks	J.C. Rosas	M. Miguel	J. Lynch
Signature/Initials:	JCR	MM	JL
Date:			

P2-UCR-1

Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the U.S.

Lead U.S. Principle Investigator
Phillip Roberts, University of California - Riverside

Collaboratoring Scientists
Ndiaga Cisse, ISRA, Senegal
Issa Drabo, INERA, Burkina Faso
Jeff Ehlers, UC-R, U.S.
António Chicapa Dovala, IIA, Angola

Project Problem Statement and Justification

The primary project focus is to:

1. increase productivity of African and U.S. cowpea producers through improved varieties that possess resistance or tolerance to the major abiotic and biotic stresses impacting production in these areas;
2. expand grower marketing opportunities by breeding cowpea varieties with desirable grain characteristics;
3. help ensure adequate seed of improved cowpea varieties; and
4. provide training and capacity building in modern cowpea breeding to African researchers.

This project addresses primary constraints under the Topical Areas of Inquiry for Theme A "reducing cowpea production costs and risks for enhanced profitability and competitiveness", and Theme B "increasing the utilization of cowpea grain, food products and ingredients so as to expand market opportunities and improve human health." Genomics and modern breeding methods will be used to improve cowpea for yield limiting constraints. By leveraging genomic resources developed under a complementary cowpea project, we will implement a comprehensive application of modern breeding protocols for cowpea. Until now cowpea, as an 'orphan crop', has lacked genomic resources for modern breeding despite its importance in African agriculture.

Increasing Cowpea Productivity: Low agricultural productivity is central to rural and urban poverty in Africa. On-farm cowpea yields in West Africa average 240 kg/ha even though potential yields (on-station and on-farm trials) are five to ten times greater. Drought, poor soil fertility, insect pests and diseases are major constraints. Cowpea varieties that yield more without purchased inputs especially benefit poor farmers, many being women who lack access to the most productive lands.

Productivity is central to increasing rural incomes irrespective of changes in cowpea acreage, because less land, labor, and capital are needed to produce the same amount of cowpeas. The resources can then be invested in other activities that help boost total family income. Productivity increases also help reduce prices to urban consumers since some farmer cost-savings can be passed through to consumers. Sustainable increases in cowpea productivity in Africa and the U.S. can be achieved by developing varieties with

resistance to insects, nematodes and pathogens, drought tolerance, and ability to thrive under low soil fertility.

Increasing Market Demand with Improved Varieties: New cowpea varieties must have features desired by consumers as well as farmers, including grain appearance, coupled with desirable cooking qualities and processing characteristics for specific products. Landrace grain types are often preferred locally, and if over-produced, prices offered to farmers can be low because of limited demand. Large white grains with rough seed-coat are preferred throughout West Africa and can be marketed over a wide area, buffering supply (and prices) in the region. Large white grains are also amenable to direct dry milling for use in value-added traditional foods such as 'akara', 'moin-moin', and prototype value-added products. Development of adapted cowpea varieties with large white grain and resistance to pests would increase the marketing opportunities of cowpea farmers and traders in both Africa and the U.S. There is also considerable demand for large rough-brown seed type, especially in heavily urbanized areas such as coastal W. African cities like Lagos, Accra and Cotonu, but standard rough-brown cultivars such as 'Ife Brown' are susceptible to pests and diseases. Other opportunities exist for new cowpea products based on the 'sweet' trait; sweeter and milder taste could help broaden cowpea consumption in the U.S. and Africa and to Latin America and elsewhere.

Increasing Seed Supply of Improved Varieties: Cowpea breeding by the CRSP, African NARS, and IITA (Senegal, Burkina Faso, Nigeria, and other countries) has led to improved cowpea varieties that are near release. However, only about 5% of the cowpea area in Africa is planted to improved varieties and their potential goes largely unrealized. Lack of seed availability for improved varieties is a key limitation to spread of newly released cowpea varieties. Common bean research showed that rural African farmers will buy seed when it is available, suggesting that there is probably a market for cowpea seed as well.

Recently, effective models for production and dissemination of improved cowpea seed have evolved in Burkina Faso and Senegal, based on collectives (e.g. women farmer organizations) and for-profit seed cooperatives (NGO-established, but now largely self-sustaining). However, their limited scope is reflected in insufficient quantities of Breeder and Foundation Seed available to growers. We propose to help support increased production of Breeder Seed and work with producers of Foundation Seed to strengthen their production and marketing capacity. Strengthening seed production and delivery at the early breeder-involved stages will promote availability of high quality planting seed.

Training and Capacity Building: The research under these topical areas will provide an excellent framework for training current and new African scientists and capacity building for Host Country Institutions (Theme D "increase the capacity, effectiveness and sustainability of agriculture research institutions which serve the cowpea sector in developing countries).

Planned Project Activities

Objective 1: Develop improved, pest resistant and drought tolerant cowpea varieties for target regions in sub Saharan Africa and the US using modern plant breeding tools.

Collaborators

Moctor Wade (weed scientist), Centre National Recherches Agronomie, Bambey, Institut Senegalais de Recherches Agricole (ISRA), Senegal.
Ngor Diagne and Ousseynou Ciss (plant pathology) ISRA/CNRA Bambey.
Tignegre Jean-Baptiste (breeder) and Mme. Clementine Dabire (entomologist), INERA, Kamboinse, Burkina Faso.
Jose Pedro, Instituto Investigacao Agronomica (IIA), Luanda, Angola.
David Kiala, Universidade Agostinho Neto, Huambo, Angola.
Antonio Castame Francisco, Instituto de Investigacao Agronomica, Luanda, Angola.

Approaches and Methods: Three main paths of work will be followed to achieve our research objective. We will complete final testing and release protocols of advanced lines developed under the previous Bean/Cowpea CRSP and Phase 1 of the Pulse CRSP, and initiate new short- and long-term breeding strategies to develop high-yielding improved varieties.

Final Testing and Release of Varieties: Several advanced breeding lines have been developed under the previous Bean/Cowpea CRSP at UCR and in Burkina Faso and Senegal that are nearing release (Table 1). Limited experiment station and/or on-farm tests are needed to complete the final evaluation of these lines.

Table 1. Varietal candidate lines

Candidate Line	**Developing Institution**	**Releasing Institution**	**Type**	**Steps Needed in Workplan Period**
P-87	UCR	UCR	Blackeye	Experiment station and On-farm performance tests; Breeder Seed increases.
07-11-577	UCR	UCR	All-white	Experiment station and On-farm performance tests; Breeder Seed increases.
03-11-350	UCR	UCR	'Dry Green'	Experiment station tests; Breeder Seed increases.
IT98K-1111-1	IITA	INERA	White	On-farm evaluation re-tests
SV1	INERA	INERA	White	On-farm evaluation re-tests
SV2	INERA	INERA	White	On-farm evaluation re-tests
SV3	INERA	INERA	White	On-farm evaluation re-tests
SV4	INERA	INERA	White	On-farm evaluation re-tests

SV5	INERA	INERA	White	On-farm evaluation re-tests
ISRA-3211, ISRA-3217 ISRA-3178 ISRA-3201	ISRA-UCR	ISRA	White, large seeded; early –medium maturing	Demonstration farm-trials with 4 selected lines

In Burkina Faso and Senegal, on-farm evaluations and demonstrations of indicated lines lines (Table 1) will be conducted. The best performing INERA lines will be planned for release at the end of the FY12 workplan period following Breeder Seed production during FY12. In Senegal, the indicated ISRA lines, focused on large-seeded types, will be grown in 20 demonstration trials during FY11, with a second year of on-farm demonstration trials planned for FY12. This should complete the performance data required for the formal release. These lines will be selected from the second-year on-farm replicated trials being conducted during the FY10 main growing season. These lines will be high yielding with resistance to the prevailing diseases (BB, CAbMV) and insects (aphids) and large seed size (at least 25 g /100 grains). The demonstration trials will be conducted in the cowpea zone, north of Senegal (Louga, Mekhe, Thilmakha). At least 20 trials will be conducted with plots size sufficiently large (400 to 500 m^2) to allow mechanical planting. Yield, diseases and insects incidence will be recorded.

In Burkina Faso, the 6 varietal candidate lines developed at INERA will be grown in on-farm trials by 5 farmer groups at 10 sites in Central (Saria, Nandiala, Donsin, Laongo, Manega) and Northern (Pobe, Pissila, Titao, Pathiri, Gourcy) zones of Burkina Faso. Sites will be considered as replications and each plot will be 100 m^2 (10 x10m). The six new varieties will be compared to one local check variety KVx396-4-5-2D in each site.

In Angola, cowpea field evaluations will be conducted at four locations targeting the main ecological zones (Beguela, Cela, Alto Capaca, Namibia/Kwanza Sul, and Huambo areas) with the aim of identifying candidate varieties among local landraces, and Bean/Cowpea CRSP (in Ghana, Senegal and/or Burkina Faso) and IITA varieties. The trials will include 26 CRSP core entries, plus a similar number of local types. The set of 36 Angolan cowpea selections being evaluated by Angolan student Antonio David in Puerto Rico with Drs Beaver and Porch will also be included in these field evaluations. At the dry zone Namibia/Kwanza Sul site, a Striga hot-spot will be chosen for the trial, and will include known differentials carrying resistance genes for the Striga races. Striga susceptibility will be scored at this site. We anticipate plantings in both 2011 and 2012 will be needed to provide necessary field evaluation data, especially due to the problems of project phase 1 field evaluations thus far due to Ascochyta and soil alkalinity (pH 8.5). We anticipate one or more of these candidates will become the first varieties for each of the production zones to be formally produced under the project. A site visit and field trip to Angola by the UCR PIs is planned for November/December 2010 at the start of the FY11 workplan period, to aid in the coordination of these activities. Under the current 2010 workplan, the Angolan materials are being SNP-genotyped. We will continue to

genotype all Angolan entries into the trials, to enable association mapping comparisons for major mapped cowpea traits.

In California: One advanced all-green pinkeye line, (07-11-350), and one all-white line (07-11-557) will be tested in on-station trials in 2010. If yields are promising with one or both of these lines, large-scale strip trials will be conducted in 2011. In addition, 12 new advanced dry green breeding lines (see Table 2) and 5 all-white lines will be evaluated in replicated trials at two locations in 2011. 26 new crosses involving these 12 lines were made in 2009 (see Table 3), and F_4 selections from these lines will be evaluated in nurseries in 2011. Now that the high-throughput marker genotyping capability is developed, a promising planned approach to expedite selection will be by using marker-assisted backcross breeding to introgress the 'green genes' into a CB46 or CB50 genetic background, thus retaining the high yield potential and other component traits of CB46 and CB50 (Table 3).

Table 2. Promising new all green lines that will be tested in replicated on-station trials in 2011 and that were used in crosses to generate new lines.

	Line	**Pedigree**
1	08-11-49	01-11-880/01-11/941
2	08-11-65	00-11-426-2/00-11-762-6
3	08-11-70	00-11-426-2/00-11-762-6
4	08-11-91	CB27/00-11-426-2
5	08-11-110	01-11-880/01-11-100
6	08-11-111	01-11-880/01-11-100
7	08-11-132	01-11-880/01-11-100
8	08-11-140	03-15-293-1-3/03-15-263-1-4
9	08-11-153	03-15-293-1-3/03-15-263-1-4
10	08-11-154	03-15-293-1-3/03-15-263-1-4
11	08-11-186	01-11-880/01-11-100
12	08-11-187	01-11-880/01-11-100

Table 3. Crosses made and advanced for selection of improved dry green varieties

	Cross Number	**Pedigree**	**Type**	**Current Generation**	**2011**
1	2009-013	08-11-70-1 x 08-11-154	Green x Green	F_2	F_4
2	2009-014	08-11-111 x 08-11-154	Green x Green	F_2	F_4
3	2009-015	08-11-153 x 08-11-110	Green x Green	F_2	F_4
4	2009-016	08-11-187-3 x 08-11-65	Green x Green	F_2	F_4
5	2009-017	CB46 x 07-11-350	Blackeye x Green	F_2	F_4
6	2009-018	CB46 x 08-11-70-1	Blackeye x Green	F_2	F_4

7	2009-019	CB46 x 08-11-91	Blackeye x Green	F_2	F_4
8	2009-020	CB46 x 08-11-187-2	Blackeye x Green	F_2	F_4
9	2009-021	07-11-350 x CB46	Blackeye x Green	F_2	F_4
10	2009-023	CB50 x 08-11-49	Blackeye x Green	F_2	F_4
11	2009-024	CB50 x 08-11-60-2	Blackeye x Green	F_2	F_4
12	2009-025	CB50 x 08-11-70-1	Blackeye x Green	F_2	F_4
13	2009-026	CB50 x 08-11-132	Blackeye x Green	F_2	F_4
14	2009-027	CB50 x 08-11-140	Blackeye x Green	F_2	F_4
15	2009-028	CB50 x 08-11-186	Blackeye x Green	F_2	F_4
16	2009-029	08-11-70-1 x CB50	Blackeye x Green	F_2	F_4
17	2009-030	08-11-78 x CB50	Blackeye x Green	F_2	F_4
18	2009-031	08-11-103 x CB50	Blackeye x Green	F_2	F_4
19	2009-032	08-11-106 x CB50	Blackeye x Green	F_2	F_4
20	2009-033	08-11-187-3 x CB50	Blackeye x Green	F_2	F_4
21	2009-034	CB46 x 02053F1	Blackeye x Green	BC_1F_1	BC_1F_4
22	2009-035	CB50 x 02053F1	Blackeye x Green	BC_1F_1	BC_1F_4
23	2009-036	02053F1 x 07-11-350	Blackeye x Green	BC_1F_1	BC_1F_4
24	2009-037	02053F1 x 02082F1	Blackeye x Green	BC_1F_1	BC_1F_4
25	2009-038	CB46 x G747-1	Blackeye x Green	F_2	F_4
26	2009-040	CB50 x G749-1	Blackeye x Green	F_2	F_4

In California: Performance tests conducted in 2009 and earlier years indicated that only P-87 deserved to be taken forward for possible release. In 2010 trials with P-87 and blackeye cultivars will be conducted, including a large-scale strip trial and including CB46, CB5, CB50 and P-87. Depending on results, it is likely that similar large-scale tests would be conducted in 2011, including tests in grower's fields (Table 1). Breeders seed of P-87 will be initiated in anticipation of release by growing head rows from 20 on-type plants, taking a single plant from the most uniformly similar lines and continuing with a greenhouse seed increase of these materials.

In California: Continued development and testing of new elite blackeye lines. A breeding nursery with several hundred F_4 generation blackeye breeding lines will be conducted. These breeding lines were derived from 26 new F_1's between selected promising breeding lines and CB46, breeding line 524B and cultivar CB27 made in 2009 and 2010 (Table 4).

Table 4. Crosses for development of high yielding, pest resistant blackeye cowpea cultivars

Cross No.	**Blackeye Crosses**	Current Generation	Generation in 2011
2010-066	CB46 x 09Sh-3-2	F_2	**F_4**
2010-067	CB46 x 09Sh-3-4- sps	F_2	**F_4**
2010-068	CB46 x 09Sh-3-6sps	F_2	**F_4**

2010-069	CB46 x 09Sh-13-6	F_2	**F_4**
2010-070	CB46 x 09Sh-36-2	F_2	**F_4**
2010-071	CB46 x 09Sh-93-3	F_2	**F_4**
2010-072	CB46 x 09Sh-105-2	F_2	**F_4**
2010-073	CB46 x 09Sh-112-6	F_2	**F_4**
2010-074	CB27 x 09Sh-13-6	F_2	**F_4**
2010-075	09Sh-93-3 x CB27	F_2	**F_4**
2010-076	09Sh-113-6 x CB27	F_2	**F_4**
2010-077	524B x 09Sh-13-1	F_2	**F_4**
2010-078	524B x 09Sh-13-6	F_2	**F_4**
2010-079	524B x 09Sh-31-1	F_2	**F_4**
2010-080	524B x 09Sh-36-8	F_2	**F_4**
2010-081	524B x 09Sh-113-10	F_2	**F_4**
2010-082	09Sh-95-8 x 09Sh-13-7	F_2	**F_4**
2010-083	09Sh-36-6 x 09Sh-109-2	F_2	**F_4**
2010-084	09Sh-95-8 x 09Sh-113-12	F_2	**F_4**
2010-085	09Sh-113-4 x 09Sh-95-8	F_2	**F_4**
2010-086	09Sh-113-4 x 09Sh-3-6 sps	F_2	**F_4**
2010-087	09Sh-113-5 x 09Sh-13-6	F_2	**F_4**
2010-088	09Sh-113-5 x 09Sh-31-10	F_2	**F_4**
2010-089	09Sh-113-5 x 09Sh-36-6	F_2	**F_4**
2010-090	09Sh-113-4 x 09Sh-93-1	F_2	**F_4**
2010-091	09Sh-113-1 x 09Sh-93-3	F_2	**F_4**

In California - Development of lygus, nematode and aphid resistant varieties: A range of lygus resistant breeding lines have been developed that are in different stages of testing (Table 5). In FY11, a subset of these lines will be selected based on their performance in lygus screening trials conducted in 2010, and evaluated for grain yield and grain damage under lygus protected and unprotected conditions at Kearney. We also initiated a new round of crosses in 2010 for breeding varieties with increased resistance to lygus and that have high quality grain, because while current lygus resistant lines including 07KN-42, 07KN-46 and 07KN-76 combine very high yield potential and resistance to lygus bug, improvement in grain quality is needed to meet market expectations. F4 lines developed from these crosses will be screened in an unprotected nursery at Kearney under strong selection for resistance to lygus and for desirable grain quality. We are also breeding an improved version of CB46 with greater resistance to root-knot nematodes derived from IITA breeding line IT84S-2049 (Table 8). Line CB46-57Rk^2 is an advanced (BC6) backcross derived breeding line closely resembling CB46 that does have greater resistance to root-knot nematodes, but that has smaller grain size than CB46. This line was crossed with CB46 in 2010 to create the BC7F1. In FY2011 inbred BC7F2 lines will be developed. These will be evaluated for resistance to nematodes in laboratory growth pouch assays and resistance lines increased in the greenhouse to obtain sufficient seed further tests. For aphid resistance, breeding lines including 07KA-34, 07KA-173 were

developed (from resistance source IT97K-556-6) that show strong resistance to this pest in aphid resistance screening trials. Following additional aphid resistance phenotyping in 2010, the most resistant lines will be crossed with CB46 and CB50 as part of the process of transferring aphid resistance to adapted varieties. In FY11, the F1s of these crosses will be grown in the greenhouse to obtain F2 seed, and the F2 generation planted in aphid screening nurseries at Kearney for selection.

Table 5. Promising lygus resistant lines and Trial Status in 2011 and 2012 if selected

Line	Current status	Status in 2011	Status in 2012
07KN-42	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
07KN-46	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
07KN-74	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
07KN-98	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-27	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-33	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-35	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-38	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-57	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-64	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-1-9	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-2-27	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments

09KLN-2-30	Replicated Unprotected Trial	Advanced Trials – P/U treatments	Advanced Trials – P/U treatments
09KLN-2-19	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-22	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-23	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-26	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-68	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-71	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-74	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-77	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-120	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-121	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-125	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-164	Replicated Unprotected Trial	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-166	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-167	Unprotected Nursery	Replicated Unprotected Trial	Advanced Trials – P/U treatments
09KLN-2-	Unprotected	Replicated	Advanced

168	Nursery	Unprotected Trial	Trials – P/U treatments

P/U = **P**rotected with Temik/**U**nprotected from lygus.
We will continue with a new two-tiered breeding strategy that was initiated in the Phase 1 workplan period, to meet the immediate and longer term needs of farmers.

Recurrent Backcrossing to Improve Existing Varieties: This *Short-Term Strategy* uses improved and local varieties having both grain quality and agronomic features appreciated by farmers such as appearance, taste, cooking qualities, yield stability, appropriate plant type and maturity. Obvious defects in local and improved varieties will be improved by breeding in resistance to diseases and pests plus other traits, using a rapid recurrent backcrossing approach that will improve productivity and be accepted by farmers. The selected varieties being improved by this approach are given in Tables 6-8.

In Senegal, from the new crosses made by Dr. Cisse at ISRA, progeny selection and advancement will be made to develop varieties with medium to late maturity to cope with the changing cropping season length in the northern zones and with the growing interest in cowpea in the south and eastern areas. These materials include thrips resistance and good grain size and color qualities. The crosses are summarized in Table 6. For introgressing Striga resistance, Yacine was crossed with a more recent line (IT90K-76) for Striga resistance and Suvita 2 for Macrophomina. In FY11, these crosses will be advanced to the BC2F2 and F4-F5 generations. Screenhouse and field techniques will be used to evaluate the different populations and generation for Striga and Macrophomina resistance. These evaluations will be combined with SSR markers for tracking Striga resistance. Thrips evaluation will be field-based at the Nioro station hotspot.

Table 6. Senegal varieties being improved by introgression of specific traits by backcrossing.

Recurrent Parent	**Trait donor parent**	**Institution**	**Trait introgressed**
Yacine	IT93K-503-1	ISRA	Macrophomina resistance
Yacine	Suvita2	ISRA	Macrophomina resistance
Yacine	58-77	ISRA	Flower thrips resistance
Yacine	IT90K-76	ISRA	Striga resistance
Mouride	Montiero derived line	ISRA	Large grain
Melakh	IT97K-499-39	ISRA	Striga resistance
Melakh	UCR 03-11-747	ISRA	Green grain

In Burkina Faso, from the new crosses made by Dr. Drabo at INERA, progeny selection and advancement will be made to develop varieties with increased seed size of the

improved varieties for Burkina Faso since large seed size is one of the most important characteristics of preference in the sub-region. The range of crosses established for backcrossing should allow selection of new larger seeded varieties carrying important insect, disease, Striga and nematode resistance traits, drawing on previous findings from the Bean/Cowpea CRSP project (Sawadogo et al., 2009). The crosses are summarized in Table 7. The national cowpea plan of action for Burkina Faso has stressed the importance of exporting the surplus cowpea production to the neighboring countries that have deficits of more than 500,000 metric tons.

Table 7: Burkina Faso varieties being improved by introgression of specific traits by backcrossing.

Recurrent parent	**Traits being introgressed**	**Donor parents**
KVx 745-11P	Medium seed size white and rough	KVx 414-22-2 derived lines and KVx 775-33-2
KVx 396-4-5-2D	Striga resistance and seed size	Kvx 414-22-2 derived lines and KVx 775-33-2
KVx775-33-2	Increased seed size	Montiero
KVx 414-22-2	Increased seed size Striga and virus resistance	KVx 414-22-2 derived lines and Montiero
KVx 414-22-2	Increased seed size and virus resistance	KVx 775-33-2
KVx 771-10	Striga and insect resistance	IT86D-716 and Moussa Local
KVx 775-33-2	Virulent race of Striga resistance	IT93K-693-2

During the FY11 workplan period the Senegal and Burkina Faso recurrent backcross populations will be advanced and inbred such that they are all at the BC2F3 stage by the end of the 2011 season. The BC progenies will be greenhouse or field selected based on the target traits for each round of backcrossing. Leaf tissue sampling for DNA extraction, SNP genotyping and selection based on SNP marker complements will be used to aid in the selection for multiples traits. Molecular markers for the target resistance traits developed from the EST-derived SNP-marker genotyping effort under the GCP-TL1 cowpea project will be used to select progenies carrying required alleles at each BC generation before flowering. This will allow quick identification of individuals without phenotyping at each generation for another round of backcrossing. Use of the DNA Landmarks out-sourcing service for SNP-based sequenome genotyping will be used, in which the leaf samples from Africa will be sent to the genotyping service. Marker interpretations will be team-based as a built-in training component. This should expedite the variety improvement under the short-term strategy.

The California blackeye lines being improved by recurrent backcrossing are summarized in Table 8, along with their current status. The status of the advanced and inbred BC populations at the start of the FY11 workplan period is given in Table 8. Depending on the stage of backcrossing and inbreeding, these materials will either be backcrossed or tested for yield performance during FY11 main growing season. The SNP-marker genotyping described above for Senegal and Burkina Faso backcross progenies will be applied similarly to check for the resistance traits (to root-knot nematode, Fusarium wilt, and aphid). Markers for Lygus bug resistance are not yet identified, and these will be pursued using the segregating progenies for marker-phenotype associations.

Table 8. California blackeye lines being improved by introgression of specific traits using backcrossing at UCR.

Recurrent Parent Line	**Trait donor parent**	**Trait being introgressed**	**Status at start of FY11 Workplan**	**FY11 action plan**
CB5	CB27	Fusarium wilt	BC2F7	Phenotype lines for wilt resistance, make BC3F1 with resistant individuals; evaluate resistant BC2F7 lines for agronomic performance
CB46	UCR 03-11-747	Green grain	BC4F10	Make BC5F1, inbreed for line development; also test BC4F10 lines in replicated tests
CB46	IT84S-2049	Root-knot nematodes	BC6F9	Make BC7F1, inbreed; replicated performance tests of advanced BC6 line CB46-57Rk^2
CB46	Montiero (Brazil)	Large grain size	BC3F9	Nursery evaluation of advanced lines
CB46	Bambey 21(Senegal)	All-white grain	BC4F10	Replicated performance tests of advanced lines
CB46	IT97K-556-6 & UCR 779	Aphid resistance	BC1F6	Phenotype lines for aphid resistance, make BC2F1, inbreed to obtain BC2F2
CB46	IT93K-2046	Lygus resistance	BC3F6	Phenotype lines for lygus resistance, make BC4, inbreed

The *Longer Term Strategy* is to pyramid resistance and grain quality factors in varieties desired by farmers using crosses between elite parents having complementary parental lines. To develop high performing, drought tolerant varieties we are using a 'two-stream' recurrent selection approach initiated in the current Phase 1 project period.

Stream One includes biparental crosses between highly drought tolerant lines SuVita 2, Mouride, IT93K-503-1 and IT97K-499-39. During the 2008-2010 project phase, the F1's were made at UCR, then advanced to the F2 generation and subjected to screening for drought tolerance. Drought-tolerant F2 individuals were identified and were advanced to the F3 for each population. The F3 lines were evaluated for drought tolerance and the best performing 100 selected and the family bulked for further evaluation. Selected families will be planted in replicated field trials (2 rows x 3 reps) in Senegal and Burkina Faso in the main 2011 season for initial performance evaluation. These trials will be located at Saria, Pobe and Kamboinse in Burkina Faso and at Bambey and Thilmakha in Senegal. Individuals from the most drought tolerant lines will be used for crossing to the improved lines developed under the backcrossing program described earlier and in Tables 6-7.

Stream Two includes a set of popular local cowpea varieties chosen by breeders in Senegal and Burkina Faso during the 2010 workplan period for targeted genetic improvement through MAS or MARS. These were hybridized to sources of known thrips resistance and heat/drought tolerance. The crosses are described in Table 9. They were made between drought tolerant Mouride, IT93K-503-1, IT97K-499-39, IT98D-1399, and Ein El Ghazal (Sudan) and elite African breeding lines KVx61-1 and KVx544-6-151 (both from Burkina Faso), Apagbaala and Marfo-Tuya (both from Ghana), UCR 779 (Botswana), and IT82E-18, IT95K-1479, IT97K-819-45 and IT98K-558-1. In 2009, 352 F3 families were screened for performance under post-flowering drought conditions and the seed bulked. The 100 top performing bulks will be re-evaluated in California in late 2010 and 4 single-plant selections made in the best 25 performing families. These 100 F5 selections will be shipped to Burkina Faso and Senegal, where they will be grown-out in field nursery plots and phenotyped for thrips tolerance and grain production under drought/heat conditions in FY2011. Some additional crosses with Yacine and Melakh (e.g. Yacine x IT93K-503-1) made in Senegal will be advanced by single seed selection to the F6 generation in 2011, with selection based on grain quality and SNP markers for drought, thrips and Macrophomina resistance. We consider the population sizes to be adequate to make significant genetic gain, based on our ability for selection of contributing trait determinant QTL by the high-throughput SNP genotyping capability.

In both Burkina Faso and Senegal, 20 elite lines from the GCP-Tropical Legumes II (TL-II) project will be tested for grain yield and agronomic characteristics in 2010 in main season small replicated trials (2 rows x 3 reps) containing local check varieties. From these the best performing lines will be evaluated in advanced trials (4 rows x 4 reps) in 2011. These trials will be located at Saria, Pobe and Kamboinse in Burkina Faso, and at Bambey and Thilmakha in Senegal.

Table 9. Crosses made and advanced to F6 generation that will provide progenies for selection of drought and pest tolerant cultivars in Burkina Faso and Senegal. Action plans for these lines are discussed in the text.

Cross	Type
SuVita2/Mouride	Elite Drought Tol. x Elite Drought Tol.
IT93K-503-1/IT84S-2246	Elite Drought Tol. x Elite Drought Tol.
Mouride /IT84S-2246	Elite Drought Tol. x Elite Drought Tol.
IT97K-499-39/IT93K-503-1	Elite Drought Tol. x Elite Drought Tol.
IT97K-503-1/IT97K-556-6	Elite Drought Tol. x Elite Drought Tol.
Mouride/Apagbaala	Elite Drought x Elite Heat Tolerant
KVx61-1/Mouride	Elite x Elite Drought Tolerant
IT93K-503-1/UCR 779	Elite Drought Tolerant x Drought Tolerant and aphid resistant landrace
Apagbaala/IT82E-18	Elite Heat Tolerant x Elite
IT97K-819-45/Ein El Ghazal	Elite x Elite Drought Tolerant
Ein El Ghazal/KVx544-6-151	Elite Drought Tolerant x Elite
IT98K-558-1/Mouride	Elite x Elite Drought Tolerant
Apagbaala/IT98K-558-1	Elite Heat Tolerant x Elite
IT95K-1479/Mouride	Elite x Elite Drought Tolerant

In California: *Pigeonpea*

GA-1, a selection made in earlier years at UCR from materials supplied from Dr. Sharad Pathak at the University of Georgia, will be tested in on-farm trials in 2011. Engagement with local farm advisors will be done to optimize a production package for this new crop. A replicated yield trial will be conducted with 10 selections identified in 2010 evaluations. In addition, a selection nursery will be planted and selections made for grain quality and productivity.

Objective 2: Strengthen cowpea seed production and delivery systems in Angola, Burkina Faso and Senegal to ensure delivery of improved varieties.

Collaborators

Samba Thiaw (agrophysiologist), Centre National Recherches Agronomie, Bambey, Institut Senegalais de Recherches Agricole (ISRA), Senegal.
Tignegre Jean-Baptiste, INERA, Kamboinse, Burkina Faso.
Jose Pedro, Centro Nacional de Recursos Fitogenetico, Luanda, Angola.
David Kiala, Universidade Agostinho Neto, Huambo, Angola.
Antonio Castame Francisco, Instituto de Investigacao Agronomica, Luanda, Angola.

Approaches and Methods: Cowpea seed production and delivery systems in Burkina Faso and Senegal will be strengthened to ensure delivery of improved varieties. Adoption of improved varieties is constrained by inadequate supply of Breeder and Foundation

Seed, which in turn limits the Certified Seed that can be produced. Insufficient resources limit growing, harvesting and storing Breeder Seed increases, in turn limiting Foundation Seed and Certified Seed for farmers is due to the lack of Foundation Seed coupled with the relatively low interest in cowpea by public and governmental organizations and private seed companies.

We will increase directly amounts of Breeder and Foundation Seed available to Certified Seed producers, help identify new Certified Seed producers, and strengthen and expand proven activities in Senegal and Burkina Faso through leveraged funding from NGOs and USAID Mission funding, if possible. We will work with the national extension services in Senegal (ANCAR), Burkina Faso, and Angola (SENSE) to reach the farmers' organizations in different communities. We will also seek to strengthen the small private seed producers, some of them already working on cowpea.

A strategy adopted by the newly created GCP/ICRISAT 'Legumes for Livelihoods' project that is on-going in Niger, Nigeria, Mali, Tanzania, and Mozambique for cowpea is to improve farmers' access to seed and enhance widespread adoption of improved cowpea varieties through the development and promotion of community seed production and promotion of local markets for seed. Their well-considered view is that no single agency can produce and provide the required quantities of high quality planting seed. Seed of improved varieties can be disseminated through rural retail networks based on government schools. In Senegal, Burkina Faso, and Angola, schools can act as a seed supply center in each village, with teachers trained on procedures for quality seed production. Several progressive farmers will be selected per village and given guidance in seed production and supplied with quality Foundation Seed for multiplication. They will become the source of improved seed for the entire village. From these efforts, local entrepreneurs may arise to form local seed companies. Strong linkages will be developed with PASS (Program for Africa's Seed Systems), WASNET (West African Seed Network) and other programs to derive synergy in promoting local seed enterprises.

In Burkina Faso, the primary effort will be to produce Foundation Seed and Certified Seed of 6 newly released varieties (IT98K-205-8l, Melakh, KVx421-2J, KVX442-3-25, KVx771-10 an33-2d KVx735-33-2) and 10 existing varieties (Gorom local, KVx61-1, KVx396-4-4, KVx396-4-5-2D, KVx414-22-2, KVx745-11P, Telma, KN1, Moussa Local). 60 tons of Certified Seed will be produced at Sourou, Bulkiemde, Sandie, Passore, Zandoma, Sanmatenga and Oubritenga provinces by trained farmers. Breeder Seed will be produced in the off-season for five varieties (IT98K-205-8, Melakh, KVX421-2J, KVX414-22-2, Gorom Local) on 200 m^2 per variety. The seed will be produced at Di under irrigation. Foundation Seed production will be made to ensure an adequate capacity on each of the three INERA stations (Saria, Pobe, and Kamboinse). This activity will generate about **7** tons of Foundation Seed. This will address the estimated 5% shortage of Foundation Seed, kick-starting an expansion of the self-sustaining seed production system. Training of farmers as Certified Seed producers will be done at Tougan (Sourou province) Saria (Bulkiemde province, Donsin (Oubritenga Province Pobe (Soum province and Pissila (Sanmatenga province). A total of 70 seed producers, a mix of women and men, will be trained. Foundation Seed will be provided

and farmers will be trained in seed production, harvest and post-harvest handling, recognizing that this process differs from the production of cowpea for consumption.

In Senegal, availability of Foundation Seed has been identified as a bottleneck for adequate supply of seed to farmers. Foundation Seed is used to produce the Certified Seed that is distributed to farmers for production planting. To overcome this, N. Cisse will produce 1 ha of Melakh, 1 ha of Yacine, and ½ ha of ISRA-2065 to complement the Foundation Seed production by the ISRA seed unit at Bambey. This effort will help to identify the demand level for Foundation Seed and provide seed for establishing new Certified Seed growers in cowpea production areas where there is currently no formal Certified Seed production effort. To achieve new Certified Seed grower establishment, we will work with the national Extension Service (ANCAR) and farmer organizations at 4 locations (Thilmakha region, Merina district, Mekhe, and Bambey). At each location, Foundation Seed will be provided and farmers will be trained in seed production, harvest and post-harvest handling, recognizing that this process differs from the production of cowpea for consumption. Organizations who contact ISRA for Certified Seed will be directed to the new Certified Seed producers, to establish a supply and demand relationship that should become self-sustaining. This plan builds on and expands the effort underway in the current period.

In Angola, we will continue to link with government and NGO institutions, including World Vision, Africare, CRS and ADRA-Angolana, to determine opportunities for advancing the cowpea seed system. This effort will be aided by the site visit in earlyFY11, in which we will coordinate with the Pulse CRSP bean breeding project of Drs. Beaver and Porch. Opportunities for a coordinated bean and cowpea seed system based on the Breeder – Foundation – Certified Seed system chain will be pursued. We will provide guidelines and descriptions for Angolan nationals in multiplication of high quality seed of selected varieties for farmers. Our parallel efforts of cowpea field evaluations under Objective 1, to identify candidate varieties among local landraces, and Bean/Cowpea CRSP (in Ghana, Senegal and/or Burkina Faso) and IITA varieties, is anticipated to provide new release for increase and distribution.

Objective 3: Technology Dissemination (Seed of Improved Cowpea Varieties in West Africa)

Collaborators

Jeff Ehlers (cowpea breeder), University of California, Riverside, USA
Samba Thiaw (Agronomist), Centre National Recherches Agronomie, Bambey, Institut Senegalais de Recherches Agricole (ISRA), Senegal.
Jean-Baptiste Tignegre, INERA, Kamboinse, Burkina Faso.
Dr. Amadou Moutari, INRAN, Niger
Dr. Mamadou Toure, IER, Mali

Approaches and Methods

INERA, Burkina Faso: In Burkina Faso during FY 11, Breeder Seed of seven improved cowpea varieties (IT98K-205-8, Melakh, KVX421-2J, KVX414-22-2, KVX442-3-25,

KVX775-33-2, Gorom Local) will be produced at Saria and Pobe. This should yield 800 kg of Breeder Seed of each variety. Theory and practical training will be conducted at five locations (Tougan, Saria, Donsin, Pobe and Pissila), during the period April –May, 2011. This activity will train 120 farmers, of which at least 30 will be women. The 120 trained farmers also will be guided in producing Certified Seed of the INERA improved cowpea varieties. Each farmer will plant 1 ha (total of 840 kg of Breeder seeds) starting at the end of June 2011 in several villages of five provinces (Sourou, Oubritenga, Bulkiemde, Soum and Sanmatenga). This activity is estimated to generate 40 T of Certified Seed produced on a total area of 60 ha. Two visits by the INERA national cowpea research team will be made to each farmer's field during the June-September production season to provide updates on practical training and advice.
Breeder (1 ha at SARIA, Koudougou) and Foundation (16 ha at Saria, Kamboinse and Pobe) Seed of the seven varieties will also be produced during the 2011 growing season (June-September). This is estimated to yield 50 kg of Breeder Seed of each variety and a total of 20 T of Foundation Seed.

ISRA Senegal: In Senegal, the availability of Foundation Seed is a bottleneck for adequate supply of seed to farmers. Additional Foundation Seed will be produced of three varieties (Melakh, Yacine, ISRA-2065) to supply new Certified Seed to growers. It is planned that 1 T of Foundation seeds will be produced during the off-season (March – May 2011) under irrigation to complement the Foundation Seed obtained during the rainy season of 2010. The project team will work with the National Extension Service (ANCAR) and 80 farmer organizations at 5 locations (Thilmakha, Merina, Mekhe, Bambey and Louga), where farmers (100 – 200) will be trained in seed production, harvest and post-harvest handling. ISRA will focus in particular on Mekhe, a federation with 70 member farmer organizations, with the capacity to supply communities with cowpea seed sold through their storage facilities and in local markets. It is estimated that 50-60 T of Certified Seeds will be produced. Seed will be packaged in 4 Kg bags from a government processing unit in Diourbel near Bambey. At least 100 ha of Melakh and Yacine will be grown initially for Certified Seed, with the goal of scaling up in future years. During the 2010 growing season 2-3 T of Foundation Seed will be produced at the ISRA Bambey Research Station. Support will also be provided to the Millennium and PADER projects of EWA to expand their cowpea seed production. One private seed company (SEDAB) will be approached to interest it in cowpea seed production.

A meeting of cowpea scientists and breeders will be held in May 2011 in Mali (with Dr. Toure, IER) and in Niger (with Dr. Moutari, INRAN) to deliver planting seed of improved Senegal and Burkina Faso cowpea varieties and to discuss protocols for field testing. At least six varieties from Senegal and Burkina Faso will be tested in southern Niger and southwest Mali during the main 2010 growing season. The two best performing varieties will be chosen for Mali and Niger expansion in 2011 using the Breeder to Foundation to Certified Seed production pipeline.

Objective 4: Capacity Building for Host Country NARS

Collaborators
James Beaver, University of Puerto Rico, US.

David Kiala, Universidade Agostinho Neto, Huambo, Angola.
Antonio David, Instituto de Investigacao Agronomica, Luanda, Angola.
Students from Africa (to be named)
A significant portion of requested budget (U.S. for Host Country) will be spent on degree training in modern breeding for African students, and for training current NARS breeders in Angola, Burkina Faso and Senegal in application of the new high-throughput based molecular genotyping protocols for marker-assisted breeding to cowpea germplasm and breeding populations described under Objective 1. We anticipate the proposed breeding and seed dissemination research and training activities will build sustainable capacity through the development of new and improved cowpea varieties and elite breeding populations in the Host Countries, coupled with strengthening and expanding the cowpea seed production and dissemination systems (Breeder, Foundation, and Certified Seed production capability). Training in and adoption of the new SNP-based marker selection technology for the Host Country cowpea breeders will build capacity in the African cowpea breeding programs, and should result in significant breeding efficiencies. We anticipate continuing the leveraging of CRSP resources with other funding to propel the cowpea program forward.

Degree (MS and PhD level) training for two African scientists will be undertaken with the goal of developing the next generation of cowpea breeders. The project team has now identified trainee candidates and applications are pending. One trainee (Antonio David) has been identified from Angola, where a new cowpea breeder will fully complement the plans to develop a new cowpea breeding program. This trainee will complete the MS course in plant breeding at the U. Puerto Rico, in collaboration with Dr. James Beaver. He started the UPR MS course in August 2009. His training will run through the new workplan period. We have been working with several trainee applicants for the PhD program at UC Riverside, but have yet to have one accepted in and matching with the program. Currently 2 candidates are in the application process, with a start date in the PhD program of Winter Quarter 2011 (January 2011). Of these two, Madame Penda Sarr is an applicant from Senegal where she is working with HC PI Dr. Cisse and ISRA scientists with interest in Plant Pathology and cowpea breeding. The second candidate is Mr. Arsenio Daniel Ndeve, from Mozambique, who recently completed a MS degree in Denmark and is working with cowpea breeder Dr Rogerio Chiulele, at Universidade Eduardo Mondlane. He would provide an excellent alternate candidate for training in cowpea breeding and pathology, building on the vigorous cowpea breeding program being established by Dr. Chiulele with assistance from IAMM and their research stations at Umbelezi and especially Chokwe, where the station manager is Celestina Jochua, HC PI for Jonathon Lynch's Pulse CRSP project in Mozambique. In countries with established senior cowpea breeders such as Burkina Faso, Senegal, and Nigeria, PhD student training would anticipate gaps arising as senior breeders reach retirement. Degree training in Mozambique would anticipate needs to build on a newly developing program where University and NARS facilities and mentoring personnel are available. Degree training for one PhD student will be conducted at the University of California Riverside in the Plant Biology (Genetics) or Plant Pathology graduate program. Research topic and guidance will be overseen by the UCR PIs and encompass Objective 1 activities for marker-assisted cowpea breeding focused on abiotic and biotic stress resistance traits.

Training current cowpea breeders in the development and application of DNA-based markers for MAS in the cowpea breeding programs will be embedded in the research effort under Objective 1. Cowpea breeders will be trained in marker application utilizing their own breeding populations generated by the high x high crosses and recurrent back-crossing for existing variety improvement made within the programs. This will focus on the Senegal and Burkina Faso programs and to some extent on Angola. This training, started under the Phase 1 FY 10 workplan, will utilize the new SNP-genotyping platform for cowpea. The approach will involve the growing of breeding progenies in Africa, leaf sampling, and shipping leaf samples to a western genotyping lab for SNP-based marker genotyping. The genotyping results will be co-analyzed by the US and HC team jointly via Skype and computer conferencing for data display on a monthly basis during the active breeding periods. Data will be project to computers with conference discussion of data. During site visits to the Host Countries planned in FY 11, additional training will be made through joint interpretation of data sets and progeny selections as a hands-on MAS and MARS experience. The genotyping will allow all target traits described under Objective 1 to be advanced by indirect selection. Markers linked to traits including drought tolerance and *Macrophomina* and thrips resistance will be emphasized. This activity will require a continuing training effort extending through FY12 and beyond, in order to build by experience the necessary competence within the project team.

Contribution of Project to Target USAID Performance Indicators

The Performance Indicators presented as 2011 workplan targets, are projections from the three Host Countries (Angola, Burkina Faso, Senegal) covering cowpea breeding, seed systems development, and training activities, and based on the following considerations. IEHA supports good governance and collaborative relationships to promote conditions that will allow agriculture to flourish in Africa, including support of science and technology driven strategies and partnerships to accelerate advances that will reduce hunger. Our project is the first comprehensive program focused on bringing modern plant breeding tools and strategies that are commonly used in other crops, to cowpea genetic improvement efforts. These tools and strategies will speed up the delivery of improved cowpea varieties to farmers. Modern plant breeding is rapidly evolving as improvements in molecular marker and other technologies evolve, and the use of modern breeding methods in African breeding programs, as we propose, represents an on-going type of dynamic and highly relevant training for African scientists.

The IEHA program has West and Southern Africa Regional Programs that include Senegal and Angola. USAID-Angola focuses on food security, democratic governance, improved maternal/child health, and economic reform. Our project contributes to food security, an important objective for all of the host countries through the development and dissemination of varieties tolerant to drought and pest attack by harnessing recent advances in plant breeding for the benefit resource-poor farmers.

Women produce much of the African cowpea crop, but are also some of the most disadvantaged in terms of access to capital to purchase farm inputs and to ‘good’ land. Our improved varieties will yield better than varieties presently in use in the face of

pest attack and do not require purchased inputs of fertilizers and pesticides to add value. Thus the improved varieties are of particular benefit to the majority of women farmers who cannot afford inputs.
Women are the main processors of popular value-added cowpea-based food products such as 'Akara' that are extensively sold in urban centers of West and Central Africa. Hence a large portion the benefits of increased productivity and improved grain quality made possible with improved varieties will flow to women producers of cowpea-based value-added foods in the form of lower prices for the raw product and higher quality of grain available in the marketplace.

In consideration of biodiversity conservation, and social, political and environmental goals, this project will increase farmer yields through the development and dissemination of cowpea varieties with improved yields as a result of improved yield potential and through the possession of resistance to abiotic and biotic stresses. Loss of biodiversity in Africa can be countered by increased rural prosperity through increased yields. Increased rural incomes will lessen the pressure on farm families to engage in environmentally destructive practices such as wood harvesting for manufacture and sale of charcoal to generate income, and unsustainable crop rotations. Pesticide use in rural Africa presents an array of human health problems. The varieties that will be released and the seed systems strengthened by this project will be more productive without pesticides, with fewer or 'softer' pesticides than existing varieties, reducing the environmental and health hazards associated with insecticides. Increased rural incomes resulting from the improved varieties will allow farmers to purchase soil-improving fertilizers, especially phosphorus, which is currently being unsustainably mined by present cropping practices in West and Central Africa. The more productive varieties should allow farmers to make money even in the face of reduced cowpea prices. The reduced price will encourage consumption. Increased acreage of cowpea, as a nitrogen-fixing legume, will improve soils for subsequent staple cereal and tuber foods. Thus, the improved varieties can contribute to the start of positive momentum towards more productive and sustainable systems in the targeted host countries.

Target Outputs and Developmental Outcomes

- New variety candidates advanced and selected from Phase I elite breeding populations.
- New cowpea varieties released in Burkina Faso, Senegal, and California.
- Existing cowpea varieties and breeding lines assessed for production potential in Angola.
- High through-put marker selection optimized for African cowpea breeding programs.
- Foundation and Certified Seed production systems strengthened in Host Countries.
- MS and PhD African students trained in modern plant breeding through research on cowpea.
- HC cowpea breeders trained in application of new molecular markers for key traits.

<u>Developmental outcomes</u> will be represented (and measurable) by increases in the area planted with and tonnage produced of Foundation and Certified Seed of new and preferred cowpea varieties, by increase in the number of hectares planted with new

cowpea varieties, and by increases in the numbers of rural households benefitting directly from the new cowpea varieties and strengthened cowpea seed systems.

Engagement of USAID Field Mission(s)

The US and HC Principal Investigators will meet with USAID Missions in Angola and Senegal during U.S. Principal Investigator visits to the host country projects. In each case the Mission staff will be informed about project activities and significant accomplishments and look for opportunities for Mission funding of projects that leverage the goals of our proposal. Similarly, the USAID West African Regional Program, which is responsible for USAID programming in Burkina Faso but located in Ghana, will be contacted about funding opportunities that are consistent with the goals of this proposal. These engagements will be used to share and learn of any opportunities for Mission Associate awards or other support for our CRSP activities.

Networking Activities with Stakeholders

We will work closely with national and international cowpea breeders, including Drs. Ousmane Boukar and Christian Fatokun, Senior Scientists and Cowpea Breeders at IITA, Dr. Mohammed Ishiyaku of the IAR in Nigeria, and Dr. Rogerio Chiulele, Eduardo Mondlane University, Maputo, in Mozambique. We will continue to work with national extension services, World Vision International and other NGOs to extend new cowpea technologies. Specifically in the Host Countries for this project, we will network with NGOs in Burkina Faso, Senegal, and Angola. This will be especially important in the Objective 2 activities on advancing and developing seed production and delivery systems.

Leveraging of CRSP Resources

Other resources leveraged from current and future funded complementary cowpea research projects include the following:

California Dry Bean Advisory Board and its Blackeye Varietal Council (funds currently and typically set at $18,000 – 20,000 per year) funded for cowpea breeding in California. This is a continuing, long term research arrangement in support of the UC Riverside cowpea breeding program.

The CGIAR Generation Challenge Program (GCP) Tropical Legumes I Project Phase 2 extension was funded for 4 years (May 2010-April 2014). The cowpea component of this project is lead by UC Riverside (Ehlers, Roberts, and Close) and includes collaborative funded cowpea breeding and research with the cowpea breeding programs in Burkina Faso (with PI I. Drabo), Mozambique (PI R. Chiulele) and Senegal (PI N. Cisse), and IITA (PI, O. Boukar). This project funded at $2.729M is applying cowpea genomic resources based on SNP genotyping for cowpea marker-assisted breeding. Use of the high throughput marker platform for major traits including insect resistance, especially flower Thrips, nematode and disease resistance, and drought and heat tolerance are being targeted in African breeding populations. This project provides an excellent leveraging for CRSP activities described here to be used for cowpea modern breeding.

A second GCP project funded to UC Riverside (Ehlers, Roberts, and Close) for $450,000 (January 2008 to December 2010), focuses on development of phenotyping protocols for cowpea drought tolerance, with work in the West Africa partner countries, California and Texas. This provides direct leveraging opportunities for the drought tolerance efforts.
The Pulse CRSP funds proposed herein will also be leveraged with opportunity funds within the Host Countries via NGOs and national sources through presentation of the CRSP effort and the associated opportunities for participatory funding.

A project funded to UC Riverside (Roberts, Ehlers, and colleagues) through USDA Southwest Consortium on Plant Genetics and Water Resources for $30,000 per year for 2 years from January 2010, focuses on establishing and testing a gene functional analysuis system in cowpea using VIGS (Virus Induced Gene Silencing).

The Kirkhouse Trust is supporting a project under Dr. Cisse at ISRA on molecular breeding for Striga resistance for 3 years (July 2009 – June 2012) for $ 80,000.

Training/Capacity Building Workplan

Degree Training:

Student #1
First and Other Given Names: Antonio Nkulo Ndengoloka
Last Name: David
Citizenship: Angola
Gender: Male
Training Institution: University of Puerto Rico, in collaboration with University of California - Riverside
Supervising CRSP PI: PA Roberts (with Dr. Beaver at UPR) and HC PI
Degree Program for training: MS
Program Areas or Discipline: Plant Breeding/Genetics/Plant Pathology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Yes
Host Country Institution to Benefit from Training: Angola
Thesis Title/Research Area: Diversity analysis of cowpea from Angola
Start Date: August, 2009
Projected Completion Date: September 2011
Training Status: Active
Type of CRSP Support (full, partial or indirect): Full

Student #2
First and Other Given Names: TBD
Last Name: TBD
Citizenship: African country (likely Senegal or Mozambique)
Gender: Female or Male
Training Institution: University of California - Riverside
Supervising CRSP PI: PA Roberts and HC PI
Degree Program for training: PhD
Program Areas or Discipline: Plant Breeding/Genetics/Plant Pathology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Yes
Host Country Institution to Benefit from Training TBD (Senegal and or Mozambique)
Thesis Title/Research Area: Genetic analysis of cowpea resistance to biotic/abiotic stress
Start Date September, 2010 or January, 2011
Projected Completion Date October 2014
Training Status: Pending
Type of CRSP Support (full, partial or indirect) Partial

Student #3
First and Other Given Names: Marti
Last Name: Portorff
Citizenship: US
Gender: Female
Training Institution: University of California - Riverside
Supervising CRSP PI: PA Roberts and HC PI
Degree Program for training: PhD
Program Areas or Discipline: Plant Breeding/Genetics/Plant Pathology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? No
Host Country Institution to Benefit from Training: N/A
Thesis Title/Research Area: Genetic analysis cowpea resistance to fungal diseases
Start Date: October, 2008
Projected Completion Date: October 2011
Training Status: Active
Type of CRSP Support (full, partial or indirect) Partial

Short-term Training

Training current cowpea breeders in the development and application of DNA-based markers for MAS in the cowpea breeding programs will be embedded in the research effort under Objective 1. Cowpea breeders will be trained in marker application utilizing their own breeding populations generated by the high x high crosses and recurrent back-crossing for existing variety improvement made within the programs. This will focus on the Senegal and Burkina Faso programs and to some extent on Angola. This training, started under the Phase 1 FY 10 workplan, will utilize the new SNP-genotyping platform for cowpea. The approach will involve the growing of breeding progenies in Africa, leaf sampling, and shipping leaf samples to a western genotyping lab for SNP-based marker genotyping. The genotyping results will be co-analyzed by the US and HC team jointly via Skype and computer conferencing for data display on a monthly basis during the active breeding periods. Data will be project to computers with conference discussion of data. During site visits to the Host Countries planned in FY 11, additional training will be made through joint interpretation of data sets and progeny selections as a hands-on MAS and MARS experience. The genotyping will allow all target traits described under Objective 1 to be advanced by indirect selection. Markers linked to traits including drought tolerance and *Macrophomina* and thrips resistance will be emphasized. This activity will require a continuing training effort extending through FY12 and beyond, in order to build by experience the necessary competence within the project team.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 20010 -- September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the US
Lead U.S. PI and University: Philip Roberts, University of California, Riverside
Host Country(s): Angola, Burkina Faso, Senegal

Output Indicators	2011 Target (October 1, 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women	1	
Number of men	1	
Short-term Training: Number of individuals who received short-term training		
Number of women	80	
Number of men	140	
Technologies and Policies		
Number of technologies and management practices under research	13	
Number of technologies and management practices under field testing	10	
Number of technologies and management practices made available for transfer	5	
Number of policy studies undertaken		
Beneficiaries:		
Number of rural households benefiting directly	26,400	
Number of agricultural firms/enterprises benefiting	19	
Number of producer and/or community-based organizations receiving technical assistance	75	
Number of women organizations receiving technical assistance	18	
Number of HC partner organizations/institutions benefiting	23	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	36,200	

Dry Grain Pulses CRSP FY2011 Budget

Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the U.S.

	First period (12 months) 10/1/2010 - 9/30/2011					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	UC Riverside	Training	Burkina Faso INERA	Senegal ISRA	Angola IIA	
a. Personnel Cost						
Salaries	31,084.50		14,000.00	14,000.00	14,000.00	
Fringe Benefit	8,109.00					
b. Travel	4,054.50		2,000.00	2,000.00	2,000.00	
c. Equipment ($5000 Plus)	0.00					
d. Supplies	1,802.00		4,000.00	4,000.00	4,000.00	
e. Training						
Degree		47,925.00				
Non-Degree		12,000.00				
f. Other						
g. Technology Dissemination	5,000.00		17,950.00	18,750.00		
h. Total Direct Cost	50,050.00	59,925.00	37,950.00	38,750.00	20,000.00	0.00
i. Indirect Cost	25,025.00		0.00	0.00	0.00	
j. Indirect Cost on Subcontracts (First $25000)						
k. Total Indirect Cost	25,025.00	0.00	0.00	0.00	0.00	0.00
Total	75,075.00	59,925.00	37,950.00	38,750.00	20,000.00	0.00
Grand Total	231,700.00					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$50,050.00	24.22%
Total direct cost budgeted for H.C institution(s)	$156,625.00	75.78%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$18,768.75		$0.00	$0.00	$0.00		$ 18,768.75
Cash							$ -
Total	$ 18,768.75		$ -	$ -	$ -	$ -	$ 18,768.75
Attribution to IEHA Objectives							
Percentage of effort	75.00%	75.00%	75.00%	75.00%	75.00%		75.00%
Amount corresponding to effort	$56,306.25	$44,943.75	$28,462.50	$29,062.50	$15,000.00	$0.00	$173,775.00
Attribution to Capacity Building (Theme "D")							
Percentage of effort	35.00%	35.00%	35.00%	35.00%	35.00%		35.00%
Amount corresponding to effort	$26,276.25	$20,973.75	$13,282.50	$13,562.50	$7,000.00	$0.00	$81,095.00

Name of PI & Institutional Affiliation: Phil Roberts, University of California, Riverside

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

FY 2011 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: ***Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the U.S.***

	Abbreviated name of institutions							
Identify Benchmark	UCR		ISRA		INERA		IIA	
Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**
Objective 1 - Breeding								
Varietial test & release	x	x	x	x	x	x		
Germplasm seed increases							x	x
Germplasm screening	x	x	x	x			x	x
Variety candidate test - Angola							x	x
Advance/test BC popns	x	x	x	x	x	x		
Advance/test elite popns	x	x	x	x	x	x		
SNP genotyping	x	x	x	x	x	x	x	x
Objective 2 - Improve Seed Systems								
Breeder Seed production			x	x	x	x		
Foundation Seed production			x	x	x	x		
Certified Seed prodn. training			x	x	x	x		
Assess seed system - Angola	x						x	
Objective 3 Seed Dissemination								
Breeder's Seed production	x	x	x	x	x	x		
Foundation Seed production	x	x	x	x	x	x		
Certified Seed production	x	x	x	x	x	x		
Certified Seed producer training			x	x	x	x		
Variety tests in Mali				x	x	x		
Variety tests in Niger				x	x	x		
Objective 4 - Training								
MS Training Angola/UPR	x	x					x	x
PhD Training UCR	x	x						
Training - MAS with SNPs	x	x	x	x	x	x	x	x

Name of the PI responsible fo reporting on benchmarks	P.A. Roberts	N. Cisse	I. Drabo	A. Chicapa
Signature/Initials:	PAR	NC	ID	AC
Date:	May 17. 2010			

P2-UIUC-1

(1) Biological Foundations for Management of Field Insect Pests of Cowpea in Africa and (2) Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa – Technology Dissemination Project UIUC West Africa

Lead U.S. Principle Investigator
Barry Pittendrigh - UIUC

Collaborating Scientists
Ibrahim Baoua, INRAN, Niger
Clèmentine Dabiré, INERA, Burkina Faso
Mohammad Ishiyaku, IAR, Nigeria
Jeremy McNiel, UWO, Canada
David Onstad, UIUC, U.S.
Larry Murdock, Purdue, U.S.
William Muir, Purdue, U.S.
Joseph Huesing, Monsanto, U.S.
Niang Malick Ba, INERA, Burkina Faso
Julia Bello, UIUC, U.S.
Manuele Tamò, IITA, Benin
Mamadou N'Diaye, IER, Mali
Dr. Madhu Viswanathan, UIUC, U.S.
George Czapar, UIUC, U.S.

Project Problem Statement and Justification
Field and storage insect pests are the most severe biotic constraints for cowpea production. Insect-resistant cultivars have the potential to resolve some of the pest problems like root-knot nematode. However, the lack of cultivars that resist major insect pests like legume pod borer, bruchids, and pod sucking bugs cannot be filled by conventional breeding because attempts to find genes conferring resistance in the cowpea genome to these pests have failed so far. Thus, farmers often resort to the use (and misuse) of neurotoxic pesticides to control cowpea insect pests in some cases with dire consequences to their health, the health of their families, and the end users that purchase the cowpeas. Thus, there is a need to develop alternative strategies for control of the insect pests of cowpea, in order to reduce the levels of pesticides used on cowpea crops.

Several major strategies have been adopted in the developed world to reduce the use of neurotoxic pesticide sprays in the field and on the stored seeds. First, biotechnology has offered us new tools to produce transgenic plants carrying insect resistance traits. Insecticidal proteins like those produced by *Bacillus thuringiensis* (*Bt*) specifically target the insect pests that actually feed on the plant. Second, Integrated Pest Management (IPM) plans have been developed to control insect pests using alternative control methodologies, including, but not limited to, host-plant resistance traits, cultural practices, biological control agents, and low-level chemical use. However, regardless of which strategy prevails for insect control, all of these strategies require an in-depth

understanding of the biology of the pest insects and how they interact with their environment.

The major pests of cowpea in the field in northern Nigeria, Niger, and Burkina Faso include: (i) the legume pod borer, *Maruca vitrata* Fabricius; (ii-iii) the coreid pod-bugs, *Clavigralla tomentosicollis* Stal and *Anoplocnemis curvipes* (F.); (iv) the groundnut aphid, *Aphis craccivora* Koch; and, (v-vi) thrips, *Megalurothrips sjostedti* Trybom and *Sericothrips occipitalis* Hood. A limited amount of work has been done to understand these insect pests in the areas we propose to work. Also, there are few alternatives to pesticide sprays for many of these pest species. Two notable exceptions to this situation exist. The first is *M. vitrata*, where a potential biotechnology-based pest control solution exists. Transgenic cowpea expressing the *Bt*-protein Cry1Ab, effective against *M. vitrata* already exists, however, these plants are unlikely to be available for use by African farmers during the current CRSP funding cycle. However, before transgenic Bt-cowpea can be released there will be a need for an insect resistance management (IRM) plan. Although not the primary focus of the current project, our studies will ultimately provide the necessary data for the eventual development of an IRM plan for Bt-cowpea. The second pest of cowpea, where a potentially new strategy for insect control exists, are thrip-resistant cultivars that have been developed by Drs. Phillip Roberts and Jeff Ehlers of University of California at Riverside (UC-R) in conjunction with Drs. Drabo and Dabiré of INERA *(e.g.*, variety 58-77). We will work with the aforementioned investigators, to investigate the interactions between thrip-resistant cowpeas and thrips in field experiments in Northern Nigeria, Niger, and Burkina Faso.

Although transgenic plants, and traditional plant breeding for insect resistant varieties are potentially effective methods for controlling at least two pests of cowpeas, a better understanding of pest populations is needed in order to integrate these, and other, pest control options into an overall integrative pest management (IPM) plan to maximize cowpea production in the field. IPM refers to a pest control strategy where a variety of complementary approaches are used to minimize the negative effects of pests on a given crop or cropping system. Before we begin to develop IPM strategies, we must understand the important life-history parameters of these pest insects in relationship to their environment. Critical life-history parameters include, but are not limited to, the following. (1) When and where do the pest insects occur? (2) What do the pest insects live on beyond just cultivated cowpeas? (3) What organisms regulate the populations of the insects that attack cowpea? (4) Are there parameters in the field that can be altered that will reduce the negative impacts that these insect pests have on cowpea? (5) Where sprayed pesticides are the only option, or a necessary component of an IPM program, how can their use be minimized while still achieving effective pest control? Regardless if biological control, insect resistant varieties, or transgenic plants, limited pesticide sprays, or a combination of these approaches are ultimately used, this project will provide a scientific foundation for such strategies.

Planned Project Activities

Objective 1: Characterizing the life-history patterns and wild alternative hosts of the coreid pod sucking-bugs, *Clavigralla tomentosicollis* Stal and *Anoplocnemis curvipes* (F.); the groundnut aphid, *Aphis craccivora* Koch; and, thrips, *Megalurothrips sjostedti* Trybom and *Sericothrips occipitalis* Hood. This objective will lay the foundation for the field knowledge that we will need to develop Integrated Pest Management-omics (IPM-omics) strategies for these aforementioned five pest species.

Collaborators
Dr. Niang Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clèmentine Dabiré, INRAN
Mr. Mamadou N'Diaye, IER
Dr. Mohammad Ishiyaku, IAR
Dr. Jeremy McNeil, UWO

Approaches and Methods: We will characterize the life-history patterns of the aforementioned pests of cowpeas in Niger, Burkina Faso, Benin, and Northern Nigeria, including determining their life history, wild alternative hosts, and where they occur during both the periods when cowpeas are and are not in cultivation. Insect populations will be surveyed throughout the year in each of the host countries for their presence in regions and on potential wild alternative host plants. Collections will occur through field net sweeps, collection of host plants from the field, and through use of insect traps. The host country scientists in Niger, Burkina Faso, and Benin already have expertise in working with these pests. Training sessions for technicians will occur in Niger, Burkina Faso, and Benin in order to build capacity and increase our own capacity to perform this project more successfully.

Insect populations will be collected in Niger, Burkina Faso, and, Benin, and shipped to UIUC for molecular characterization. In Burkina Faso and Niger, in depth studies of these pests, (i) on cultivated cowpeas (during the cowpea-growing season), and (ii) survey work, on alternative host plants, will be performed throughout the two-year extension. Insects will be collected from all the aforementioned surveys and studies, for shipment to UIUC, in order to perform molecular analyses of these pests in relation to their locations and host plants. This will allow us to determine when and where the pest populations are coming from and where best to deploy pest control strategies. In Northern Nigeria, Northern Benin, and Mali, which all surround Niger and Burkina Faso, we will collect these pest insects where possible, through scouting, throughout the year in order to determine if there is long-distance migration between host countries. Determining this potential long-distance movement will involve using "omics" tools to determine the relationships of the insect populations that will be collected (*e.g.*, if they migrate North and South, we should observe commonalities between insect in a north-south gradient).

Objective 2: Develop molecular markers to study populations of *C. tomentosicollis*, *Anoplocnemis curvipes*, *A. craccivora*, *M. sjostedti*, and *S. occipitalis*.

Collaborators
Dr. Manuele Tamò, IITA
Dr. Brad Coats, University of Iowa
Dr. Niang Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clèmentine Dabiré, INRAN
Dr. Venu Margam, Purdue University
Dr. George Czapar, UIUC

Approaches and Methods: We will perform large-scale 454 sequencing of *C. tomentosicollis*, *A. curvipes*, *A. craccivora*, *M. sjostedti*, and *S. occipitalis* populations obtained from Mali, Burkina Faso, Niger, Northern Benin, and Northern Nigeria. This 454 sequencing approach (i) will allow us to sequence a large component of the genome of each species and (ii) will result in sequencing of many copies from any given gene, and (iii) provides us with the data to bio-informatically determine many polymorphisms that can be used to characterize populations of the given pest. We will first use the populations obtained from West Africa to (i) determine polymorphisms to characterize the pest populations and (ii) then use the polymorphisms (in conjunction with our field data) to determine local and regional movement patterns of these pest species using the same Sequenom® technology that we used to characterize *M. vitrata* populations. The Sequenom® technology allows one to determine detailed polymorphic information on individuals, based on the polymorphisms identified in the 454 sequencing. From both the field and molecular data, we can then make decisions on where to deploy biological control agents. For example, for species that are endemic in a region (*i.e.*, they live there all year long) we will deploy biological control agents in that area. By knowing the wild alternative host plants on which they live, we can also determine which local areas will most likely be optimal for deployment of the bio-control agents (*e.g.*, where an abundance of wild alternative host plants occurs). For species that are migratory, we may need to deploy bio-control agents at the most northerly point of their endemic zone.

Specifics of the genomics work: The aforementioned insect species will be collected by host country scientists and immediately transferred into vials with RNAlater (Ambion Inc.) and these materials will be shipped to UIUC for further analysis (described below). The host country scientists will collect insects once per month (minimally) from a diversity of regions within their countries.

In FY11 we will perform the 454 runs in order to identify the various polymorphisms in the insect populations, which we will later use in to pick apart movement patterns of these pest populations. Once the insects arrive at UIUC, total RNA will be extracted from samples using the TRI Reagent extraction protocol (Molecular Research Center, Cincinnati, OH) and further purified by Qiagen RNeasy kit (Qiagen, Valencia, CA) with an on-column DNase digestion procedure. RNA quantity and quality will be measured and will be used to produce amplified cDNA using protocols routinely used in the Dr.

Pittendrigh's laboratory. The amplified cDNA will be submitted to the Keck Genomic Center (University of Illinois Urbana-Champagne) for sequencing using the 454 sequencing equipment. Sequences (fasta format) will be imported into Blast2GO, which is a software package used to perform sequence homology based blastx (Altschul et al. 1990) searches, which retrieves Gene Ontology (GO) terms allowing the function of ESTs to be determined and compared (Conesa et al. 2005, Gotz et al. 2008). Single nucleotide polymorphisms will be detected using the CLC Genomics Workbench tool. We will also identify potential EST-based microsatellites.

References

Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. 1990. Basic Local Alignment Search Tool. Journal of Molecular Biology 215: 403-410

Conesa A, Gotz S, Garcia-Gomez JM, Terol J, Talon M, Robles M. 2005. Blast2GO: a universal tool for annotation, visualization and analysis in functional genomics research. Bioinformatics 21: 3674-3676

Gotz S, Garcia-Gomez JM, Terol J, Williams TD, Nagaraj SH, et al. 2008. High-throughput functional annotation and data mining with the Blast2GO suite. Nucleic Acids Research 36: 3420-3435

Objective 3: Development and deployment of extension materials for IPM of pests of cowpeas.

Collaborators

Dr. Niang Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Julia Bello, UIUC
Dr. Clèmentine Dabiré, INERA
Dr. George Czapar, UIUC
Mr. Mamadou N'Diaye, IER
Dr. Mohammad Ishiyaku, IAR
Dr. Manuele Tamò, IITA

Approaches and Methods: We will continue to develop and deploy both our extension tools (*e.g.*, MP3s and videos) for (i) Peace Corps volunteers in host countries, (ii) local extension services, and (iii) farmer field-schools. As part of this development process, we will have key people from INRAN (Dr. Baoua) and INERA (Dr. Ba) visit UIUC for upwards of four months to develop (as part of their stay) comprehensive packages of extension materials (both electronic and printed versions) for all the pests of cowpea. During their stay, they will work with UIUC Extension in order to (i) receive training in necessary computer technologies to develop new video, audio, and printed materials, and (ii) we will purchase the most appropriate equipment and software for them to take back to their home institutions (for capacity building), such that they can continue to develop new extension materials during and beyond the scope of the current project. We expect that these materials will be deployed in minimally a dozen villages in

each host country during the remaining life-time of the project (along with bio-control agents and pest-tolerant varieties of cowpeas) through the use of farmer field schools and extension presentations that run in conjunction with other organizations, such as Peace Corp volunteers.

Objective 4: Build capacity at host country institutions for the rearing and mass release of bio-control agents that are currently ready for release (Objective 1 for the "Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa – Technology Dissemination Project UIUC West Africa").

At the current moment farmers in West Africa often resort to using pesticide sprays to minimize pest populations. These pesticides are often misused or over-used (or both), with detrimental health effects to (i) those that spray the pesticides, (ii) those that work in the fields after the pesticides are sprayed (often women and children), (iii) traders, retailers, market women and (iv) in some cases also to consumers that purchase cowpeas that have been sprayed immediately prior to harvest.

One extremely cost-effective and sustainable option for the control of pest insects in Africa has been the use of biological control agents (*e.g.*, parasitic wasps, viruses, predators, etc.). With the advent of biotechnology-based "solutions", some have considered the use of bio-control strategies as passé or "it has all been done before", mainly referring to the unprecedented success achieved by IITA and national partners in the continent-wide control of the cassava mealybug. Nothing could be further from the truth. In fact, with the advent of genomics we are entering a fascinating new stage of the use of bio-control approaches. Scientists are now in a position to use genomics as a tool to make better decisions as to when and where to deploy these bio-control agents. An emerging field termed "Integrated Pest Management omics" (IPM-omics), is being spearheaded by the members of the Dry Grain Pulses CRSP project entitled, "Biological Foundations of Pest Management in Cowpea in West Africa." Briefly, molecular markers are used to characterize pest populations, including the location and migrations of endemic pest populations as well as those of introduced beneficial biologicals. Determination of the positioning and movements of pest populations is critical for the scheduling of the rearing of biologicals and their successful deployment to effectively control pests in cowpeas. Essentially the use of "omics" tools, coupled with currently developed IPM strategies, has the potential to allow for good decision making as to where and when to release the bio-control agents and how to achieve the greatest return on the investment in terms of pest control.

Bio-control strategies involve a "pipeline of discovery to deployment" just like traditional pesticides and transgenic plants. The difference lies in the fact that the success rate of candidate bio-control agents has been much better than that for candidate transgenes and pesticides. Although candidate bio-control agents are in the pipeline, with some being ready for large-scale release, such a pipeline needs resources for large-scale releases and short-term high-level impact.

A team of NARS and entomologists with extensive experience in all aspects of the "bio-control agent pipeline" are in place in Niger, Mali and Burkina Faso. The group will develop effective rearing and release strategies for multiple pests of cowpeas. Additionally, genomics tools will be used to track the bio-control populations.

Collaborators
Dr. Manuele Tamò, IITA
Dr. Niang Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clèmentine Dabiré, INERA
Dr. George Czapar, UIUC
Mr. Mamadou N'Diaye, IER

Approaches and Methods: We will be developing rearing and delivery systems for biological control agents (including training of staff, extension agents, and farmers where necessary) against major cowpea pest which can easily be implemented by Host Country (HC) collaborators. In particular, we will carry out the following activities:

1. Refining and validating the recently developed mass rearing technique for *M. vitrata* using germinating cowpea sprouts. The methodology needs to be refined using different sources of cowpea, and different types of material. In addition, this rearing procedure needs to be validated in a range of different temperatures and air humidity regimes in order to determine its suitability in varying conditions as met in HC laboratories (to be completed at the end of FY11). Dr. Tamò at IITA will be responsible for development and deployment of this technology to HC scientists. The above rearing methodology will be used to mass rear the parasitoid *A. taragamae* in HC laboratories for field inoculations. At the same time, we will be developing an in-field mass rearing technique using nurseries of the host plant *Sesbania sp.* (to start during FY11). All three HC scientists will perform these activities. We will also use the above rearing methodology for mass production of the entomopathogenic virus MaviMNPV in HC laboratories for field applications. This will lead to the development of in-field mass production technique using nurseries of the host plant *Sesbania sp.* (to start during FY11) in all three host-countries.

2. Establishing nursery plots of the host plant *Tephrosia candida* at different locations in HC for in-field mass rearing of the thrips parasitoid *Ceranisus femoratus*. The plots will be inoculated with a start-up culture of the parasitoids provided by IITA. All three HC scientists will perform these activities.

Objective 5:
A. Collections of biological control agents for sequencing and development and of IPM-omics tools

(Objective 2 for the "Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa – Technology Dissemination Project UIUC West Africa").

B. Bring new bio-control agents into the pipeline for development and deployment

(Objective 3 for the "Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa – Technology Dissemination Project UIUC West Africa").

Collaborators
Dr. Manuele Tamò, IITA
Dr. Niang Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clèmentine Dabiré, INERA

Approaches and Methods
5A. Priority natural enemies for sequencing (these are all introduced ones in West Africa):

5A1. The parasitoids *Apanteles taragamae* (attacking the pod borer *Maruca vitrata*): we will compare a presumably 'genetically bottlenecked' population from our current rearing colony at IITA in Benin with samples from wild population from different locations in Taiwan and from continental Asia. These will be shipped to UIUC in FY11 for sequencing.

5A2. The parasitoid *Ceranisus femoratus* (attacking the flower thrips *Megalurothrips sjostedti*): compare released populations from various locations in Benin, Burkina Faso, and Niger with rearing population from lab, original population from Cameroon and samples from Kenya. These samples will be shipped to UIUC in FY11 for sequencing.

Dr. Manu Tamò will be primarily responsible for the collection and shipping of insect samples to UIUC. Dr. Pittendrigh's laboratory will receive samples of the biological control agents from IITA, sequence populations of insects, and determine molecular markers useful in the monitoring of these pest populations. The current budget has enough funds, based on 2009 prices and technology to perform such experiments with two of the biological control agents. Thus, we will work with *Apanteles taragamae* and *Ceranisus femoratus* for the molecular component of this project. Where time and resources permit the Pittendrigh laboratory will also perform these genomics studies on the other biological control agents.

5B. In partnership with HC collaborators, we will be developing rearing and delivery systems for the following priority natural enemies:

Against *M. vitrata*:

1. The trichogrammatid *Trichogrammatoidea eldanae*. This parasitoid is locally available in the moist savanna of West Africa. We propose to use field cages to demonstrate its potential, while at the same time develop simple and efficient rearing and delivery systems for field inoculations.

2. The tachinid *Nemorilla maculosa*. Upon delivery of import permits into our laboratories at IITA Benin, we will introduce this parasitoid from AVRDC Taiwan and develop rearing and delivery systems.

Against *C. tomentosicollis*:

The parasitoids *Gryon fulviventre*. This parasitoid is locally available in West Africa. We will first need to develop a cheap and efficient rearing technique for its intended host *C. tomentosicollis* using dry cowpea seeds or continuous green pods in cowpea field planted through the year. We will develop a rearing methodology adapted to HC laboratories, and a final delivery system, which can be applied directly by farmers in their own field, thus will be prepared for FY12.

Objective 6: Increase the capacity, effectiveness and sustainability of agricultural research institutions, in order to serve the bean and cowpea sectors in Burkina Faso, Niger, and northern Nigeria. We will perform degree and non-degree training in order to build institutional capacity. We will also perform farmer field schools in order to develop the capacity for the eventual deployment of novel pest control strategies. Within the current funding cycle the main goal is to train farmers in the basic biology of the insect pests.

Collaborators
Dr. Manuele Tamò, IITA
Dr. Niang Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clèmentine Dabiré, INERA
Dr. Julia Bello, UIUC, U.S.
Dr. George Czapar, UIUC, U.S.

Approaches and Methods
1) Technician, Peace Corps, and NGO training programs
As per the recommendation of the TMAC, we will hold seminars in Benin, Niger, Mali, and Burkina Faso to train technicians, and where possible other partner organization (*e.g.*, Peace Corps volunteers and local NGOs) in cowpea pests and pest control strategies.

2) Farmer Field For a
We will continue to perform farmer field fora in partnerships with other local extension organizations (and where possible Peace Corps volunteers) in each of the countries in the summer of FY11 with an approximate 50%: 50% mix of men and women. Each farmer field school will have a minimum of 15-20 individuals. The farmers will be expected to collect data on their cowpea crops to be presented at a subsequent farmer field school. We will assess the differences in the knowledge of the farmers (and their datasets collected). All five host-country collaborators have conducted such farmer field schools, including collecting data from farmers to determine the impact of training on the farmers. Where feasible audio file and video file educational materials will be deployed in villages or in the case of audio files to local radio stations for local broadcasts. Every

effort will be made to deploy materials to equal or greater numbers of women as compared to men.

3) Audio and video files for control strategies for pests of cowpeas.
We have and will continue to develop video and audio files on best practices for insect control for use in our target countries. We have and will continue to translate these documents for use both in our host countries and for sharing with other Pulses CRSP groups. We have developed an online extension sharing system for extension materials that will be available in FY11 and beyond the scope of this project for the use by host country scientists and extension agents.

2) Non-degree training
Within Africa, the H.C. P.I.s will interact with each other to provide training on insect biology as well as their respective experimental designs and outcomes. This will also include exchanges of information regarding potential biological control strategies.

3) Degree Training
Dr. Pittendrigh has identify a female Nigerian graduate student who will continue her studies at UIUC and will likely complete her PhD at the end of FY12.

Host country scientists will continue to train their graduate and undergraduate students throughout FY11.

Contribution of Project to Target USAID Performance Indicators
In keeping with USAID's objectives, our project seeks to improve the social, economic, and environmental sustainability of agriculture by developing and deploying IPM strategies for the control of pest insects that attack cowpea, with the intent of reducing pesticide use. We have and will continue to strengthen agricultural training and education, outreach, and adaptive research in our targeted host countries through (1) training host country scientists and (2) development/deployment of outreach materials that emerge from our research efforts. We will also mobilize cutting edge science and technology and foster capacity for innovation through the coupling of genomics technologies with field studies in order to develop Integrated Pest Management-omics strategies for the control of pest insects that attack cowpea.

Target Outputs
(1) We expect to create the foundational knowledge necessary for the development of an IPM program for the pests of cowpea. This will allow for the targeted deployment of biological control agents in the host countries, into areas most likely to impact pest populations.

(2) We will (i) increase the extension capacity of our host country scientists in Niger and Burkina Faso and (ii) develop and deploy a repertoire of extension materials for the control of pests of cowpeas in our host countries.

(3) We expect to have successful biological control agents deployed in the field in test regions of Benin, Niger, and Burkina Faso. As part of this project we will also develop

the molecular tools necessary to monitor the biological control agents as they are established in the field. This will allow us to verify the success of our various deployment operations (i.e., do they come from the populations we released?) and potentially determine if certain genotypes are more effective than others in establishing themselves in the environment. As part of our capacity building we expect our HC collaborators to develop the ability to rear and deploy biological control agents. They will also work with local extension services, NGOs, Peace Corps volunteers (Niger), and farmer organizations to deploy these biological control agents.

(4) We will continue to seek to increase the participation of women in workshops, and that women be trained in the monitoring of cowpea insect pests and that these women have access to all technologies that we plan to use in the development of extension materials.

(5) Once biological control agents are ready to be evaluated in the management of the cowpea pests IITA is currently in a position to continually rear these bio-control agents (beyond the scope of FY11 and FY12) and make them available to other groups wishing to use such agents.

(6) Where bio-control agents for legume pod borer are successful in reducing damage by this insect we do not expect other cowpea insect pests to fill the ecological niche of this pest, as the pest numbers will simply be reduced.

(7) Successful establishment of the bio-control agent will be determined by surveys in the years that follow the release of the bio-control agents. Where feasible, molecular markers may be useful to determine if the bio-control agent populations that we release are in fact the ones that have established in the region.

(8) We expect that the bio-control agents will integrate into the ecosystem, thus, there are likely to be insect predators that will keep their populations at an eventual equilibrium level.

(9) Development of IPM materials for pests of cowpeas that can be used in regional training workshops with technicians working at institutions within host countries.

Engagement of USAID Field Mission(s)

Dr. Pittendrigh previously visited the missions in Mali and Nigeria and certainly will take advantage of any opportunities during this project to discuss ongoing efforts with the USAID Field Missions. Our group will also work with the CRSP office to identify opportunities to interact with the USAID Field Missions. Where possible Dr. Pittendrigh will interact with USAID Field Missions to provide them information both on the project and extension materials, along with our online extension sharing system, in order to explore possibilities to increase the impact of our overall project in the countries where we are working.

Networking Activities with Stakeholders

As with the rest of our ongoing project we will make efforts to involve NGOs, Peace Corps volunteers, local extension networks, and existing farmer field school organizations to assist in the deployment process of the biological control agents. We will also make efforts to increase our interactions with other programs such as CORAF that can help increase the sustainability of our bio-control program beyond the FY11 and FY12 budget cycles.

Leveraging of CRSP Resources

The financial support for a research assistantship for Agunbiade Tolulope Adebimpe to continue her graduate studies at University of Illinois at Urbana-Champaign (UIUC) be 100% supported by funding from UIUC. Thus, there is no direct cost to the Pulses CRSP for her time and effort. The TMAC raised the concern regarding if this is an efficient use of resources for training. The UIUC resources that are being used for this project are resources that must be used on campus for graduate training and thus could not be used for other in-country training projects and programs. The graduate student is both involved in the molecular aspects of the project and in the development of video-based extension materials that will be released no later than the beginning of FY11. Again, there is no direct cost to the CRSP, but there are both direct training benefits and this student is playing an active role in the development of training materials that are and will be sent back to host countries. When host country scientists visit UIUC, she will play an active role in assisting them to develop the necessary set of skills to use novel tools to develop more extension materials.

We have received funding from the following sources to develop an online extension information sharing system for both our own extension materials and can also be used by other Pulses CRSP groups: (1) Center for International Business Education and Research (to MV, JB, & BP), (2) the Academy for Entrepreneurial Leadership (MV, JB, & BP), and (3) the Office of Public Engagement (MV, JB & BP), the University of Illinois Extension (to JB) and (4) C.W. Kearns, C.L. Metcalf and W.P. Flint Endowment Funds (to BP). The alpha-version of this system has already been built with these aforementioned resources and it is currently online for internal testing.

C.W. Kearns, C.L. Metcalf and W.P. Flint Endowment Funds have also been used to assist in travel costs for collaborators on the project.

Institutional Capacity Building Activities

Degree Training

First and Other Given Names: Traore
Last Name: Fousseni
Citizenship: Burkina Faso
Gender: Male
Degree: M.S.
Discipline: Entomology
Host Country Institution to Benefit from Training: INERA
Training Location: University of Ouagadougou
Supervising CRSP PI: Dabiré, Clèmentine
Start Date: 09/08
Project Completion Date: 11/10
Training Status: Active
Type of CRSP Support (full, partial or indirect**):** Full (Category 1)

First and Other Given Names: Agunbiade Tolulope
Last Name: Adebimpe
Citizenship: Nigerian
Gender: Female
Degree: Ph.D.
Discipline: Entomology
Host Country Institution to Benefit from Training**:** Nigeria
Training Location: UIUC
Supervising CRSP PI: Pittendrigh, Barry
Start Date: 08/09
Project Completion Date: 09/12
Training Status: Active
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

First and Other Given Names**:** Elie
Last Name: Dannon
Citizenship: Benin
Gender: Male
Degree: Ph.D.
Discipline: Entomology/Biological Control
Host Country Institution to Benefit from Training**:** IITA/Benin
Training Location: Agricultural University, Wageningen, The Netherlands
Supervising CRSP PI: Tamò, Manuele
Start Date: 06/08
Project Completion Date: 06/12
Training Status: Active
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

First and Other Given Names: Laura
Last Name: Loko
Citizenship: Benin
Gender: Female
Degree: M.S.
Discipline: Biology/Biological Control
Host Country Institution to Benefit from Training: IITA/Benin
Training Location: Universite d'Abomey Calavi
Supervising CRSP PI: Tamò, Manuele
Start Date: 03/09
Project Completion Date: 05/13
Training Status: Active
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

First and Other Given Names: Hermann
Last Name: Somakpon
Citizenship: Benin
Gender: Male
Degree: M.S.
Discipline: Biology/Biological Control/Entomology
Host Country Institution to Benefit from Training**:** IITA/Benin
Training Location: Universite d'Abomey Calavi
Supervising CRSP PI: Tamò, Manuele
Start Date: 11/08
Project Completion Date: 12/12
Training Status: Active
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

First and Other Given Names: Kouami
Last Name: Gnammi
Citizenship: Benin
Gender: Male
Degree: M.S.
Discipline: Biology/Biological Control/Entomology
Host Country Institution to Benefit from Training: IITA/Benin
Training Location: Universite d'Abomey Calavi
Supervising CRSP PI: Tamò, Manuele
Start Date: 11/08
Project Completion Date: 12/12
Training Status: Active
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

First and Other Given Names: Venu
Last Name: Margam
Citizenship: Indian
Gender: Male
Degree: Ph.D.
Discipline: Entomology
Host Country Institution to Benefit from Training: Burkina Faso --- Mr. Margam trained Dr. Ba in molecular biology approaches during Dr. Ba's stay in the USA
Training Location: Purdue University
Supervising CRSP PI: Pittendrigh, Barry
Start Date: 10/04
Project Completion Date: 12/09
Training Status: Completed – Currently participating as a post-doctoral collaborator
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

First and Other Given Names: Louisiane
Last Name: Bachabi
Citizenship: Benin
Gender: Female
Degree: B.S.
Discipline: Biology/Biological Control/Entomology
Host Country Institution to Benefit from Training: IITA/Benin
Training Location: Universite d'Abomey Calavi
Supervising CRSP PI: Tamò, Manuele
Start Date: 10/08
Project Completion Date: 05/09
Training Status: Completed
Type of CRSP Support (full, partial or indirect**):** Indirect (Category 2c)

First and Other Given Names: Monipo
Last Name: Kolany
Citizenship: Togo
Gender: Male
Degree: B.S.
Discipline: Biology/Biological Control/Entomology
Host Country Institution to Benefit from Training**:** IITA/Benin/Togo
Training Location: at Universite d'Abomey Calavi
Supervising CRSP PI: Tamò, Manuele
Start Date: 04/09
Project Completion Date: 10/09
Training Status: Completed
Type of CRSP Support (full, partial or indirect): Indirect (Category 2c)

Short-term Training

Each country will use at least $2000 for its in-country short-term training. This will include both local workshops and farmer field schools (as described above).

Drs. Baoua and Ba will visit UIUC for training in technologies associated with the development of audio and video-based extension materials. During these visits they will also develop materials that will be used in the field in FY11 and FY12. Such materials will be shared with other institutions and organizations in the host countries in order to increase the impact of these materials on farmers. Additionally, Dr. Baoua and Ba will both participate in the continued development of our online extension information sharing system (Bello *et al*., 2010) and they will be trained in its use from an editorial and reviewer prospective. Once they return to their home countries, they will hold workshops in the use of this system. This system will help build capacity in these institutions to easily share extension materials and this sharing system will be maintained long after the completion of the FY11 and FY12 budget cycles.

Bello-Bravo, J., Diaz, R., Venugopal, S., Viswanathan, M., and B. R. Pittendrigh. 2010. Expanding the impact of practical scientific concepts for low-literate learners through an inclusive and participatory virtual knowledge ecosystem. Journal of the World Universities Forum. In press.

Equipment (costing > $5000): None.

Dry Grain Pulses CRSP : FY 2011

(1) Biological Foundations for Management of Field Insect Pests of Cowpea in Africa and (2) Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa – Technology Dissemination Project UIUC West

	10/01/10 - 09/30/11						
	U.S. Institution	U.S. for Host Country*	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (4)
Institution Name	UIUC	INERA/INRAN	IITA	INERA	INRAN	IAR	IER
a. Personnel Cost							
Salaries	$30,900.00	$16,449.70	$2,000.00	$8,000.00	$8,000.00	$2,700.00	$2,700.00
Fringe Benefit	$10,956.00	$5,757.40	$200.00	$800.00	$800.00		
b. Travel	$5,946.55	$8,000.00	$1,600.00	$1,600.00	$2,200.00	$270.00	$270.00
c. Equipment ($5000 Plus)		$3,000.00					
d. Supplies	$15,000.00		$600.00	$1,600.00	$2,000.00		
e. Training							
Degree			$1,600.00	$3,000.00			
Non-Degree				$3,000.00	$5,000.00	$3,030.00	$3,030.00
f. Other							
g. Technology Dissemination	$19,898.00		$24,000.00	$18,000.00	$18,000.00		
h. Total Direct Cost	**$82,700.55**	**$33,207.10**	**$30,000.00**	**$36,000.00**	**$36,000.00**	**$6,000.00**	**$6,000.00**
i. Indirect Cost	$45,486.95	$18,263.90	$6,120.00	$3,600.00	$1,800.00	$900.00	$900.00
j. Indirect Cost on Subcontracts (First $25000)							$3,795.00
k. Total Indirect Cost	$45,486.95	$18,263.90	$6,120.00	$3,600.00	$3,600.00	$900.00	$4,695.00
Total	**$128,187.50**	**$51,471.00**	**$36,120.00**	**$39,600.00**	**$39,600.00**	**$6,900.00**	**$10,695.00**
Grand Total	$312,573.50						

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)		**41.00%**
Total direct cost budgeted for H.C institution(s)		**59.00%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$32,046.88						$ 32,046.88
Cash							$ -
Total	$ 32,046.88	$ -	$ -	$ -	$ -	$ -	$ 32,046.88

Number of policy studies undertaken	N/A	

Beneficiaries:		
Number of rural households benefiting directly	>1000	
Number of agricultural firms/enterprises benefiting	>5	
Number of producer and/or community-based organizations receiving technical assistance	50	
Number of women organizations receiving technical assistance	25	
Number of HC partner organizations/institutions benefiting	5	

Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	>5000	

*We are searching for two more female students (to bring this number to four) to maintain gender equity in degree training.

Attribution to Capacity Building							
Percentage of effort	50.00%	100.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Amount corresponding to effort	$64,093.75	$51,471.00	$18,060.00	$19,800.00	$19,800.00	$3,450.00	$5,347.50

U.S Institution PI: Barry Robert Pittendrigh

IAR
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: *(1) Biological Foundations for Management of Field Insect Pests of Cowpea in Africaand (2) Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa – Technology Dissemination Project UIUC West Africa*

	Abbreviated name of institutions											
	UIUC		IITA		INERA		INRAN		IER		IAR	
Identify Benchmark Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**
Objective 1 Characterize life-history patterns of pests of cowpeas												
Pod sucking-bugs			X	X	X	X	X	X				
Groundnut aphid			X	X	X	X	X	X				
Aphids			X	X	X	X	X	X				
Maruca (for baseline work for impact of biocontrol agents)			X	X	X	X	X	X				
Objective 2 Develop molecular markers to study populations of C. tomentosicollis, A. curvipes, A. craccivora, M. sjostedti, and S. occipitalis.												
Begin collection of insects genomics work			X		X		X					
Finalize collection of insects				X		X		X				
Sequencing of insect populations		X										
Objective 3: Development and deployment of extension materials for IPM of pests of cowpeas.												
Develop MP3s and videos for training in pest control technologies	X	X	X	X	X	X	X	X	X	X	X	X
Dr. Baoua visits UIUC for training in extension development tools		X						X				
Dr. Ba visits UIUC for training in extension development tools		X				X						
Purchase of materials for longterm development of extension materials		X				X		X				
Objective 4: Capacity at host country institutions for the rearing and mass release of bio-control												
Maruca parasitoid *A. taragamae*			X	X	X	X	X	X				
thrips parasitoid *C. eranisus menez*			X	X	X	X	X	X				
Maruc entomopathogenic virus MaviMNPV												
Objective 5: Genomics of biological controls and new biological controls												
Sequencing of Apanteles taragamae and Ceranisus femoratus		X										
New biological control agents in development			X	X	X	X	X	X				
Objective 6: Institutional capacity building												
Technician, Peace Corps, and NGO training programs	X	X	X	X	X	X	X	X				
Farmer Field Forums / MP3 players				X		X		X		X		X
Audio and videos for control strategies for pests of cowpea	X	X	X	X	X	X	X	X	X	X	X	X
Non-degree training				X		X		X		X		X
Degree Training	X	X	X	X	X	X						

Name of the PI responsible for reporting on benchmarks	Barry Pittendrigh	Manuelle Tamo	Clementine Dabire	Ibrahim Baoua	Mamadou N'Diaye	Mohammad Ishiyaku
Signature/Initials:						
Date:	14-May-09	14-May-09		14-May-09		

P2-UPR-1

Development, Testing and Dissemination of Genetically Improved Bean Cultivars for Central America, the Caribbean and Angola

Lead U.S. Principle Investigator
James Beaver, UPR, U.S.

Collaboratoring Scientists
Juan Carlos Rosas, EAP, Honduras
António Chicapa Dovala, IIA, Angola
Consuelo Estevez de Jensen, UPR, U.S.
Timothy Porch, USDA-ARS, U.S.
Emmanuel Prophete, CRDA, Haiti

Project Problem Statement and Justification

Common bean (*Phaseolus vulgaris* L.) is an important source of protein for low income families in Central America, the Caribbean and Angola. Increased or more stable bean yield can improve the diet and provide a reliable source of income for small-scale farm families in these countries. An increased supply of beans should also benefit urban consumers of beans.

The development of improved bean varieties has proven to be an effective strategy to address biotic and abiotic factors that limit bean production in Central America and the Caribbean. During the past 10 years, however, only a limited number of black bean cultivars have been released in Latin America and the Caribbean. This is the result of a lower level of investment in black bean breeding and less emphasis in Central America on the testing and on-farm evaluation of advanced black bean breeding lines by national programs. As a consequence, black bean cultivars tend to have lower seed yield potential and less disease resistance than the most recently released small red bean cultivars. The most promising small red bean cultivars developed at Zamorano can be readily used to improve black beans. In fact, the lowland bean breeding project of the Bean/Cowpea CRSP initiated the development of black bean breeding lines and a sizeable number of breeding lines have already been distributed to bean research network members in Guatemala and Haiti. The bean research network supported by the Bean/Cowpea CRSP was a key element in the success of the cultivar development program in Central America. The Dry Grain Pulse CRSP project will emphasize field-testing of black bean breeding lines in Central American and Caribbean countries. The project will also complete the evaluation, release and dissemination of Andean (red mottled and light red kidney) bean lines that have resistance to BGYM, BCNM and rust.

The research project is in the position to make significant impacts in Central America, the Caribbean, and Angola. Many small red and black bean breeding lines with enhanced disease resistance and tolerance to abiotic stress are already in an advanced stage of development. There is an established network of bean researchers in Central America with a proven capability of testing, releasing and disseminating improved bean cultivars. The Dry Grain Pulse CRSP project will complement ongoing collaborative bean research in Central America. In addition, the project includes partners from Haiti that will extend the potential impact of the collaborative research. The project will provide formal and

informal training to Instituto de Investigacão Agronómica (IIA) researchers based on the critical experiences and successes in Central America and the Caribbean. The project also plans to improve Instituto de Investigacão Agronómica facilities and develop populations and bean breeding lines that will permit the Legume Program to develop improved bean cultivars for Angola.

Improved bean breeding lines developed by the Dry Grain Pulse CRSP bean breeding program in Central America and the Caribbean may be useful in some bean production regions of Africa, given the similarity in agroecological zones and production constraints. Results from the exchange of breeding lines during Phase I of the project identified a few red mottled beans from the Caribbean that were well adapted to Rwanda. Some small red bean cultivars and breeding lines developed in Central America have resistance to diseases (BCNM, rust, angular leaf spot, and anthracnose) and tolerance to abiotic stresses (low soil fertility, drought and high temperature) that are important constraints to bean production in Africa. Although black beans are estimated to account for < 5% of bean production in Africa, this seed type is often a component of mixtures grown in low fertility soils. The lowland bean breeding team has developed Andean (red mottled and light red kidney) bean breeding lines with resistance to BCNMV (bc3) and rust (Ur-11) that may be useful in Southern Africa.

Planned Project Activities

Objective 1: Development, release and dissemination of improved bean cultivars for Central America, the Caribbean and Angola.

Collaborators

James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Consuelo Estevez de Jensen, University of Puerto Rico
Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala and António Francisco Castame, Instituto de Investigacão Agronómica (IIA), Angola

Approaches and Methods: Plant breeders will focus on the combination of disease (BGYMV, BCMNV, rust, common bacterial blight, anthracnose, Ascochyta blight and angular leaf spot) resistance with enhanced resistance to pests (bruchid, leafhopper) and greater tolerance to abiotic stress (drought, low soil fertility, high temperature). Elite bean breeding lines with multiple disease resistance have already been crossed with sources of resistance to pests or tolerance to abiotic stress. Bean lines will be screened for the selected traits each generation in environments that are most likely to provide the desired abiotic or biotic stress. This can be most easily achieved through collaboration among Dry Grain Pulse CRSP scientists and the regional bean research network in Central America and the Caribbean. Regional performance trials for black, small red, red mottled and light red kidney bean lines will be conducted in collaboration with national bean research programs in Latin America and the Caribbean.

Basic seed stocks of bean varieties developed and released by the project will be multiplied and small lots of seed will be distributed to farmers in Latin America and the Caribbean for testing in on-farm trials. Performance of the varieties in the on-farm trials also provides bean breeders with valuable feedback concerning the direction of their research. The project will also produce basic seed stocks of the most promising bean breeding lines and make seed available to the national bean research programs and NGO's involved in the multiplication and dissemination of improved seed.

The project will strengthen collaborative research with the Legume Program of the Instituto de Investigacão Agronómica (IIA) in Angola. Bean breeding lines from Central America, the Caribbean and the U.S. that have performed well in preliminary trials conducted in Angola have been used as parents in crosses with Angolan bean landrace varieties. The focus of the research in Angola will be development and evaluation of bean breeding lines. Project personnel will visit Angola twice each year to meet with Antonio Chicapa Dovala, António Francisco Castame, and other members of the IIA Legume Program. The goal is to develop the capacity to develop, select, release, multiply and disseminate seed of at least one improved bean cultivar before the end of the current period of funding.

Objective 2: Selection of beans for adaptation to low N soils.

Collaborators
James Beaver, University of Puerto Rico
Consuelo Estevez de Jensen, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala and António Francisco Castame, Instituto de Investigacão Agronómica (IIA), Angola

Approaches and Methods: Inadequate soil nitrogen is a frequent yield constraint for common beans in the Tropics. The use of nitrogen fertilizers increase production costs and, in some intensive bean production systems, can contribute to groundwater contamination. Researchers have pointed out the need to develop integrated soil nutrient management practices for beans that would combine biological nitrogen fixation with limited use of fertilizers, sustainable crop management practices, and the development of crop varieties better adapted to low fertility soils. Bean varieties with greater efficiency in the utilization of nitrogen should have enhanced biological nitrogen fixation capacity, root traits such as greater root hair density that contribute to tolerance to low soil P, and healthy root systems that can take advantage of available soil nitrogen and other nutrients.

Recurrent selection (RS) has proven to be useful in the selection of quantitatively inherited traits such as web blight resistance and tolerance to low soil P. We propose to conduct an additional cycle of recurrent selection to develop Mesoamerican and Andean breeding lines with greater adaptation to low soil N. Preliminary screening conducted in Honduras and Puerto Rico has identified disease resistant bean breeding lines that can be

used to form the base population for the next cycle of recurrent selection. A few elite small red bean breeding lines from Zamorano were found to have good biological nitrogen fixation when evaluated in field trials in Minnesota. The root rot resistant black bean line PR0443-151 and the small red line PR0340-3-3-1 from Puerto Rico and CIAT bean breeding lines A 774 and VAX 3 have performed well in a low N soil field site in Puerto Rico. During the past five years, the Zamorano bean breeding program and Dr. Jonathan Lynch have collaborated in the development of small red and black bean breeding lines with greater tolerance to low P soils and drought. Some of these lines also have better yield under low N soils due to increased nodulation by resident rhizobia. Zamorano has experience conducting strain selection and inoculation studies, maintains a collection of bean rhizobia and has the expertise needed to conduct the multifaceted research related to biological nitrogen fixation. Black bean lines (F_5) developed at the University of Puerto Rico with enhanced levels of root rot resistance and adaptation to low N soils will be evaluated in replicated yield trials and will be screened using molecular markers for disease resistance and traits associated with tolerance to low P soils. The most promising breeding lines from each cycle of recurrent selection will be included as entries in regional performance trials in Central America and the Caribbean. Less progress has been made in the selection of Andean bean lines for adaptation to low N soils. The performance of Andean bean landrace varieties from Haiti and the Dominican Republic will be evaluated in a low N soil in Puerto Rico to attempt to identify germplasm with greater tolerance to this edaphic constraint. During the two-year extension period, the project plans to develop the capacity to produce inoculum in Haiti and Angola.

Objective 3: Develop and test molecular markers for disease and pest resistance.

Collaborators
James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras

Approaches and Methods: Marker-assisted selection has proven to be a very useful tool for bean breeders. Unfortunately, molecular markers are not available for some important genes and the use of other molecular markers is often limited to either the Andean or Middle American gene pools. The development of new molecular markers for valuable traits or markers with greater versatility would benefit the entire bean research community.

Resistance to charcoal rot caused by *Macrophomina phaseolina* has been reported to be associated with drought tolerance and it has been recommended that breeding for terminal drought tolerance should include breeding for resistance to charcoal rot. The charcoal rot resistance in the breeding line BAT 477 was found to be controlled by the dominant complementary genes *Mp-1* and *Mp-2*. A RIL population derived from the cross 'DOR 364 x BAT 477' was acquired from CIAT and evaluated at the Isabela Substation during two growing seasons for reaction to charcoal rot. Lines resistant and susceptible to charcoal rot were selected. These lines will be used to identify putative

markers for resistance to this disease using AFLP markers and bulk segregant analysis. Greenhouse screening techniques using inoculation with Macrophomina at germination and inoculation of stems with Macrophomina infested toothpicks are being optimized.

Project personnel (Porch and Beaver) will collaborate with Dr. Mildred Zapata (UPR) in the evaluation of a bean population that may lead to the identification of genes and new molecular markers for resistance to common bacterial blight. The project also plans to evaluate the effectiveness of molecular markers identified by Mbogo and Myers to identify bean lines with resistance to bruchids.

Although marker-assisted selection is routinely used by some breeding programs, it is currently used by only a few programs in Latin America and the Caribbean. The molecular marker lab at Zamorano will assist other bean research programs in the region in the use of this new technology by providing informal training and assistance in screening elite bean breeding lines and in the application of any new molecular markers developed by this project.

Ongoing research projects in the U.S. to sequence the common bean genome and plans to develop a genetic map based on SNPs may provide powerful tools to identify new molecular markers for traits of economic importance. Project personnel will keep abreast of research progress and seek opportunities to apply this new technology.

Objective 4: Evaluation of other dry pulse crops for Central America and the Caribbean.

Collaborators
James Beaver, University of Puerto Rico
Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala and António Francisco Castame, Instituto de Investigacão Agronómica (IIA), Angola

Approaches and Methods: The Lima bean (*Phaseolus lunatus* L.) is a heat and drought tolerant dry grain pulse crop that is produced and consumed throughout the Caribbean. Most landrace varieties are indeterminate, short day plants that produce pods during the dry season when there is often a scarcity of common beans. Because Lima beans grow well in fence rows or on walls, the crop is well suited for urban agriculture. Lima bean landraces have been cultivated in the Caribbean during the past 500 years and may have acquired unique traits of economic value. At present, the USDA and CIAT bean germplasm collections contain very few accessions from the region. The germplasm collections currently have 2 accessions from Haiti, ≤ 3 accessions from Puerto Rico and no accessions from the Dominican Republic. We plan to collect and characterize the agronomic traits of at least 20 Lima bean landrace varieties from Puerto Rico and Haiti. Passport data will be collected so that the germplasm can be included in the CIAT and USDA germplasm collections. Seed of superior Lima bean accessions will be increased for further evaluation and possible release in the country of origin.

Cowpea [*Vigna unguiculata* (L.) Walp] is produced on a limited scale in Central America and the Caribbean. During the two-year extension period, the project plans to test in the region cowpea breeding lines from the University of California, Riverside. Zamorano will conduct preliminary evaluations of cowpea lines and will provide seed of the best adapted lines to institutions and organizations in Central America and Haiti interested in this crop. Potential areas of adoption of new cowpea lines are the semi-arid regions in northern Nicaragua and southern Honduras where the crop is used as an alternative to common beans during the 'postrera' season. We also plan to collaborate with the University of California, Riverside Dry Grain Pulse CRSP project in the evaluation cowpea landrace varieties from Angola as part of the M.S. degree research of Antonio David.

The project will provide collaborators in Haiti with seed of pigeonpea [*Cajanus cajan* (L.) Millsp.] breeding lines that have been selected in Puerto Rico for resistance to the pigeonpea pod fly [*Melanagromyza obtusa*].

Objective 5: *Capacity Building*
Increase the capacity, effectiveness and sustainability of agriculture research institutions that serve the bean and cowpea sectors in Central America, Haiti and Angola.

Collaborators
James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala and António Francisco Castame, IIA, Angola
Jeff Ehlers, University of California, Riverside, California
Phillip Roberts, University of California, Riverside, California

Degree Training:
Trainee # 1
First and Other Given Names: Monica
Last Name: Mmbui-Martins
Citizenship: Angolan
Gender: Female
Degree Program for Training: Masters
Program Areas or Discipline: Plant Breeding and Genetics
Host Country Institution to Benefit from Training: Angola
University to provide training: University of Puerto Rico
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID? – No
Supervising CRSP PI: Tim Porch or James Beaver
Start Date: August 2009
Projected Completion Date: January 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds
Amount Budgeted in Workplan, if providing full or partial support:
Direct cost: $40,000 (two years)
Indirect cost: None
U.S. or HC Institution to receive CRSP funding for training activity: The University of Puerto Rico

Trainee # 2
First and Other Given Names: Antonio
Last Name: Ndengoloka-David
Citizenship: Angolan
Gender: Male
Degree Program for Training: Masters
Program Areas or Discipline: Plant Breeding and Genetics
Host Country Institution to Benefit from Training: Angola
University to provide training: University of Puerto Rico
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? – No
Supervising CRSP PI: Tim Porch or James Beaver
Start Date: August 2009
Projected Completion Date: January 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds
Amount Budgeted in Workplan, if providing full or partial support:
Direct cost: $40,000 (two years)
Indirect cost: None
U.S. or HC Institution to receive CRSP funding for training activity: The University of Puerto Rico

Trainee # 3
First and Other Given Names: TBD
Last Name: TBD
Citizenship: TBD
Gender: Female
Degree Program for training: B.S.
Program Areas or Discipline: Plant Science
Host Country Institution to Benefit from Training: TBD
University to provide training: Zamorano
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? - No
Supervising CRSP PI: Juan Carlos Rosas
Start Date: January 2010
Projected Completion Date: December 2010
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s)s of leveraged funds
Family support
Amount Budgeted in Workplan, if providing full or partial support:
Direct cost: $ 4,000.00
Indirect cost: 0
U.S. or HC Institution to receive CRSP funding for training activity: Zamorano

Short-term Training:

Training activity # 1
Type of training: Informal training for seed production and storage on small farms
Emmanuel Prophete, Gasner Demosthene
Location: Haiti
Duration: One week
Scheduling of training activity: Winter months 2010-2011
Participants/Beneficiaries of Training Activity: Bean producers in Haiti
Anticipated numbers of Beneficiaries (male and female): 30 people
Amount Budgeted in Workplan
Direct cost: $1,500
Indirect cost: $0
If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:
None

Training activity # 2
Type of training: Informal training for the production, storage and use of *Rhizobium* inoculum
Consuelo Estevez de Jensen, Antonio Chicapa, Antonio Castame
Location: Angola
Duration: One week
Scheduling of training activity: November 2010
Participants/Beneficiaries of Training Activity: IIA Grain Legume Program
Anticipated numbers of Beneficiaries (male and female): 20 people
Amount Budgeted in Workplan
Direct cost: $1,500
Indirect cost: $0
If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:
None

Contribution of Project to Target USAID Performance Indicators

All of the host countries participating in this Dry Grain Pulse CRSP project are USAID-eligible countries. Increased or more stable bean yields contribute to economic growth and improve the lives of the families who produce the crop. A more reliable supply of staple crops such as beans fosters stability in the Latin American and Caribbean region. With the advent of CAFTA, increased opportunities exist to link bean markets within the region and to export beans to niche markets in the U.S. Because Central America is one of the Centers of Domestication of the common bean, collaboration with bean research programs in LAC provides U.S. bean breeding programs with greater access to bean germplasm with traits of potential economic value. Disease pressure is often more severe in LAC, which permits the development of bean lines having greater levels of disease resistance. Bean research in Central America and the Caribbean helps to identify emerging bean diseases and permits researchers to respond more rapidly and effectively when new diseases threaten bean production in the U.S. All of the abovementioned activities support U.S. foreign policy in Latin America and the Caribbean (http://www.usaid.gov/locations/latin_america_caribbean/issues/trade_issue.html).

The development of bean cultivars for Angola with enhanced levels of resistance to biotic and abiotic constraints contributes directly to the Presidential Initiative to End Hunger in Africa (IEHA)(http://www.usaid.gov/locations/sub-saharan_africa/initiatives/ieha.html). The proposed research provides the innovations needed to reduce vulnerabilities and risks of bean producers in Angola. The proposed Dry Grain Pulse CRSP project will establish collaborative research and training activities among U.S., LAC and Angolan bean research institutions that are in accord with the IEHA science and technology strategy.

This project addresses two of the four global themes of the Dry Grain Pulse CRSP. The development and release of bean cultivars with enhanced disease resistance and greater tolerance to abiotic stress should reduce production costs and risks for bean producers in Central America, the Caribbean and Angola. Lines with resistance to bean diseases, such as rust, should also be useful germplasm for U.S. bean breeding programs. Disease and pest resistance are key components in effective crop management systems. Bean breeding lines developed by the project will be screened for tolerance to drought and low soil fertility. Bruchid resistance should improve the quality of bean seed.

Participatory plant breeding methods and multiplication of basic stocks on underutilized research stations should result in more sustainable seed production and distribution systems. The project will use informal training to strengthen the capacity of the bean research programs in Central America, the Caribbean and Angola.

Target Outputs

The most important output of the proposed Dry Grain Pulse CRSP project is the release and dissemination of bean cultivars having enhanced levels of resistance to disease, pests and abiotic stress. The research team has a proven record of success. At present, more than 100,000 farmers in Central America plant small red bean cultivars developed by the Bean/Cowpea CRSP project. We propose to use a similar approach to develop, release and disseminate improved black bean varieties. Because promising black and red mottled bean lines are already in an advanced stage of development, it is likely that the project will demonstrate significant impact in Central America and the Caribbean during the next 24 months of funding from the Dry Grain Pulse CRSP through the dissemination and release of improved bean breeding lines. We expect to test and release at least two improved black bean culltivars in Central America. In Haiti, we expect to test and release at least two black and one red mottled cultivar. In El Salvador, Honduras and Nicaragua, we expect to release at least two new small red cultivars in collaboration with CIAT and national bean programs. In Puerto Rico, we expect to release pink and white bean cultivars. At the end of the two year extension period, sufficient seed stocks of these cultivars will be produced to initiate on-farm testing of these cultivars throughout Central America and the Caribbean.

Research achievements in Angola are expected to be more modest. The project has identified potential sources of resistance to the principal biotic and abiotic constraints and has initiated the development of bean breeding populations. The project plans to continue to conduct informal training that will strengthen bean research capabilities in Angola. At the end of the two-year extension period, bean research personnel in Angola should have sufficient experience and skills to develop, test and release improved bean lines. The M.S. degree training of Monica Mmbui and Antonio David at the University of Puerto Rico includes training in plant breeding, plant pathology, and molecular methods. Upon their return to Angola, Ms. Mmbui and Mr. David should be able to strengthen the capacity of IIA to conduct common bean and cowpea research.

The development and release of bean germplasm better adapted to low N soils will be of potential benefit throughout the Tropics where inputs such as fertilizer are beyond the means of many small-scale bean producers. Bean producers in the U.S. would also benefit from bean cultivars that have a lower requirement for N fertilizer. At the end of the two-year extension period at least one bean germplasm line with greater adaptation to low N soils is expected to be released.

Molecular markers have become an important tool for bean breeders in developed countries. There is a need, however, to continue to develop molecular markers for genes of economic importance, particularly for traits that are needed for the improvement of beans for the Tropics. During the two-year extension period, the project would focus on

the development of molecular markers for the putative dominant genes for resistance to charcoal rot. These molecular markers will improve the efficiency and effectiveness of selection for resistance to this disease and should contribute to the development of breeding lines having greater levels of resistance to terminal drought. A manuscript describing the protocol to use the molecular markers will be prepared for the Annual Report of the Bean Improvement Cooperative.

At least 20 Lima bean landraces will be collected from Puerto Rico and Haiti. Morphological, phenological and agronomic traits of the landraces will be collected at the Isabela Substation. Arrangements will be made to include the Lima bean landraces in the USDA and CIAT germplasm collections. Landraces with superior performance will be considered for release in Haiti and/or Puerto Rico.

Project personnel will collaborate with the Dry Grain Pulse CRSP cowpea breeding project in the evaluation of cowpea breeding lines in Haiti and Central America. A cowpea breeding line with superior performance will be considered for release as a cultivar.

Engagement of USAID Field Mission(s)

U.S. and Host Country Principal Investigators will maintain USAID Missions in Central America, Haiti and Angola informed of progress in achieving research and training objectives. Project personnel will meet with USAID Mission representatives during visits to the Host Countries to identify additional research and training activities that might lead to buy-ins.

Networking Activities with Stakeholders

Collaborative research has been a key element in the success of the small red bean breeding activities in Central America. The Dry Grain Pulse CRSP project will build upon these achievements by placing greater emphasis on the improvement of black bean lines. This collaboration will enhance the impact of the Dry Grain Pulse CRSP project research in Guatemala and Haiti where the black bean is the preferred seed type. Mr. Emmanuel Prophete and the recent Bean/Cowpea CRSP trainee from Haiti, Gasner Demosthenes, speak Spanish, which facilitates communication with other bean researchers in Central America and the Caribbean. The proposed Dry Grain Pulse CRSP project will collaborate with the bean research network in Central America and the Caribbean in the evaluation of bean lines and the multiplication of basic seed stocks of recently released cultivars. Dr. Rosas will coordinate regional performance trials for black and small red beans in Central America and the Caribbean. At least 20% of the funds assigned to the Escuela Agrícola Panamericana will be used to support activities of national bean research programs in Central America. James Beaver will coordinate the evaluation of red mottled and light red kidney bean regional performance trials in the Caribbean and will provide seed of these seed types to collaborators in Ecuador and Africa. Dr. Tim Porch will collaborate with Mr. Antonio Chicapa Dovala in the evaluation of bean lines in Angola. Ing. Emmanuel Prophete will be responsible for the evaluation and on-farm testing of black, white and red mottled bean lines in Haiti. The project will also collaborate with NGO's and participatory plant breeding programs in

Central America and the Caribbean to promote the dissemination and adoption of bean cultivars. As project personnel learn more about the bean subsector and ongoing research and extension activities in Angola, opportunities for greater collaboration will be pursued. For example, additional informal training activities with Agostinho Neto University in Huambo, Angola could be developed. Dr. Porch has communicated with CIAT bean scientists and Dr. Rowland Chirwa to identify opportunities for collaboration with the SABRN bean research network. He has also communicated with Mr. Kennedy Mmbui of the ZARI bean research program to determine if Dry Grains Pulse CRSP activities in Angola can benefit bean research in Zambia.

Leveraging of CRSP Resources

The Dry Grain Pulse CRSP has access to mature bean breeding projects at the Escuela Agrícola Panamericana in Honduras and the University of Puerto Rico. Both breeding programs have alternative sources of funding that will indirectly benefit the research goals of the project. Promising bean breeding lines are already in an advanced stage of development that will enable the project to achieve significant impact in a short period. Ing. Emmanuel Prophete is the leader of the Ministry of Agriculture seed program in Haiti that will provide resources for the multiplication and distribution of bean cultivars developed by the proposed Dry Grain Pulse CRSP project. The EAP is an active participant in the Central American bean research network supported by IICA/COSUDE that provides a limited amount of resources for activities that complement proposed research and training activities. Dr. Rosas is a leader of a participatory plant breeding program supported by the Norwegian Development Fund that funds bean research in Central America. Dr. Beaver and Dr. Porch are PIs for Regional Hatch Project W-1150 that shares many research objectives with the Dry Grain Pulse CRSP. Project personnel will continue to attempt to obtain additional support for research and training activities from USAID Missions. The project will also seek opportunities for support or collaboration with NGO’s and private companies.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2012)

PERFORMANCE INDICATORS/TARGETS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Development, Testing and Dissemination of Genetically Improved Bean Cultivars for Central America, the Caribbean and Southern Africa.
Lead U.S. PI and University: James S. Beaver, University of Puerto Rico
Host Country(s): Angola

Output Indicators	2011 Target (Oct 1,2010 - Sept 30, 2011)	2011 Actual (Oct 1,2010 - Sept 30, 2011)
Degree Training: Number of individuals who have received degree training		
Number of women	0	
Number of men	1	
Short-term Training: Number of individuals who have received short-term training		
Number of women	10	
Number of men	15	
Technologies and Policies		
Number of technologies and management practices under research	3	
Number of technologies and management practices under field testing	3	
Number of technologies and management practices made available for transfer	1	
Number of policy studies undertaken	0	
Beneficiaries:		
Number of rural households benefiting directly	75	
Number of agricultural firms/enterprises benefiting	1	
Number of producer and/or community-based organizations receiving technical assistance	4	
Number of women organizations receiving technical assistance	1	
Number of HC partner organizations/institutions benefiting	3	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	1,000	

Dry Grain Pulses CRSP : FY11

Development, testing and dissemination of genetically improved bean cultivars for Central America, the Caribbean and Angola.

	FY11 (12 months) 10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	**UPR**	**0**	**USDA-ARS**	**EAP**	**Haiti**	**Angola**
a. Personnel Cost						
Salaries	$3,040.00		$19,000.00	$19,950.00	$7,125.00	$5,700.00
Fringe Benefit	$760.00		$3,800.00	$3,990.00	$2,375.00	$1,900.00
b. Travel	$11,100.00	$0.00	$8,000.00	$5,700.00	$2,850.00	$7,125.00
c. Equipment ($5000 Plus)		$0.00	$0.00	$0.00	$0.00	$0.00
d. Supplies	$7,600.00		$5,875.00	$7,600.00	$7,125.00	$7,125.00
e. Training						
Degree	$6,000.00	$0.00	$0.00	$3,800.00	$0.00	$0.00
Non-Degree	$0.00	$0.00	$0.00	$3,800.00	$2,500.00	$2,135.00
f. Other			$0.00	$11,825.00	$0.00	
g. Total Direct Cost	**$28,500.00**	**$0.00**	**$36,675.00**	**$56,665.00**	**$21,975.00**	**$23,985.00**
h. Indirect Cost	$7,125.00		$4,075.00	$8,500.00	$0.00	$0.00
i. Indirect Cost on Subcontracts (First $25000)					$0.00	$0.00
j. Total Indirect Cost	$7,125.00	$0.00	$4,075.00	$8,500.00	$0.00	$0.00
Total	**$35,625.00**	**$0.00**	**$40,750.00**	**$65,165.00**	**$21,975.00**	**$23,985.00**
Grand Total	**$187,500.00**					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	**$58,500.00**	**35.69%**
Total direct cost budgeted for H.C institution(s)	**$105,400.00**	**64.31%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$24,412.00			$45,000.00			$ 69,412.00
Cash	$0.00			$10,700.00			$ 10,700.00
Total	$ 24,412.00		$ -	$ 55,700.00	$ -	$ -	$ 80,112.00
Attribution to IEHA Objectives							
Percentage of effort	10.00%		100.00%	20.00%		100.00%	43.38%
Amount corresponding to effort	$3,562.50	$0.00	$40,750.00	$13,033.00	$0.00	$23,985.00	$81,330.50
Attribution to Capacity Building (Theme "D")							
Percentage of effort	25.00%		25.00%	50.00%		50.00%	33.96%
Amount corresponding to effort	$8,906.25	$0.00	$10,187.50	$32,582.50	$0.00	$11,992.50	$63,668.75

Name of PI & Institutional Affiliation: James S. Beaver, Dept. of Agron. and Soils, Univ. of Puerto Rico, Mayaguez, PR 00681-9030

Dry Grain Pulses CRSP
Report on the Achievement of "Semi-Annual Indicators of Progress"
(For the Period: April 1, 2011 – September 30, 2011)

Dry Grain Pulses CRSP
Report on the Achievement of "Semi-Annual Indicators of Progress"
(For the Period: October 1, 2010 – April 1, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by April 1, 2011

Project Title: **Development, Testing and Dissemination of Genetically Improved Bean**

	Provide abbreviated name of institutions in columns below														
	UPR			USDA			EAP			IIA			Haiti		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmark Indicators by Objectives	4/1/11	Y	N *	4/1/11	Y	N *	4/1/11	Y	N *	4/1/11	Y	N *	4/1/11	Y	N *
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1: Development, release and dissemination of improved bean cultivars.															
Germplasm acquired for key abiotic and biotic stress factors of Angola															
Germplasm tested in Angola				X											
Breeding populations developed															
Breeding populations tested	X						X						X		
Advanced trials conducted	X						X			X			X		
Promising lines validated on farm	X						X						X		
Cultivar released	X						X								
Objective 2: Selection of beans for adaptation to low N soils.															
Complete field and greenhouse evaluations to identify most promising sources of BNF germplasm	X						X								
Complete crosses for the first cycle of recurrent selection for enhanced BNF	X						X								
Harvest F2 seed for the first cycle of recurrent selection	X						X								
Objective 3: Develop molecular markers for disease resistance genes.															
Sources of ashy stem blight resistance acquired				X											
RAPD products cloned and sequenced					X										
SCAR markers designed and initially tested					X										
Objective 4: Evaluation of other pulse crops for Central America and the Caribbean															
Complete collection of P. lunatus															
Complete first year of field testing of cowpeas in PR, Haiti, and Central America	X														
Characterize the phenological, morphological, and agronomic traits of P. lunatus (Haiti, PR)	X												X		
Objective 5: Increase the capacity, effectiveness and sustainability of agricultural research institutions that serve the															
M.S. training of Monica Mmbui	X														
M.S. training of Antonio David	X														
Workshop in Angola concerning the production, storage and distribution of *Rhizobium* inoculum							X								
Name of the PI reporting on benchmarks by institution	James Beaver			Tim Porch			Juan Carlos Rosas			Antonio Chicapa			Emmanuel Prophete		

Name of the U.S. Lead PI submitting this Report to the MO

Signature **Date**

* *Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

Existing RAPD markers tested				X											
Effectiveness of RAPD markers in acquired germplasm determined				X											
RAPD products cloned and sequenced				X											
SCAR markers designed and initially tested				X											
Objective 4: Evaluation of other pulse crops for Central America and the Caribbean															
Complete collection of P. lunatus															
Complete first year of field testing of cowpeas in PR, Haiti, and Central America	X														
Characterize the phenological, morphological, and agronomic traits of P. lunatus (Haiti, PR)	X												X	X	
Objective 5: Increase the capacity, effectiveness and sustainability of agricultural research institutions that serve the bean and cowpea sectors in Central America, Haiti and Angola.															
M.S. training of Monica mmbui initiated	X														
M.S. training of Antonio David initiated	X														
Informal training in Angola in bean research techniques				X											
Workshop in Angola concerning the production, storage and distribution of *Rhizobium* inoculum							X								
Name of the PI reporting on benchmarks by institution	James Beaver			Tim Porch			Juan Carlos Rosas			Antonio Chicapa			Emmanuel Prophete		

Name of the U.S. Lead PI submitting this Report to the MO	

Signature **Date**

* *Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

P3-ISU-2

Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

Lead U.S. Principal Investigator
Mark E. Westgate, Iowa State University

Collaborating Scientists
Mateete Bekunda: Makerere University, Uganda.
Lynne Carpenter-Boggs: Washington State University, USA
Karen Cichy: USDA-ARS, USA
James D. Kelly: Michigan State University, USA
Phillip Miklas: USDA-ARS, USA
Henry Kizito Musoke: Volunteer Efforts for Developmental Concerns, Uganda
Susan Mchimbi-Msolla: Sokoine University, Tanzania
Augustine Musoni: Institit des Sciences Agronomiques du Rwanda (ISAR), Rwanda
Eda Reinot: Becker Underwood, Inc. USA
Hamisi Tindwa: Sokoine University of Agriculture, Tanzania
Michael Ugen: National Crops Research Institute, Uganda
Peg Armstrong-Gustafson: amson technology l.c., USA

Project Problem Statement and Justification

Common beans are the most important legume crop in Uganda, Rwanda and Tanzania occupying a very large proportion of land devoted to legumes. For example, over 45% of the protein intake by Ugandans comes from beans providing 25% of dietary calories. Likewise, over 75% of rural households in Tanzania depend on beans for daily subsistence. Common bean is an important source of protein for low-income families in rural and urban areas providing about 38% of utilizable protein and 12-16% of daily caloric requirements. Improved bean production in Uganda, Rwanda, and Tanzania offers unique opportunities to address the deteriorating food security situation there and elsewhere in sub-Saharan Africa.

Loss of soil fertility is recognized as the most important constraint to food security in sub-Saharan Africa. Low levels of nitrogen and phosphorous are the primary fertility constraints. Because soils are increasingly becoming degraded, an affordable means of improving soil fertility and productivity of nitrogen-accumulating crops is critical. Properly nodulated legumes can leave up to 350 kg nitrogen per hectare in the soil, depending on effectiveness of the nitrogen fixation process, type of legume, length of time the legume is grown, soil nutrient levels and nitrogen already available. Because inoculum is much cheaper than inorganic fertilizer, use of inoculants can provide an affordable and sustainable way to improve production of nitrogen fixing legumes.

Numerous studies have shown the potential of improving legume productivity by enhancing nodulation through proper use of a biological inoculant. Yet field trials in sub-Saharan Africa have provided mixed results. Likely causes for variable response include poor quality control of inoculant formulation, failure to compete with local rhizobia,

inhibition by indigenous microbial flora, or failure of the inoculant species to survive in low pH and/or droughty soils. Modern inoculant formulations designed to deliver a synergistic suite of biological and chemical enhancements for biological nitrogen fixation under stressful soil conditions have been made available to our collaborative research project by Becker Underwood, Inc. Becker Underwood's *BioStacked®* inoculant technologies for legume crops consist of well stabilized *Rhizobium* bacteria, a biological fungicide, plant growth promoting rhizobacteria, and other biologically derived proprietary biostimulant technologies which promote plant growth and overall plant health. These stacked inoculants have been shown to decrease chemical fertilizer use in crop rotations, increase legume yields, suppress root diseases, and improve rhizosphere conditions for root growth. We anticipate they will be particularly effective under degraded soil conditions encountered on small-landholder farms in Uganda, Rwanda, and Tanzania.

To optimize BNF, it also is essential to identify germplasm with greatest capacity for this trait. Although common bean has the potential for BNF, it is reported to have the lowest percent N_2 derived from N fixation among legumes. Genetic variation for BNF has been reported within the primary gene pool, and lines with superior BNF have been identified. Superior BNF lines such as Puebla 152 and BAT 477 have been used as parents in crosses to generate populations for genetic studies and to examine selection and breeding for improved BNF. Few breeding lines with improved BNF, however, have been developed. The optimal selection environment for BNF is under low soil N since application of nitrogen fertilizer reduces N fixation capacity. Marker-assisted selection (MAS) under such conditions is highly sought after as a means to facilitate breeding for traits like BNF with low to moderate heritability.

Molecular mapping in combination with germplasm screening and MAS would be a powerful way to improve locally adapted germplasm for BNF in a host country. Recombinant inbred populations currently available are ideal for tagging and mapping genes that influence quantitative traits (QTLs). Few QTLs associated with BNF, however, have been identified to date, and those identified have not been validated. Identifying and validating QTL-conditioning enhanced BNF would be a major contribution to the scientific community, and represent a major step toward effective marker-assisted selection for BNF.

Our BNF-CRSP program objectives address the need to identify production systems that enhance BNF, develop germplasm that benefits most from symbiotic inoculation, and aggressively share this new information with small landholder farmers in sub-Saharan Africa whose health and well being depend heavily on legume production.

Planned Project Activities

Objective 1: The *first strategic aim* is to improve BNF and seed yields of common beans significantly using superior seed inoculants such as Becker Underwood's BioStacked® inoculant through farmer-based experimentation and adoption of innovative production techniques.

Sub-Objective1a: *To evaluate effectiveness of biologically stacked inoculants on local and improved germplasm.*
We expect to:

1. Establish Field Trial 2 (MSU, WSU, NaCCRI, SUA, ISAR)
2. Quantify yield advantage of inoculation for second crops seasons (MSU, WSU, NaCCRI, SUA, ISAR)

Sub-Objective 1b: *To quantify genotype by environment interactions and constraints to enhancing BNF of inoculated plants.*
We expect ISU to:

3. Complete analysis of plant/soil/weather data completed (ISU, Makerere, NaCCRI, SUA, ISAR)
4. Identify unique responses to inoculant x genotype x environment (ISU, Makerere, MSU, WSU, NaCCRI, SUA, ISAR)
5. Extract and analyze soil DNA for indigenous rhizobia strains (WSU, Makerere, NaCCRI, SUA, ISAR)
6. Establish indigenous rhizobia levels and environmentally tolerant strains (MSU, WSU, NaCCRI, SUA, ISAR)

Collaborators: *Becker Underwood, Inc.* (BU) is an international developer of bio-agronomic and specialty products. The company is the leading global producer of inoculants, beneficial nematodes, and a wide range of agricultural and horticultural products. BU will produce the *Bio-stacked®* legume inoculants (see http://www.beckerunderwood.com/en/newsreleases/100104) for distribution to HC and US researchers in this CRSP project. BU has worked with numerous universities around the world and has implemented quality assurance programs and technical support to ensure proper formulation and field application.

Approaches and Methods: In Rwanda, Tanzania, and Uganda multiple sites will be used to evaluate popular cultivars of both determinate bush and indeterminate vine growth habit types for response to different rhizobia-inoculum treatments. Site selection will be defined by where beans are already grown and consumed, and will encompass the range of soil types and weather conditions documented at each site (1c). Four cultivars will be chosen representing different market types, evolutionary origin, in addition to the different plant types. For example in Tanzania popular cultivars (genotypes) representing the major speckled purple-Kablanketi (Type III, Andean), yellow-Njano (Type I, Andean), Red Kidney (Type I, Andean), and Carioca (Type II, MA) market types would be tested. Adapted non-nodulating genotype(s) (~BAT477, DOR364 from CIAT) will be useful for this and subsequent BNF trials as checks. Rhizobia inoculum treatments will include *Bio-stacked®*, other commercially available inoculants (e.g. Bio-N-Fix), and no inoculum. The *Bio-stacked®* inoculum from Becker-Underwood, Inc. is formulated for enhanced BNF under stressful soil conditions (see product note from Becker Underwood, Inc.). A RCBD with four replications, and moderately large plot size will be used (4 to 6 rows wide by 5 to 7 m length), Established research station sites will be used initially and expanded to on farm and community co-op trials using select genotypes which exhibit

greatest BNF response. It is envisioned by year 2 that HC Extension personnel, NGO, or other business partners will be identified to help develop and implement strategies for technology dissemination to numerous farmers (Strategic Aim 3). A low N treatment will be targeted the first few years and expanded to include low and high N in subsequent years as HC and US project participants gain training and experience with experimental protocols and procedures.

Standard agronomic practices will be employed in the controlled location studies (Opio et al 2001). Incidence and severity of disease and pest damage will be recorded to determine their indirect impact on N-fixation, plant performance and response to inoculant treatments. Agronomic data collected for each treatment includes: soil analysis, final plant stand (pl/m), seed yield (kg/ha), disease and insect pest ratings (mid-season for leaves), days to physiological maturity, pods per plant, seed quality (color, % not mature, % mottled, and economic return on investment in the inoculant technology. The latter will be assessed by careful record keeping of agronomic input costs and grain sales. Thermometers, rain gauges, and soil moisture sensors will be positioned on site for recording local weather conditions. Plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity on a plot basis will be used to measure BNF response of the different genotypes and treatments. These measurements are the most affordable in terms of cost and labor and correlate well with seasonal BNF. Select genotypes or treatments with large or interesting BNF responses, could be further characterized by evaluation of root biomass, nodulation number and mass, isotope assays, or post crop response. Data collection will be coordinated by HC scientists and students.

Objective 2: The *second strategic aim* is to examine the inheritance of genetic and environmental variation in BNF in common bean, and to identify molecular markers associated with QTL conditioning for enhanced BNF.

Sub-Objective 2a: *To identify parental materials for inheritance studies of BNF.*
We expect to:

7. Screen germplasm for BNF in low soil N +/- inoculants in HC field trials (MSU, WSU, NaCCRI, SUA, ISAR)
8. Initiate greenhouse screening trials on selected lines for BNF response (ISU, WSU)
9. Initiate Greenhouse BNF screening on selected lines (WSU)
10. Test parental lines for BNF in the field: US and HC sites (ISU, MSU, WSU, NaCCRI, SUA, ISAR)

Sub-Objective 2b: *To phenotype existing mapping populations for BNF response, populate with molecular markers, and conduct QTL analysis.*
We expect to:

11. Test selected populations for BNF in the field: US and HC sites (ISU, MSU, WSU, NaCCRI, SUA, ISAR)
12. Establish correlative response of BNF in field and GH trials (ISU, MSU, WSU, Makerere, NaCCRI, SUA, ISAR)

13. Establish nodule rhizobia occupancy established on selected lines (WSU)
14. Advance selected RILs to F2 (ISU, WSU, NaCCRI, SUA, ISAR)

Collaborators: Host country field managers at NaCRRI, ISAR, and SUA and experiment station managers at ISU, MSU, and WSU in the US.

Approaches and Methods: We will collect and increase seed of representative commercial market types and advanced breeding lines from host countries Rwanda, Uganda, Tanzania and the US; lines known to differ for BNF (BAT 477, Pueblo 152, CAL 143, RIZ lines, etc.); super-nodulating and non-nodulating; and select parents of existing mapping populations; in total about 50 materials. These materials will be tested for BNF response under low N conditions in the field (single locations in Rwanda, Tanzania, and Uganda) and greenhouse (US-WSU). The materials will be split into groups of 30 genotypes each. The plan is to test half the lines in Rwanda and the other half in Tanzania in Year 1, and vice versa in Year 2. The plots will be smaller (single row, 3 m length) and with fewer reps (2 to 3).

The materials will also be tested in the greenhouse in the US (WSU and ISU). Single plants will be sown in 1 liter pots containing 50% sand/potting soil mixture, N-deficient fertilizer solution, and arranged in RCBD with 5 replications, and at least two treatments – non-inoculated and inoculated (with mixture of rhizobia strains). The materials will be similarly grouped (20 to 30 materials each group) for the GH experiments conducted over a period of two years. BNF response will be measured by plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity for field studies. For greenhouse studies, plant biomass on shoot/root basis, nodulation score, and plant N concentration at 12 wks after planting will be used to measure BNF response.

Crosses will be conducted between parents with contrasting BNF response (low vs. high) to initiate generation of genetic mapping populations (recombinant inbred line – RIL populations). It takes three years to obtain mapping populations and increase seed for F5 or later derived RILs for replicated multi-site testing. Four populations will be developed (two by ARS-Prosser and two by ARS-East Lansing) consisting of approximately 150 lines each. Efforts will be made to cross high X low parents that are adapted for each country (Rwanda, Tanzania, Uganda, and US). Basic agronomic information will be collected, e.g. biomass at flowering, biomass at harvest, shoot N at harvest, seed yield, seed N, HI and NHI. From these RIL populations we expect to obtain advanced breeding lines with good BNF, good agronomic performance, and identify acceptable HC market types.

Given the three year time frame necessary to generate new mapping populations, existing mapping populations with promise for mapping QTL conditioning BNF response will be tested in HC and US. Two existing mapping populations will be phenotyped for BNF response (EP=Eagle/Pueblo 158, 78 F8 RILs, 357 markers; RC=Rojo/CAL 143, 147 F5 RILs, no markers). Seed of the RILs will be increased (January-May, Year 1, EP by ARS, East Lansing and RC by ARS-Prosser). The parents for EP, RC, and a few other bi-

parental populations will be tested in the GH to confirm divergent phenotypic response for BNF (January – Year 1, WSU). Given divergent response for the parents the EP population will be tested at two sites (ARS-Prosser and -East Lansing) under low N, using 1-2 row plots and 3-4 reps as determined by seed availability, using a RCBD design (summer Year 1).

Objective 3: The *third strategic aim* is to improve the productivity, profitability, and sustainability of agricultural systems on degraded soils through effective dissemination of new information and technologies to small-landholder farmers.

Sub-objective 3a: *To improve farmer awareness of inoculation technologies*
We expect to:

15. Conduct farmer KPA evaluations on benefits of inoculation and BNF (VEDCO)
16. Train Extensionists at HC institutions in benefits of BNF and inoculant use (VEDCO, NaCCRI, SUA, ISAR)
17. Establish format for field demonstrations at HC research stations (ISU, MSU, WSU, VEDCO, Makerere, NaCCRI, SUA, ISAR)
18. Conduct field days in each HC to present research results (VEDCO, NaCCRI, SUA, ISAR)

Sub-objective 3b: *To conduct on-farm demonstrations comparing inoculant strategies*
We expect to:

19. Identify farmer cooperators for on-farm trials (VEDCO, NaCCRI, SUA, ISAR)
20. Train farmer cooperators on proper methods for conducting on-farm trials (VEDCO, NaCCRI, SUA, ISAR)
21. Initiate on-farm trials initiated with selected farmer cooperators (WSU, MSU, VEDCO, NaCCRI, SUA, ISAR)

Sub-objective 3c: *To strengthen farmers' collective capabilities to purchase inoculants and incorporate them into a profitable and sustainable system for small landholders,*
We expect to:

22. Create training materials to disseminate through PELUM farmer network (ISU, WSU, MSU, Makerere, VEDCO, NaCCRI, SUA, ISAR)
23. Conduct advocacy meetings with farmer groups and agribusiness interests (VEDCO)

Collaborators: PELUM is an a network of 207 civil society organizations in Eastern, Central and Southern Africa working towards poverty eradication, food security, and sustainable community development (see http://www.pelumrd.org/).

Approaches and Methods: Ultimately our outreach activities will include training field staff on the use and potential benefits of inoculation technology, selecting farmers to

participate in on-farm trials, sensitizing farmers and farmer groups about inoculant technology, identify local bean varieties to include in the field trials, training farmers on proper methods for conducting on-farm trials, data management, economic returns, and supporting data collection for site characterization. This will be completed through on-farm demonstrations, mass media, field schools, and local forums that the PELUM network has established in the region.

Our approach in Year 2 and 3 will be to disseminate information about the application of inoculant technologies directly to small landholder farmers through our partner connections in PELUM. PELUM's work focuses on enhancing farmers' livelihoods through sustainable agriculture, seed and food security. PELUM has active networks in 10 countries: Botswana, Kenya Lesotho, Malawi, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. As a network their strength lies in efficient and effective collaboration and communication.

Objective 4: "I*ncrease the capacity, effectiveness and sustainability of agriculture research institutions which serve the bean and cowpea sectors in developing countries"*

Capacity building in terms of degree training includes formal education for seven (7) MS level graduate students and five (5) undergraduate students from host countries. Two graduate students will be trained in the Soil Science Department at Makerere University under the direction of Dr. Mateete Bekunda, Professor of Soil Science. Two graduate students will be trained at Sokoine University of Agriculture under the direction of Dr. Susan Mchimbi, Associate Professor of Plant Breeding and Genetics. One HC graduate student will be trained at Washington State University under the co-direction of Dr. Lynn Carpenter-Boggs, Assistant Professor of Soil Microbiology and Biochemistry, and Dr. Phillip Miklas, Legume Research Geneticist with USDA-ARS. One HC graduate student will be trained at Iowa State University under the direction of the program PI, Dr. Mark Westgate, Professor of Crop Production and Physiology. And one HC graduate student will be trained at Michigan State University under the co-direction of Dr. Jim Kelly, Professor of Crop Breeding and Genetics, and Dr. Karen Cichy, Research Geneticist with USDA-ARS.

It is expected that HC students training in the US will spend some time conducting practical field work in their home country. The student enrolled at Michigan State University in Crop and Soil Sciences, for example, will conduct in depth studies on promising lines indentified in Rwanda field trials and will develop linkage maps of a recombinant inbred line population to conduct QTL analysis of BNF capacity. Once the student has completed his or her coursework at MSU, he or she will spend an estimated 4 months in Rwanda gathering data on BNF variability in the RIL population. The student will then return to MSU to complete degree requirements. It also is expected that HC students trained at US institutions will return to their home countries to engage in research in their chosen field.

Capacity building in terms of non-degree training include formal internships for five (5) undergraduate students and training of HC laboratory technicians, field agronomists and

extension staff on use and agricultural benefits of seed inoculants. In the first year, three undergraduate students will be assigned to the three field sites in Rwanda to assist in germplasm evaluation. These students will be supervised by Dr. Augustine Musoni, and interact directly with US PIs during their visits to the field sites. Two undergraduate intern will be assigned to work with VEDCO staff on information dissemination in Year 2 and 3.

An additional short-term training activity is planned for SUA microbiologist Mr. Hamisi Tindwa in the microbiology lab of Dr. Lynne Carpenter-Boggs at Washington State University. The intent of this training activity is for Mr. Tindwa to learn about modern molecular and biochemical methods to identify and quantify soil microflora.

Training/Capacity Building Workplan Format (January 1 to September 28, 2010)
This program includes formal training for seven MSc students, five undergraduate interns, and one visiting scientist to Washington State University. Five graduate students and three undergraduate interns will be identified in during the first funding period. Two graduate students and two interns will begin training in year 2.

Degree Training:
Seven host country M.Sc. graduate students
First and Other Given Names: TBD
Last Name
Citizenship: Uganda
Gender:
Training Institution: Iowa State University
Supervising CRSP PI: Westgate
Degree Program for training: M.S.
Program Areas or Discipline: Plant Physiology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training:
Thesis Title/Research Area: TBD
Start Date: Fall 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

First and Other Given Names: TBD
Last Name:
Citizenship: Uganda
Gender:
Training Institution: Makerere University
Supervising CRSP PI: Bekunda
Degree Program for training: M.S.
Program Areas or Discipline: Soil Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training: Makerere University
Thesis Title/Research Area: TBD
Start Date: Summer 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

First and Other Given Names: TBD
Last Name:
Citizenship: Uganda
Gender:
Training Institution: Makerere University
Supervising CRSP PI: Bekunda
Degree Program for training: M.S.
Program Areas or Discipline: Soil Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training: Makerere University
Thesis Title/Research Area: TBD
Start Date: Summer 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

First and Other Given Names: TBD
Last Name:
Citizenship: Rwanda
Gender:
Training Institution: Michigan State University
Supervising CRSP PI: Kelley, Cichy
Degree Program for training: M.S.
Program Areas or Discipline: Plant Breding/Genetics
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training: ISAR
Thesis Title/Research Area: TBD
Start Date: 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

First and Other Given Names: TBD
Last Name:
Citizenship: Tanzania/Rwanda/Uganda
Gender:
Training Institution: Washington State University
Supervising CRSP PI: Carpenter-Boggs, Miklas
Degree Program for training: M.S.
Program Areas or Discipline: Soil Microbiology/Biochemistry
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training: Sokoine University Agriculture
Thesis Title/Research Area: TBD
Start Date: Fall 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

First and Other Given Names: TBD
Last Name:
Citizenship: Tanzania
Gender:
Training Institution: Sokoine University Agriculture
Supervising CRSP PI: Mchimbi, Tindwa
Degree Program for training: M.S.
Program Areas or Discipline: Breeding and Genetics

If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training: Sokoine University Agriculture
Thesis Title/Research Area: TBD
Start Date: Summer 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

First and Other Given Names: TBD
Last Name:
Citizenship: Tanzania
Gender:
Training Institution: Sokoine University Agriculture
Supervising CRSP PI: Mchimbi, Tindwa
Degree Program for training: M.S.
Program Areas or Discipline: Breeding and Genetics
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES
Host Country Institution to Benefit from Training: Sokoine University Agriculture
Thesis Title/Research Area: TBD
Start Date: Summer 2010
Projected Completion Date: Summer 2012
Training status (Active, completed, pending, discontinued or delayed): pending
Type of CRSP Support (full, partial or indirect) for training activity: full

Short-term Training:

Two undergraduate internships at VEDCO
Type of training:Undergraduate Internship on inoculant technologies, management and benefits
Description of training activity: Participation in field operations
Location: Varied, depending on staff and farmer group locations
Duration: 8 weeks
When will it occur? Summer 2011
Participants/Beneficiaries of Training Activity: Extension staff, farmer groups
Anticipated numbers of Beneficiaries (male and female): Up to 22,000 VEDCO farmers
PI/Collaborator responsible for this training activity: VEDCO, Musoke
List other funding sources that will be sought (if any):
Training justification: Adaptation of new technology requires user understanding of appropriate use management, and pitfalls.

Three undergraduate internships at ISAR
Type of training: Undergraduate Internship on inoculant technologies, management and benefits
Description of training activity: Participation in field operations
Location: Varied, depending on staff and farmer group locations
Duration: 8 weeks
When will it occur? Summer 2011
Participants/Beneficiaries of Training Activity: Extension staff, farmer groups
Anticipated numbers of Beneficiaries (male and female): 1000 farmers
PI/Collaborator responsible for this training activity: ISAR, Musoni
Training justification: Adaptation of new technology requires user understanding of appropriate use, management, and pitfalls.
Type of training: Staff and farmer education on inoculant technologies, management and benefits
Description of training activity: Formal lecture and open discussion
Location: Varied, depending on staff and farmer group locations
Duration: 4 hours
When will it occur? Spring-summer 2010
Participants/Beneficiaries of Training Activity: Extension staff, farmer groups
Anticipated numbers of Beneficiaries (male and female): 50 male, 50 female

PI/Collaborator responsible for this training activity: VEDCO/ISAR/SUA, Musoke, Nchimba, Musoni
Training justification: Adaptation of new technology requires user understanding of appropriate use, management, and pitfalls.
Type of training: Staff and farmer education on inoculant technologies, management and benefits
Description of training activity: Formal lecture and open discussion
Location: Varied, depending on staff and farmer group locations
Duration: 4 hours
When will it occur? Spring-summer 2010
Participants/Beneficiaries of Training Activity: Extension staff, farmer groups
Anticipated numbers of Beneficiaries (male and female): 50 male, 50 female
PI/Collaborator responsible for this training activity: Westgate, Musoke
Training justification: Adaptation of new technology requires user understanding of appropriate use, management, and pitfalls.

Contribution of Project to Target USAID Performance Indicators

Graduate and undergraduate training is central to this project. Supporting advanced education for HC students with world-class scientist and training field technicians will contribute directly to HC capacity building.

Training of farmers and farmer groups on technologies to improve bean productivity will contribute to income and food security of small landholder farmers.

Improved on-farm productivity will enhance marketing opportunities for farmer associations.

Advancing inoculant technology for legumes will promote agricultural enterprise associated with inoculant production and sales.

Target Outputs

New knowledge on bean germplasm x inoculant x environment interactions to inform ongoing variety development programs in the U.S. and host countries about specific improvements in BNF needed to realize enhanced yield, nutritional value, and marketability of dry beans and other pulses.

Seven graduate students and (at least) five undergraduate students trained in agricultural research and extension.

Methods and conditions for profitable use of superior legume inoculants determined.

Engagement of USAID Field Mission(s)

Work in this project is closely aligned with USAID's goals of increasing agricultural production, enhancing the sustainable use of natural resources, reduce threats to biodiversity, and improve food security. USAID assistance seeks to increase and diversify commercial agricultural production and increase Uganda's competitiveness in local and international markets. This project will contribute to USAID's mission of strengthening producer organizations by working with individual farmers and farmer groups. In particular, the CRSP project explores the benefits of modern agricultural (micro-biological) technology to increase agricultural productivity and income to small landholder farmers.

Outcomes of this CRSP program directly support the USAID Rwanda Mission program for economic growth and expanded opportunities in rural areas, increase household incomes, employment, and corresponding rural financial services for targeted communities. The central Mission goal of increasing agricultural productivity is promoted by developing sustainable production practices to increase legume yields through training and access to modern agricultural inputs. Knowledge and experiences gained through VEDCO's dissemination activities in Uganda provide an excellent model for disseminating information to farmer groups in rural communities in Rwanda.

The major objectives of the USAID Mission in Tanzania is to stabilize population growth, prevent the spread of HIV/AIDS, arrest environmental degradation and promote democracy, human rights and broad-based national and regional economic growth. CRSP activities Tanzania will contribute to USAID's mission of strengthening producer organizations by working with individual farmers and farmer groups. Through our participatory approach, this program will disseminate new knowledge about sustainable agricultural technologies and build capacity of farmer groups and associations. This program also contributes directly to the US Presidential Initiative to End Hunger In Africa, which is designed to help Africa countries reduce hunger in half by 2015.

Networking Activities with Stakeholders

We anticipate our direct interaction with these programs will expand the impact of current CRSP-funded variety development programs in the US. Dr. Phil Miklas has ongoing research activities with the bean breeding program at the Sokoine University of Agriculture. This connection will provide direct linkage between US and Tanzanian scientists using molecular genetics tools to select for improved bean germplasm. Prof. Jim Kelly at Michigan State University has ongoing germplasm development projects with colleagues at the Institit des Sciences Agronomiques du Rwanda/ISAR in Rwanda. Our research team has ongoing collaboration with bean breeders at the Rwanda through PABRA (CIAT and ECABREN) in the area of exchange of germplasm, esp. snap beans, climbing beans and root rot resistant bean lines.

Dr. Michael Ugen and colleagues at NaCRRI in Uganda work in collaboration with CIAT and ECABREN (East and Central Africa Bean Research Network) under PABRA (Pan African Bean Research Alliance) for germplasm exchange, sharing equipment and research results, trainings, support to monitoring tours, exchange of scientists, backstopping national research programs (breeding, pathology, participatory monitoring and evaluation and seed system), supervision of students, co-designing 5-year collaborative research programs.

Through VEDCOs leadership in the PELUM network, we will work with farmers groups and associations and agribusiness concerns in Rwanda, Tanzania, Uganda, and Kenya using participatory methods to understand local livelihoods, agronomic practices, their previous and current linkages with various types of institutions and service providers (governmental and non-governmental), private sector traders, transporters, their livelihood aspirations, assets, capabilities, and strategies. Involving local leadership is a key component of this approach to mobilization of farmers and local agricultural concerns.

CSRL uses 'Learning Forums' regularly to interact with various institutions and service providers (governmental and non-governmental), private sector traders, agricultural processors and distributors etc., to gain and maintain appropriately broad perspectives on key issues in production, the value chain, benefit from their special expertise, and build new collaborative relationships for high levels of success.

Leveraging of CRSP Resources

US Institutions have committed $154,236 in 'in-kind' dollars towards the successful completion of the projects outlined in this proposal. Our industrial partner, Becker Underwood, Inc (BU) is contributing about 43% of this amount. This level of commitment from an industry partner is significant and clearly indicative of the potential for leveraging additional industry funds to expand the program. Through its collaboration with the Lutheran World Relief, Becker Underwood is currently supporting the expansion of Inoculant Technology in Burkina Faso, Niger, Tanzania, Kenya, and Mali. This activity involves local seed companies and is designed to minimize dependence on inorganic N fertilizer. While a formal commitment of funds from the CSRL program is not possible, many of the management, development, and research activities conducted by the Center with our partners in Sub Saharan Africa Uganda support the research and development activities outlined in this proposal.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 20010 -- September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

Lead U.S. PI and University: Mark E. Westgate, Iowa State University
Host Country(s): Rwanda, Tanzania, Uganda

Output Indicators	2011 Target (October 1, 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women	4	
Number of men	3	
Short-term Training: Number of individuals who received short-term training		
Number of women	50	
Number of men	50	
Technologies and Policies		
Number of technologies and management practices under research	1	
Number of technologies and management practices under field testing	1	
Number of technologies and management practices made available for transfer	1	
Number of policy studies undertaken		
Beneficiaries:		
Number of rural households benefiting directly	1000	
Number of agricultural firms/enterprises benefiting	6	
Number of producer and/or community-based organizations receiving technical assistance	50	
Number of women organizations receiving technical assistance	3	
Number of HC partner organizations/institutions benefiting	6	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	1000	

Dry Grain Pulses CRSP : SECOND PERIOD

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

10/01/10 - 09/30/11

	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	HC or U.S. Institution (6)	HC or U.S. Institution (7)	HC or U.S. Institution (8)	HC or U.S. Institution (9)
Institution Name	ISU		MSU/Kelly	ARS/Cichy	WSU/Boggs	ARS/Miklas	Makerere U	VEDCO	NaCCRI	ISAR, Rwanda	Sokoine Univ
a. Personnel Cost											
Salaries	$0.00	$19,615.00	$17,232.00	$0.00	$18,128.00	$16,562.00	$7,200.00	$8,400.00	$6,000.00	$9,000.00	$15,600.00
Fringe Benefit	$0.00	$2,569.00	$1,854.00	$0.00	$5,741.00	$2,454.00	$0.00	$0.00	$0.00	$0.00	$0.00
b. Travel	$8,850.00	$2,700.00	$7,200.00	$4,200.00	$3,900.00	$7,950.00	$7,450.00	$3,880.00	$13,145.00	$2,485.00	$6,515.00
c. Equipment ($5000 Plus)	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00	$6,500.00	$0.00	$0.00	$0.00
d. Supplies	$6,200.00	$0.00	$2,000.00	$5,000.00	$5,000.00	$5,000.00	$2,250.00	$9,050.00	$3,300.00	$3,000.00	$3,000.00
e. Training											
Degree	$0.00	$4,582.00	$9,438.00	$0.00	$0.00	$10,134.00	$1,500.00	$0.00	$0.00	$0.00	$3,600.00
Non-Degree	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00	$1,200.00	$0.00	$3,600.00	$0.00
f. Other	$1,350.00		$900.00	$0.00	$1,400.00	$800.00	$1,300.00	$1,800.00	$1,500.00	$1,300.00	$550.00
g. Total Direct Cost	$16,200.00	$29,486.00	$38,324.00	$9,200.00	$34,169.00	$44,930.00	$19,700.00	$30,810.00	$23,945.00	$19,385.00	$29,265.00
h. Indirect Cost	$10,687.00		$15,021.00	$1,022.00	$17,016.00	$4,992.00	$1,970.00	$4,622.00	$2,395.00	$0.00	$0.00
i. Indirect Cost on Subcontracts (First $25000)	$15,066.00										
j. Total Indirect Cost	$26,753.00	$0.00	$15,021.00	$1,022.00	$17,016.00	$4,992.00	$1,970.00	$4,622.00	$2,395.00	$0.00	$0.00
Total	$42,953.00	$29,486.00	$53,345.00	$10,222.00	$51,185.00	$49,922.00	$21,670.00	$35,432.00	$26,340.00	$19,385.00	$29,265.00
Grand Total	$368,185.00										

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$142,823.00	48.35%
Total direct cost budgeted for H.C institution(s)	$152,571.00	51.65%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	HC or U.S. Institution (6)	HC or U.S. Institution (7)	HC or U.S. Institution (8)	HC or U.S. Institution (9)	Total
In-kind	$43,890.00		$6,184.00	$0.00	$3,507.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$53,581.00
Cash												$ -
Total	$ 43,890.00	$ -	$ 6,184.00	$ -	$ 3,507.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 53,581.00
Attribution to Capacity Building												
Percentage of effort	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Amount corresponding to effort	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: *Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania*

	Abbreviated name of Institutions															
	ISU		MSU		WSU		VEDCO		NaCORI		SUA		Makerere		ISAR	
Identify Benchmark Indicators by Objectives	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11	4/1/11	9/30/11
Objective 1																
Field Trial 2 established			x		x				x		x				x	
Quantified yield advantage of inoculation for two crops assume				x		x				x		x				x
Analysis of plant/soil/weather data completed		x								x		x		x		x
Unique responses to inoculant x genotype x environment identified		x		x		x				x		x		x		x
Soil DNA extracted and analyzed for indigenous rhizobia strains						x				x		x		x		x
Established indigenous rhizobia levels and environmentally tolerant strains						x				x		x				x
Objective 2																
Screened germplasm for BNF in low soil N +/- inoculants in HC field trials			x		x				x		x				x	
Greenhouse screening trials initiated on selected lines for BNF response	x				x											
Parental lines tested for BNF in the field (US and HC sites)	x		x		x				x		x				x	
Selected populations tested for BNF in the field (US and HC sites)		x		x		x				x		x				x
Correlative response of BNF in field and GH trials established		x		x		x				x		x		x		x
Nodule rhizobia occupancy established on selected lines						x										
Selected RILs advanced to F2				x		x				x		x				x
Objective 3																
Trained Economists at HC institutions in benefits of BNF and inoculant use								x		x		x		x		x
Conducted farmer KPA evaluations on benefits of inoculation and BNF							x									
Established format for field demonstrations at HC research stations		x		x		x		x		x		x		x		x
Conducted field days in each HC to present research results								x		x		x		x		x
Identified farmer cooperators for on-farm trials							x		x		x				x	
Trained farmer cooperators on proper methods for conducting on-farm trials							x		x		x				x	
Initiated on-farm trials with selected farmer cooperators				x		x		x		x		x				x
Created training materials to disseminate through PELUM farmer network		x		x		x		x		x		x		x		x
Conducted advocacy meetings with farmer groups and agribusiness interests								x								
Objective 4																
Graduate students identified	x		x		x						x		x			
Graduate research programs initiated	x		x		x						x		x			
Undergraduate student interns identified							x								x	
Undergraduate student projects initiated							x								x	
Visiting scientist activities completed																
Name of the PI responsible for reporting on benchmarks	Westgate		Cichy		Miklas		Musoke		Ugen		Mchimbi		Bekunda		Musoni	
Signature/Initials:																
Date:																

P3-MSU-3

Improving Nutritional Status and CD4 Counts in HIV-Infected Children Through Nutritional Support

Lead U.S. Principal Investigator
Maurice R. Bennink, Michigan State University

Collaborating Scientists
Theobald Mosha, Sokoine University of Agriculture, Tanzania
Henry Laswai, Sokoine University of Agriculture, Tanzania
Elizabeth Ryan, Colorado State University, USA
Reuben Kadigi, Sokoine University of Agriculture, Tanzania

Project Problem Statement and Justification

The overall goal of the research is to determine if eating beans will improve the immune status of children that are not being treated with antiretroviral drugs. The global theme addressed by this research is B "To increase the utilization of bean and cowpea grain, food products and ingredients so as to expand market opportunities and improve community health and nutrition" and the topical area that will be addressed is 2 "Achieving Nutritional Security for Improved Health of Target Populations". HIV has caused an estimated 25 million deaths worldwide in just 27 years and there are approximately 33 million people in the world infected with HIV. Around 2 million children less than 15 yr of age have HIV and 90% of the children living with – and dying from – HIV live in sub-Saharan Africa. Furthermore, about 140,000 of these children live in Tanzania. Most children living with HIV are innocent victims as they are infected during pregnancy, at birth or via breastfeeding. It is well known that insufficient intake of macronutrients and some micronutrients leads to a decrease in immune function and an increase in infectious diseases. Infections in turn cause nutrient loss that quickly leads to greater malnutrition and a vicious cycle is set in motion. Since the human immunodeficiency virus destroys CD4 cells (immune cells), opportunistic infections are common place among those living with HIV. In addition, most young children (not infected with HIV) in resource poor countries are under nourished or have marginal nutrition status. Since the insults of malnutrition and HIV on the immune system are synergistic, it is not surprising that young children with HIV are 2.5 – 4 times more likely to die than their counterparts that are not infected. We previously showed that providing HIV+ children with a bean-maize supplement containing minerals and vitamins could reverse malnutrition if present <u>and</u> improve the immune system (increased CD4 counts) even though the children were not receiving highly active antiretroviral (HAARV) drugs. This is an extremely important finding since 50% of HIV+ people do not have access to HAARV drugs and consuming the bean based supplement could be an important stop gap until more people are able to obtain HAARV drugs. Children receiving HAARV treatment also benefited from the bean-based supplement in a second study we have done and so, the bean-based supplement would also be useful to children that have access to HAARV medicine. Consuming a bean-based supplement could improve the lives of millions of HIV infected people which would at the same time benefit the entire bean value-added chain from farmers to consumers.

Planned Project Activities

Objective 1: Determine if HIV infected, HAARV naïve, 2 to 15 year old children and adolescents eating a bean-maize supplement will maintain higher CD4 % than HIV infected, HAARV naïve, 2 to 15 year old children and adolescents eating a fish-maize supplement.

Collaborators
none

Approaches and Methods
1. Enroll 205 additional subjects (anticipated total number of subjects for the 30 month project is 355).
2. Purchase ingredients, cook and package food supplements, transport and distribute food supplements to 355 subjects.
3. Collect and analyze blood samples for CD4, CD8, CD3 and total lymphocyte counts.
4. Train six M.S. students to assist in research.
5. Provide field practical training in community nutrition and health for 10 undergraduates.
6. Analyze blood samples for CD4, CD8, CD3 and total lymphocyte counts.

Objective 2: Determine the relative costs of three dietary treatments compared to HAARV drug treatment (Note: this will complete the data gathering begun in FY10).

Collaborators
Reuben Kadigi, Sokoine University of Agriculture, Tanzania

Approaches and Methods
1. Determine costs associated with cooking beans in a pot and preparing Ugali (corn based local food).
2. Determine costs associated with preparation of the bean-maize supplement and thin porridge from the supplement.
3. Determine costs associated with preparation of the fish-maize supplement and thin porridge from the supplement.
4. Determine costs associated with HAARV drug treatment.

Objective 3: Determine if eating the bean-based supplement improves the integrity of the mucosal barrier in the gut and leads to reduced gut permeability and release of pro-inflammatory cytokines.

Collaborators
Elizabeth Ryan, Colorado State University, USA

Approaches and Methods
1. Analyze dried blood samples shipped from Tanzania for HIV load, selected pro-inflammatory cytokines, and R16s.

2. Conduct studies with rats to ascertain extent of bacterial translocation across the gut and release of pro-inflammatory cytokines. This will be a continuation of the work begun in FY10 and the exact experiments will depend upon the results obtained from those studies.

Objective 4: Capacity Building

- Pudensiana Kiwale, a doctoral student in Agricultural Marketing at SUA, will receive partial support and will conduct the cost analysis study.
- Sharon Hooper, a doctoral student in Food Science at MSU, will receive partial support and she will assist in assays related the rodent studies to be conducted at MSU.
- Two M.S. students in Nutrition and one M.S. Food Science student will be enrolled in the respective graduate programs at SUA. They will participate in the clinical trial which will become part of their dissertations.
- Two students in Nutrition and one in Food Science at SUA will complete their M.S. degrees and the work conducted as part of this overall project will be the basis for their dissertations.

Degree Training:

Trainee # 1

First and Other Given Names: Sharon
Last Name: Hooper
Citizenship: Jamaican
Gender;: Female
Training Institution: MSU
Supervising CRSP PI M. Bennink
Degree Program for training: Doctorate
Program Areas or Discipline: Food Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? No
Host Country Institution to Benefit from Training: University of West Indies, Jamaica
Thesis Title/Research Area: Characterization of Bean Starch
Start Date: August 15, 2009
Projected Completion Date: August, 2012
Training status (Active, completed, pending, discontinued or delayed): Active
Type of CRSP Support (full, partial or indirect) for training activity: Partial

Trainee # 2

First and Other Given Names: Pudensiana
Last Name: Kiwale
Citizenship: Tanzania
Gender;: Female
Training Institution: SUA
Supervising CRSP collaborator: Reuben Kadigi
Degree Program for training: Doctorate
Program Areas or Discipline: Agricultural Marketing
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Agricultural Marketing
Start Date: August, 2009
Projected Completion Date: August, 2012
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Indirect

Trainee # 3
First and Other Given Names: To be named
Last Name:
Citizenship: Tanzania
Gender: Female
Training Institution: SUA
Supervising CRSP PI: Theobald Mosha
Degree Program for training: MS
Program Areas or Discipline: Nutrition
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Nutrition
Start Date: 2009
Projected Completion Date: August, 2011
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full

Trainee # 4
First and Other Given Names: To be named
Last Name:
Citizenship: Tanzania
Gender;: Female
Training Institution: SUA
Supervising CRSP PI: Theobald Mosha
Degree Program for training: MS
Program Areas or Discipline: Nutrition
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Nutrition
Start Date: 2009
Projected Completion Date: August, 2011
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full

Trainee # 5
First and Other Given Names: To be named
Last Name:
Citizenship: Tanzania
Gender;: Female
Training Institution: SUA
Supervising CRSP PI: Henry Laswai
Degree Program for training: MS
Program Areas or Discipline: Food Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Nutrition
Start Date: 2009
Projected Completion Date: August, 2011
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full

Trainee # 6
First and Other Given Names: To be named
Last Name:
Citizenship: Tanzania
Gender;: Female
Training Institution: SUA
Supervising CRSP PI: Theobald Mosha
Degree Program for training: MS
Program Areas or Discipline: Nutrition
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Nutrition
Start Date: 2010
Projected Completion Date: August, 2012
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full

Trainee # 7
First and Other Given Names: To be named
Last Name:
Citizenship: Tanzania
Gender;: Female
Training Institution: SUA
Supervising CRSP PI: Theobald Mosha
Degree Program for training: MS
Program Areas or Discipline: Nutrition
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Nutrition
Start Date: 2010
Projected Completion Date: August, 2012
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full

Trainee # 8
First and Other Given Names: To be named
Last Name:
Citizenship: Tanzania
Gender;: Female
Training Institution: SUA
Supervising CRSP PI: Henry Laswai
Degree Program for training: MS
Program Areas or Discipline: Food Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Tanzania
Thesis Title/Research Area: Nutrition
Start Date: 2010
Projected Completion Date: August, 2012
Training status (Active, completed, pending, discontinued or delayed) Active
Type of CRSP Support (full, partial or indirect) for training activity: Full

Short-term Training: No activities planned for FY 11.

Equipment (costing >$5,000)**:** none

Contribution of Project to Target USAID Performance Indicators

Two women are currently enrolled in doctoral programs and 3 women are currently enrolled in M.S. programs. Three more women will began M.S. programs in FY11. Their training will:

1. Increase awareness of the importance of good nutrition for adolescents/children infected with HIV to improve community health and nutrition and thereby improve the health of vulnerable children.
2. Enhance human development, gender equity, medical testing and treatment capabilities, and infrastructure of host country institution in Tanzania

Target Outputs

1. Three hundred and fifty five vulnerable (HIV+) children will receive supplements to improve their nutritional and immune status.
2. Two Ph.D. candidates will receive training in research methodology.
3. Six M.S. candidates will receive training in research methodology.
4. Ten undergraduates will receive field practical training.
5. Two hundred potential entrepreneurs will visit the SUA exhibit displaying food products prepared from beans.

Engagement of USAID Field Mission(s)

An update will be provided to the USAID Field Mission so that they will be aware of the research progress and we will solicit their assistance in identifying key national and international decision makers in our efforts to disseminate information and to influence policy.

Networking Activities with Stakeholders

Networking will be a high priority and costs associated with networking were budgeted for FY 11. We will target international agencies and emphasize the importance of nutrition and dry beans in the care of children and adolescents living with HIVAIDS.

Leveraging of CRSP Resources

The H. J. Heinz Company Foundation is providing funds for using the bean-maize supplement to rehabilitate malnourished children and this will be a parallel humanitarian effort to what will be done in this project. Very expensive equipment (multiplex analyzer, real time PCR, and other instruments) at MSU and CSU that USAID has not purchased will be used in this project and should be considered as leveraged resources. Moreover, USAID does not pay for all of the time that the US PI and collaborator will spend on the project and this too is a “leveraged” resource.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Improving Nutritional Status and CD4 Counts in HIV-Infected Children Through Nutritional Support
Lead U.S. PI and University: Maurice R. Bennink, Michigan State University
Host Country(s): Tanzania

Output Indicators	2011 Target (October 1 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women	7	
Number of men	0	
Short-term Training: Number of individuals who received short-term training		
Number of women	0	
Number of men	0	
Technologies and Policies		
Number of technologies and management practices under research	0	
Number of technologies and management practices under field testing	0	
Number of technologies and management practices made available for transfer	0	
Number of policy studies undertaken	0	
Beneficiaries:		
Number of rural households benefiting directly	300	
Number of agricultural firms/enterprises benefiting	4	
Number of producer and/or community-based organizations receiving technical assistance	4	
Number of women organizations receiving technical assistance	3	
Number of HC partner organizations/institutions benefiting	1	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	0	

Dry Grain Pulses CRSP : SECOND PERIOD

Improving Nutritional Status and CD4 Counts in HIV-Infected Children Through Nutritional Support

	10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	MSU	MSU	SUA	0	0	0
a. Personnel Cost						
Salaries	$8,000.00		$89,200.00			
Fringe Benefit						
b. Travel	$8,000.00		$6,000.00			
c. Equipment ($5000 Plus)						
d. Supplies	$58,750.00	$4,900.00	$80,250.00			
e. Training						
Degree			$16,800.00			
Non-Degree						
f. Other		$2,700.00	$32,400.00			
g. Total Direct Cost	$74,750.00	$7,600.00	$224,650.00	$0.00	$0.00	$0.00
h. Indirect Cost (52%)	$38,870.00	$3,952.00				
i. Indirect Cost on Subcontracts (First $25000)						
j. Total Indirect Cost	$38,870.00	$3,952.00	$0.00	$0.00	$0.00	$0.00
Total	$113,620.00	$11,552.00	$224,650.00	$0.00	$0.00	$0.00
Grand Total	$349,822.00					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$74,750.00	24.35%
Total direct cost budgeted for H.C institution(s)	$232,250.00	75.65%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$25,709.00						$ 25,709.00
Cash							$ -
Total	$ 25,709.00	$ -	$ -	$ -	$ -	$ -	$ 25,709.00

Attribution to Capacity Building							
Percentage of effort							20.04%
Amount corresponding to effort	$0.00	$0.00	$70,103.00	$0.00	$0.00	$0.00	$70,103.00

Name of PI & Institutional Affiliation: Maurice R. Bennink, Michigan State University

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: Improving Nutritional Status and CD4 Counts in HIV-Infected Children Through Nutritional Support

	Abbreviated name of institutions							
Identify Benchmark	SUA		MSU					
Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**
Objective 1								
Enroll additional subjects	100	105						
Provide student training		16						
Analyze blood samples	250	250						
Objective 2								
Investigate costs of supplement production		1						
Investigate costs of HAARV treatment		1						
Objective 3								
Analyze blood samples			250	250				
Conduct animal studies			1	1				

Name of the PI responsible fo reporting on benchmarks	M. Bennink			
Signature/Initials:				

Date: _____

P3-MSU-4

Impact Assessment of Bean/Cowpea and Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination in Africa, Latin America and the U.S.

Lead U.S. Principal Investigator

Mywish K. Maredia, Michigan State University

Collaborating Scientists

Richard Bernsten and Eric Crawford, Michigan State University; HC and U.S. collaborators to be identified

Project Problem Statement and Justification

Impact assessment is essential for evaluating publicly-funded research, capacity building and outreach programs and planning future research. Organizations that implement these programs should be accountable for showing results, demonstrating impacts, and assessing the cost-effectiveness of their implementation strategies. It is therefore essential to document outputs, outcomes and impacts of public investments in research for development (R4D) activities. Anecdotal data and qualitative information are important in communicating impact to policymakers and the public, but must be augmented with empirical data, and sound and rigorous analysis.

Methods have been developed to quantify economic impacts of agricultural research investments (e.g., Alston et al., 1998, Masters et al., 1996, Walker et al., 2008). The CRSP must make use of the best methods available in all fields, including impact assessment. The method of economic assessment is relatively well established because it can make use of secondary data collected in most countries (e.g., commodity prices, interest rates and crop production statistics). Assessment of other types of impact is less standardized and is currently the focus of methodological research by researchers and organizations active in agricultural R4D (for example, see the workplan and reports by the CGIAR Science Council's Standing Panel on Impact Assessment at www.sciencecouncil.cgiar.org).

Impact assessments are widely recognized to perform two functions--accountability and learning. Greater accountability (and strategic validation) is seen as a prerequisite for continued support for development assistance. Better learning is crucial for improving the effectiveness of development projects and ensuring that the lessons from experience – both positive and negative – are heeded. Accountability and strategic validation has long been core concerns for **ex-post impact assessments** and learning has been primarily a concern of **impact evaluation**.[3] The primary focus of this project over the next three years will be on ex post impact assessment. However, attention will be also devoted by the project PI to find (and fund, if budget allows) opportunities to include impact

[3] Although in the evaluation profession, the terms impact assessment and impact evaluation are used synonymously, in this project we make a nuanced distinction between ex post impact assessment and impact evaluation based on the timing of when they are conducted, the scale at which they occur and the motivation for doing an assessment (Maredia 2009).

evaluation as part of CRSP projects to be implemented in Phase 2 and 3.

Planned Project Activities

Objective 1: To build an inventory of past documented outputs, outcomes and impacts of investments by the Bean/Cowpea CRSP and develop a trajectory of outputs and potential types of impacts of investments made by the Dry Grain Pulses CRSP

Collaborators: This will be a core activity of the lead PI and will be conducted in collaboration with past and present CRSP PIs and a graduate student (as needed)

Approaches and Methods: Towards this objective, this project will complete and finalize the following two activities: a) inventory of outputs and documented outcomes and impacts of past investments by the Bean/Cowpea CRSP, and b) develop a trajectory of projected outputs and impacts from the ongoing and proposed investments by the Pulse CRSP. The goal of this exercise is to systematically identify CRSP outputs (from past and ongoing research) and then map out the impact pathway of these outputs based on documented evidence or projections. This will also help identify gaps in documented impacts (if any) which can be subjected to in-depth impact assessment in the next phase. The methods/approaches to achieve this objective are as follow:

1a. Building an inventory of past outputs and documented impacts:

(To be completed in early FY 11). A systematic database of CRSP outputs, outcomes and impacts is being developed as part of FY 10 activity. This database will be completed in early part of FY 11 and will include an inventory of major outputs (defined as technologies, practices, goods and services, intellectual properties and policy recommendations resulting from partial or full support of CRSP investments), characteristics of those outputs, and any evidence of documented outcomes and impacts of those outputs. In FY 11, the plan is to attempt to expand this database to also include the training outputs, outcomes and impacts (as much as possible). The documented evidence will be in the form of anecdotal evidence or rigorous field based substantiation. The primary sources of information to build this inventory/database include: research reports and impact assessment studies conducted by the Bean/Cowpea CRSP. Through a structured questionnaire, attempts will be made to contact the trainees and the U.S. and HC PIs of the project to which an output is attributed to solicit further information on the subsequent status or updates on documented evidence of outcomes and impacts. The database will be developed in Excel spreadsheet, which can be transferred into a searchable Access database in future if need be.

1b. Develop a trajectory of outputs and potential outcomes/impacts of ongoing investments by the Pulse CRSP:

(To be completed in early FY 2011). This activity is similar in scope to activity 1a, except that it will be forward looking since the focus will be on ongoing CRSP projects in Phase 2 and 3. Pulse CRSP is responsible for quantifiably demonstrating outputs (the first node in the impact pathway) in the form of

knowledge, improved materials, practices, intellectual properties, human capital improvement and policy recommendations intended to increase productivity, profitability and sustainability of pulse value chains in developing countries. Based on project workplans, annual progress reports, and the 'impact pathway' worksheet to be submitted by each project PIs, a list of 'outputs' (i.e., innovations realized or expected) will be identified for each Pulse CRSP project. A database will be developed that will include for each output as much information as possible on projections for outcomes and impacts based on researchers' own opinion, and assumptions/risks for realizing those outcomes and impacts. This database and trajectory of outputs, outcomes and impacts will serve as a 'logframe' for the MO (and project teams) to monitor progress on how the CRSP projects are moving towards achieving the outputs (in the form of new knowledge and human capital) and how those outputs are translated into (or projected to be transferred into) outcomes and impacts.

Objective 2: Conduct ex post impact assessment of Bean/Cowpea and Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination in Africa, Latin America and the U.S.

Collaborators: This will be the core activity of the Lead PI and Co-PIs and will be conducted in collaboration with graduate students and U.S. and HC PIs of CRSP projects (P1-UCR-1, P1-UPR-1, P1-MSU-1)

Approaches and Methods: Ex post impact assessments usually occur after there is some evidence of adoption/uptake and examine the long-term effects of investments by a program. It requires the estimation of two key model parameters to assess the 'impact'—adoption (how widely is a research output used?) and effect size (what is the effect of a research output on indicators of interest?—e.g., yield, profitability, cost reduction, reduced risk, etc.). The approach to be used in the proposed ex post impact assessment is to estimate benefits as a function of the size of the effect of an improved technology/product/practice as a result of CRSP research and the scale of adoption/use/uptake of a given CRSP output. The impact estimation approach will involve making theory-based assumptions about the underlying relationships between model parameters, and then estimating total benefits which will then be compared with total costs (including partner costs) to derive rates of return (ROR) on research investments. This last step is not necessary for impact assessment, but will be pursued if comprehensive cost data are accessible and available. The emphasis in ex post impact assessment will be not as much on precision of impact estimates as it will be on the range of plausible impacts. Sensitivity analysis based on different scenario and assumptions about key model parameters will be also part of impact analysis.

In FY 11, the project team will focus on completing two ex-post impact assessments (see description under 2a and 2c) and initiate a third study (see description under 2b) to enable the Dry Grain Pulses CRSP to "tell a story" of effective contributions of CRSP's research efforts to developmental impacts and institutional capacity building. All these studies will focus on the impacts of genetic improvement research, which has been the

cornerstone of investment efforts by the past Bean/Cowpea and the current Dry Grain Pulses CRSPs. For crop improvement research, the magnitude of adopted area is the most important determinant of the size of economic benefits. Despite the vital importance of a healthy crop improvement effort, current knowledge of the diffusion and impact of improved crop varieties is spotty in Sub-Saharan Africa and parts of Latin America. Identifying geographic areas where varietal turnover is high or low and understanding key impediments to uptake has not received sufficient and sustained research attention. Improving information on adoption is often regarded as the most important area for strengthening in assessing the impact of specific technologies attributed to agricultural research. Studies 2a and 2c will specifically focus on this aspect of ex post impact assessment of crop improvement research.

2a. Synthesis and update study on the adoption and impact of CRSP's bean improvement efforts in the LAC region. (To be completed in FY 2011). For over 20 years, the CRSP—in collaboration with national agricultural research centers and CIAT--has supported bean research in Latin America (including Central America, the Caribbean countries and Ecuador) focusing on developing improved bean varieties. This support has contributed to the release of numerous bean varieties—which are higher yielding than traditional cultivars and are more tolerant to both abiotic and biotic stresses. These varieties have been widely adopted by farmers throughout the region. While studies have been carried out to estimate farm-level adoption rates in Costa Rica, Mexico, El Salvador, Dominican Republic and Honduras, the region-wide impact of the CRSP-funded bean research program has not yet been documented.

This study will document the impact of the CRSP's support to bean varietal development in the target countries of the region (i.e., Costa Rica, Ecuador, El Salvador, Guatemala, Haiti, Honduras, and Nicaragua). The plan is to update the adoption and economic impact estimates of CRSP varietal technologies in the past 5 years and present a comprehensive picture of CRSP's long-term contribution to research, institutional capacity building, technology dissemination and impacts at the beneficiary level in this important bean producing and consuming region of the world.

Key factors that have contributed to the success of the bean research program in Central America include strong leadership that has been provided by the head of the bean program at Escuela Agricola Panamericana (Zamorano), research planning and coordination through the regional bean research network, and the active participation of bean scientists associated with the CRSP and CIAT.

The study will document both a) the historical evolution of the regional research program, including key factors that have contributed to its success and sustainability, and b) the adoption and impact of improved varieties that have been released in each country.

The data from key informant interviews, secondary sources, and seed DNA analysis (for Honduras) will have been collected by September 2010. In FY 11, the plan is to complete data analysis and report writing to: a) document the impact of CRSP support to the establishment and maintenance of the regional bean program (e.g., Zamorano, regional network), b) document the impact of the bean research program in each of the target countries and the region as a whole, c) identify lessons learned regarding key factors that have contributed to the bean program's impact; and provide recommendation regarding future research and funding priorities.

A graduate student (Byron Reyes) is taking the lead in all the aspects of this study.

2b. Global contribution of CRSP to genetic improvement of common bean (including the U.S., LAC and SSA). (Continuation of the study in FY 11). The Bean/Cowpea CRSP supported bean breeding programs in the U.S. and in host countries have contributed to the genetic improvement of common beans in the form of direct varietal releases as well as indirect contributions to the gene pool present in the pedigree of released varieties. This second type of contribution of CRSP-supported research using advanced techniques (e.g., molecular markers) can be seen today throughout the bean producing regions of the world, including the U.S. A study initiated in FY 10 to take a stock of all the genetic contributions of the research supported by the bean/cowpea and the Dry Grain Pulses CRSP will result in a database that includes varietal releases of all commercially important bean varieties (*phaseolus vulgaris)* in countries/regions where CRSP has been historically active in bean improvement research. Data on varietal releases will be sufficiently detailed so that CRSP content and the dynamics of new varietal production and dissemination can be assessed.

A major activity in FY 11 will focus on obtaining adoption data for the released varieties and getting estimates of the economic benefits of improved 'genetics' in the adopted varieties. Methods to be used include expert opinion/key informant interviews (i.e., 'quick and clean' estimates), exploring the option of DNA marker technology, and getting data from the study conducted under 2a. A standardized protocol for the acquisition of all the information will be drafted in collaboration with bean breeders. Other possible sources of this data will be basic seed production and seed sales data and estimates from any existing adoption surveys that were conducted in CRSP-involved countries.

Activities in FY 11 will also include literature review focused on methodologies for estimating economic benefits of genetic improvement research, and developing conceptual models to estimate the economic value of the contribution of CRSP program in terms of value addition to genetic materials grown by bean farmers around the world.

2c. Benefits of genetic improvement of cowpea in Senegal and West Africa. (To be completed in FY 11). Over the past 20 years, due to collaborative efforts of CRSP researchers, several varieties of cowpeas with resistance to biotic and abiotic stresses have been released in Senegal and other countries in West Africa (i.e., Burkina Faso). Although a few studies in the past have documented the impact stories in Senegal, the evidence is still spotty when it comes to West Africa as a region. Thus, a study is being initiated in late FY 10 and continue in FY 11 to update and document the adoption of improved cowpea varieties in Senegal and to expand the analysis to include other countries in West Africa (e.g., Burkina Faso, and, if data permit, Niger, Ghana, Nigeria, as appropriate) where the Bean/Cowpea and the Pulse CRSP have been active in the past 7-10 years. The goal is to document the adoption and benefits attributed to CRSP-NARS investments in cowpea improvement research.

In FY 11, the activities will include:

1. Finalizing the database of improved cowpea varieties released in Senegal and other CRSP partner countries. The data will be consistent with those to be collected for beans in LAC and globally (activity 2a and 2b). The goal will be to collect sufficient information to assess CRSP content in those improved varieties and the dynamics of new varietal production and dissemination in West Africa.

2. Conducting field research to estimate adoption of improved cowpea varieties by farmers in CRSP target countries using a combination of expert opinion/key informant estimates and community surveys. A standardized protocol for the acquisition of all this information will be drafted in collaboration with cowpea breeders. Other possible sources of this data to be explored include seed production and sales data and estimates from any existing adoption surveys.

The data collection and analysis is targeted to be completed by the end of FY 11.

Objective 3: Investigate opportunities to integrate baseline data collection and impact evaluation strategies as part of the CRSP project design

Collaborators: This will be a core activity of the lead PI and will be conducted in collaboration with Phase 2 and Phase 3 CRSP PIs

Approaches and Methods: (To be explored in FY 11). CRSP investments in "research for development" (R4D) fall across the wide spectrum of activities ranging from basic/fundamental research to applied/adaptive research to technology transfer. Since resources to conduct research are scarce, many CRSP projects on the applied end of the R4D spectrum are pilot scale initiatives and programs designed to test the efficacy and effectiveness of a science-based intervention in a developing country setting with the aim of deriving lessons on what works and what doesn't. Such applied field based research initiatives are undertaken and supported by the CRSP with the goal of identifying the most effective strategy/models which can then be scaled up to achieve developmental

impacts. For a research project to be successful in achieving this goal requires some forethought on the design of field activities and a strategy for collecting appropriate data or making use of available data. The purpose of such strategizing is to make sure that at the end of an intervention/activity, opportunity to assess the cause-effect relationship between a research project and indicators of outcomes/impact is not lost. This is the underlying goal of "impact evaluation" research in the context of development projects.

As part of this project, the PI will work with the MO and the Phase 2 and Phase 3 PIs to assess the feasibility of integrating data collection and impact evaluation strategies as part of the CRSP project design, especially those directly related to technology transfer interventions. Opportunities will be explored within the existing and the new planned activities (through additional funds from USAID) to assess the following:

a. Feasibility of identifying a valid comparison group to simulate the counterfactual
b. Existing data sets that can inform about the baseline and help in the analysis of impact attribution
c. Possibility of collecting relevant data as part of the CRSP project design, with technical backstopping provided by the impact assessment project team.
d. Possibility of collaborating with other CRSP project teams in writing joint proposals to leverage resources from other sources.

Objective 4: Build institutional capacity and develop human resources in the area of impact assessment research

Collaborators: None

Approaches and Methods: Although this project does not include a host-country partner as in other CRSP projects, it does address the objective of institutional capacity building and human resource development through following methods:

a. Field activities under objective 2 will include collaboration with HC PIs and partners. For example, data collection and information gathering activities for the ex post impact studies will involve host country PIs/collaborators in the planning and conduct of field activities as much as possible.
b. Activities under objectives 1 and 3 will be conducted in close collaboration with the U.S. and HC PIs from existing CRSP projects. The discussion and exchange of information envisaged in these activities will hopefully increase awareness and influence the outlook of CRSP scientists towards impact assessment research and its importance. This may contribute to enhancing the impact culture within the host country partner organizations.
c. The activities planned under this project will involve several graduate students in the planning and conduct of field research and write-up of research results. These students will be recruited from within the Department of Agricultural, Food and Resource Economics at MSU. Some students identified for engagement in this research opportunity who will continue under this project in FY 11 include:
    1. Byron Reyes, a citizen of Ecuador
    2. Nelissa Jamora, a citizen of the Philippines

3. A graduate student to be identified to assist in the West Africa project activities (activity 2c)

Contribution of Project to Target USAID Performance Indicators
This project does not involve any host country based research and outreach activities. Hence it is not relevant to Target USAID Performance Indicators.

Target Outputs
Specific outputs to result from this project by the end of project timeframe (November 1, 2009 -September 30, 2012) include:

a. Completion of 3 theses (or dissertation papers) on impact assessment research
b. At least 4 Impact Briefs which can be more widely disseminated to convey the impact stories of USAID's investments in Dry Grain Pulses CRSP (and its predecessor Bean/Cowpea CRSP).
c. At least 3 manuscripts for publication in academic journals and presentations at professional meetings.

Engagement of USAID Field Mission(s)
The project activities in host countries will mainly involve data collection from farmers fields, secondary sources, and information gathering through stakeholder interviews. No field research experiments are planned at this time in host countries. Data collection will be done in collaboration with CRSP HC partners in countries where CRSP is already engaged and where activities are occurring in concurrence with USAID country or field missions.

Networking Activities with Stakeholders
Field activities to be conducted in host countries will engage and involve appropriate stakeholders – research organizations, NGOs and private sector – in data collection and dissemination efforts. One of the Co-PIs plans to attend the World Cowpea Conference to be held in Senegal in early October 2010. This will be used as an opportunity to network with other researchers from the region and around the world.

Leveraging of CRSP Resources
The project PI will be actively engaged in identifying opportunities to leverage additional resources to further the goals of advancing impact assessment and impact evaluation research within the Pulse CRSP program. The following opportunities will continue to be explored in FY 11:

1. The Bill and Melinda Gates Foundation recently awarded a grant to CGIAR centers under the leadership and oversight of the Standing Panel on Impact Assessment (SPIA) of the CGIAR/Science Council to document outputs, adoption and impacts of crop genetic improvement research focused on major staple crops, including beans and cowpeas, in Africa. This project is a major building block towards the construction of a routine system for monitoring varietal adoption and impact in Sub-Saharan Africa. It will involve collecting nationally representative survey data on varietal adoption and assessing the impact of varietal change. Seven CGIAR Centers and their partners will carry out the project. The lead PI of

this CRSP project serves as a member of the Project Steering Committee and will use this platform to seek opportunity to collaborate with appropriate partners in collecting information and adoption data that will offer mutual benefits to CRSP and CGIAR centers in the area of documenting impacts for cowpea research in West Africa and bean research in East/Southern Africa.

2. The International Initiative for Impact Evaluation (3ie) routinely issues RFPs to promote research in the area of impact evaluation of development interventions in developing countries. Opportunities will be sought to leverage funding from this organization to conduct 'impact evaluation' of a CRSP project in partnership with host country PIs and collaborators to promote objective 3 of this project.

Training/Capacity Building

Degree Training:
None

Short-term Training:
None

Equipment (costing >$5,000):
None

Dry Grain Pulses CRSP FY2011 Budget

P3-MSU-4: Impact Assessment

	10/01/10 - 09/30/11					
	MSU	U.S. for Host Country	HC or U.S. Institution	HC or U.S. Institution	HC or U.S. Institution	HC or U.S. Institution
Michigan State University						
a. Personnel Cost						
Salaries (incl. GA stipend)	$34,722.50	$34,722.50				
Fringe Benefit (for staff, excl GA)	$2,609.50	$2,609.50				
b. Travel	$17,151.00	$17,151.00				
c. Equipment ($5000 Plus)						
d. Supplies	$515.00	$515.00				
e. Training (degree)						
Tuition/fees	$11,414.50	$11,414.50				
Other costs (e.g. insurance)	$2,300.00	$2,300.00				
f. Other						
g. Total Direct Cost	**$68,712.50**	**$68,712.50**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
h. Indirect Cost	$29,795	$29,795				
i. Indirect Cost on Subcontracts (First $25000)						
j. Total Indirect Cost	$29,794.96	$29,794.96	$0.00	$0.00	$0.00	$0.00
Total	**$98,507.46**	**$98,507.46**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Grand Total	**$197,015**					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	**$68,712.50**	**50.00%**
Total direct cost budgeted for H.C institution(s)	**$68,712.50**	**50.00%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
In-kind	$23,321.00					
Cash						
Total	$ 23,321.00	$ -	$ -	$ -	$ -	$ -
Attribution to Capacity Building						
Percentage of effort	50.00%	50.00%				
Amount corresponding to effort	$49,253.73	$49,253.73	$0.00	$0.00	$0.00	$0.00

P2-TAMU-1
Increasing utilization of cowpeas to promote health and food security in Africa

Lead U.S. Principal Investigator
Joseph Awika, Texas A&M University

Collaborating Scientists
Susanne Talcott, Texas A&M University, USA
Lloyd Rooney, Texas A&M University, USA
Bir Bahadur Singh, Texas A&M University, USA
Chitundu Kasase, University of Zambia, Zambia
John Shindano, University of Zambia, Zambia
Kalaluka Lwanga Munyinda - University of Zambia, Zambia
Kennedy Muimui, Zambia Agriculture Research Institute (ZARI), Zambia
Abdul Faraj, Egerton University, Kenya
Prisca Tuitoek - Egerton University, Kenya
Amanda Minnaar, University of Pretoria, South Africa
Gyebi Duodu, University of Pretoria, South Africa

Project Problem Statement and Justification

Many poor families in Sub Saharan Africa suffer high rates of malnutrition, especially among children, while diet-related chronic diseases have become a common phenomenon among urban African populations. Moreover, evidence indicates that childhood malnutrition may lead to increased risk of chronic diseases, e.g., cancer in adulthood. In fact nutrition-related chronic diseases are becoming increasingly common in Africa, especially in urban areas, thus putting a large strain on the limited health infrastructure and imposing economic burden among the poor.

In Africa, malnutrition is closely linked to food insecurity, and thus the most vulnerable groups are those in marginal rainfall rural areas, and the urban poor. Grain pulses are an important source of protein for these vulnerable groups. Cowpea is one of the most drought tolerant crops and has a big potential as a food security crop for many poor African subsistence farmers. A strong and broad demand for cowpea is needed for the small scale farmers in the marginal areas to realize economic benefits of cowpea production.

A limited number of studies have also demonstrated that cowpeas have high antioxidant capacity, cholesterol-lowering properties as well as chemopreventive potential. Cowpeas thus may produce additional health benefits commonly associated with fruits and vegetables. However, information on how cowpea and its constituents may provide directly impact human health is lacking. Additionally, how variations in cowpea genetics affect their composition of potentially beneficial compounds is unknown. This makes it difficult to promote cowpea as a healthy grain which dampens its demand and utilization. *Accurate and credible information on how cowpea may influence human health is important as a primary step in promoting wide consumption of cowpeas*. This will also allow for breeding of varieties with improved health properties that target specific applications or markets.

Constraints to consumption cowpeas
The image of cowpea as a healthy food lags behind other commodities. Part of this is due to lack of scientific data on health and nutritional benefits of cowpea. In many parts of East and Southern Africa, the common perception that beans, cowpeas, and other pulses are 'poor man's food' has also been a major impediment to broader consumption of these grains. Thus most of cowpea use is still restricted to the low income population. This leads to *weak demand and depressed economic value of the crop*, which in turn leads to limited incentive to invest in cowpea production and utilization infrastructure. Thus even in higher use regions like West Africa, demand for cowpea is showing declining trends, especially in urban areas. In the USA, lack of nutritional benefit information limits incentive to promote cowpea use as a mainstream part of diet.

Project Rationale
Reliable scientific evidence is essential to make educated dietary recommendations on type of cowpea, level of consumption, and design of food processing strategies that maximize the beneficial effects. The evidence will also provide a basis for genetic and agronomic improvement aimed at optimizing composition of beneficial compounds. Sound scientific evidence is essential for consumer buy in. It is a first step in transforming cowpea into a primary food to address malnutrition in poor populations, and promoting cowpea as a mainstream part of healthy diet. This will *lead to increased demand for cowpea and improvement in economic well being of producers and overall health of consumers*.

Planned Project Activities

Objective 1: Identify cowpea lines with high content of health enhancing compounds and their relationship to seed color and other seed traits.

Collaborators
Donna Winham, Arizona State University Polytechnic, USA
Jeff Ehlers, University of California, Riverside, USA
Philip A. Roberts, University of California, Riverside, USA
Boukar Ousmane, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria
Ruth Oniang'o, Rural Outreach Program (ROP), Nairobi, Kenya
David Macharia, Kenya Agricultural Research Institute (KARI), Katumani, Kenya
Davies Lungu, University of Zambia, Lusaka, Zambia

Approaches and Methods: The goal is to determine genetic variability in cowpeas for the types and levels of key bioactive components [flavonoids, triterpenoids, phenolic acid esters, phytate, soluble and insoluble dietary fiber], as well as protein content and quality. Association between these traits and seed color and seed characteristics will be determined.

Gross phenolic composition. Based on screening tests from Year 1, selected lines will be crossed and their progeny screened for gross phenolic proflies. The following analyses will be used for the screening: gross phenol content, anthocyanin pigments, and tannins content, ground samples will be extracted in 0.12 mol/L HCl in methanol. Anthocyanin

pigment content will be measured by pH differential method, which is based on measuring absorbance in pH 1.0 and pH 4.5 buffers at λ_{max} using a scanning UV-Vis spectrophotometer, The Folin-Ciocalteu method will be used to estimate gross phenols content, by measuring reactant absorbance at 600 nm using gallic acid as the standard. The vanillin-HCl method will be used for condensed tannin assay; reactant absorbance (with blank subtraction to correct for non tannin pigments) will be measured at 500 nm, catechin will be used as standard. (**Egerton University**, University of Zambia, Texas A&M) Detailed characterization of specific compounds will be done using the following methods:

Flavonoids and terpenoids profiling. Sample extracts obtained as described above will be washed through a C-18 column to remove sugars and other non-flavonoid constituents. Flavonoids will be eluted using 70% acidified methanol, rotoevaporated and reconstituted in 10% methanol containing 10 mL/L formic acid and filtered through 0.45 μm membrane before analysis. For terpenoids, n-butanol extracts fractions will be characterized. A reversed phase C-18 column will be used for separation; and an Agilent 1200 HPLC system will be used for characterization. MS analysis will performed using a Thermo-Finnigan TSQ7000 triple-quadrupole mass spectrometer equipped with an API2 source, and an Electrospray Ionization (ESI) interface. (**Texas A&M**)

Phenolic acid and phenolate esters. Free phenolic acids will be measured in methanol extract whereas alkaline hydrolysis of residue will be used to measure esterified phenolic acids. Reversed phase HPLC separation, with appropriate standards, will be used to identify the compounds; LC-MS will be used for structural determination when needed. (**University of Zambia**, University of Pretoria, Texas A&M)

Protein content and quality. These tests will be conducted on elite cultivars selected for crossing, and their selected progeny. To obtain relevant data from this procedure, samples will initially be cooked by boiling in water for 75 min, and then drying at 45 – 50 ^{o}C. Protein content will be measured using the combustion method (AOAC Method 990.03). Complete amino acid profile will be measured using the AOAC method 982.30, whereas available lysine will be measured using the OAC Method 975.44. In vitro protein digestibility will be determined by pepsin/pancreatin digestion method. (**University of Zambia, Egerton, University of Pretoria**).

*Bold denotes lead institution that will be primarily responsible for analysis and coordination of data for specific activity.

Objective 2:

Collaborators

Donna Winham, Arizona State University Polytechnic, USA
Ruth Oniang'o, Rural Outreach Program (ROP), Nairobi, Kenya
Fredie Mubanga, Nutrition, Food and Nutrition Commission (NFNC), Lusaka, Zambia

Approaches and Methods: This will establish how the phytochemical profiles affect the ability of cowpeas to influence metabolic, cardiovascular and chemoprotective health predictors *in vitro*. The F1 and F2 progeny will be screened for predictors of bioactivity using the following methods:

Hydroxyl/free radical scavenging properties; protection against oxidative stress is an important component of chronic disease prevention. Both lipophilic (hexanes extract) and hydrophilic (aqueous acetone extract) antioxidant capacity of cowpeas and their fractions will be measured by two widely accepted methods that involve hydrogen atom transfer (HAT) and single electron transfer (SET) that have been shown to correlate with biological oxidative status measures. Oxygen radical absorbance capacity (ORAC), will be the HAT method. Ability of cowpea extract to protect fluorescein from free radical attack by AAPH will be monitored for 90 min at 37°C using a fluorescence spectrophotometer (excitation 485 nm, emission 528 nm). The Trolox Equivalent Antioxidant Capacity (TEAC) will be used for SET assay. Samples will be reacted with preformed ABTS^{o} free radical, and ability of the sample to quench the free radical measured after 30 min by monitoring color at 734 nm. Trolox will be used as standard in both assays. (**Texas A&M**)

From these tests, representative crosses will be selected and tested using the following methods:
Bile acid-binding assay: Increased bile acid excretion by binding to food components is one of the most important mechanisms by which food components lower cholesterol. The bile acid binding assay as described by Ma and Xiong (2009) will be used to characterize cowpea for potential cholesterol-lowering properties. Freeze-dried cowpea extracts will be dissolved in pH 6.3 sodium phosphate buffer and incubated at 37°C for 2 h with bile acid solutions (2 mM) (Sigma, St Louis, MO). The bile acid binding assay kit (Kit 450, Trinity Biotech, Berkeley Heights, NJ) used to colorimetrically estimate bile binding (530 nm). (**Egerton**)

Inhibition of low density lipoprotein (LDL) oxidation: Oxidation of LDL leads to impairment in the regulation of cholesterol uptake. This potentially leads to development of artherosclerosis and cardiovascular disease. The ability of extracts from the cowpea/bean varieties to inhibit LD oxidation will be determined using the method described by Puhl et al. (1994) by monitoring formation of conjugated dienes at 234 nm. (**University of Pretoria**)

Glycemic properties: Procedures described by Goni et al (1997) will be used to measure rate of *in vitro* starch hydrolysis in selected cowpea lines. Hydrolysis index and estimated glycemic index will be calculated from area under curve (30 min intervals to 180 min digestion) as detailed by the authors, using fresh white bread as a control. (**University of Zambia**)

Cell culture assays: Two strategies will be used to assess how cowpea compounds can *protect against cancer and also cardiovascular disease, two major chronic diseases*:
Anti-cancer effects:

- *Phase II detoxifying enzyme assay*. This method is based on the fact that enhanced activity of enzymes that detoxify potential carcinogens will lead to prevention of cancer initiation. We will employ the NAD(P)H:quinone oxidoreductase (NQO) inducer activity as previously described (Yang *et al.* 2009). Murine hepatoma (Hepa 1c1c7) cells will be incubated with various concentrations of cowpea extracts and

NQO enzyme activity as well as cytotoxicity measured as described by Prochaska, et al. (1992). Sulforaphane will be used as a positive control; this compound is a potent natural phase II enzyme inducer. (**Texas A&M**)

- *Anti-proliferation assays*. These methods will measure how the various cowpea extracts affect growth of pre-formed cancer cells. We will use the widely studied HT-29 and Caco-2 human colon carcinoma cells for this assay following the viable cell (MTT) and DNA (PicoGreen) procedures as recently modified (Awika et al. 2009). Various concentrations of the cowpea extracts will be incubated with the cells for 48 hr after which the MTT assay kit (Sigma, St Louis, MO) will be used to measure viable cell population by established protocols. Double stranded DNA will be measured using the PicoGreen Quant-iT assay kit (Invitrogen Inc, Carlsbad, CA) as described by Ahn et al (1996). Genistein will be used a positive control in both assays. *Apoptosis* will be assessed by analyzing in cells by analyzing PARP-cleavage as previously described (Chintharlapalli, Papineni et al. 2009) (**University of Pretoria/Texas A&M**)

Cardiovascular Disease: In order to determine the in vitro effects of total polyphenolic extracts and fractions from cowpea on biomarkers for antioxidant properties and inflammation in vascular endothelial cells (HUVEC). We will measure:

- *Biomarkers for inflammation*: nuclear factor kappa B (NFκ-B), interleukins IL-6, IL-8, tumor necrosis factor TNF-□ and Nf-kB will be determined by ELISA assays obtained from E-bioscience, San Diego, CA and Life Diagnostics, West Chester, PA, as previously performed (76, 77). These biomarkers are typically used to assess inflammation and cowpeas extract is expected to decrease LPS-induced inflammation these cells. (**Texas A&M**)

- *Antioxidant biomarkers:* As previously performed (71), cells will be treated with different extract concentrations and antioxidant effects will be determined after different incubation times with the ORAC assay as well as the generation of reactive oxygen species (ROS). Additionally, oxidative stress will be induced with hydrogen-peroxide and the mitigation of pro-oxidant potential by different concentrations of cowpea extract will be assessed. Oxidative DNA damage will be assessed in the same manner; after the induction of DNA-damage with H_2O_2, the alleviating effects of cowpea will be assessed with the ApoAlertTM DNA Fragmentation Assay (BD Biosciences) according to the manufacturer's protocol. (**University of Pretoria/Texas A&M**)

*Bold denotes lead institution that will be primarily responsible for analysis and coordination of data for specific activity.

Objective 3: Elucidate the mode of inheritance (heritability) of selected bioactive traits in cowpea and genetic association between physical and bioactive traits.

Collaborators

Creighton Miller, Texas A&M University, USA
Jeff Ehlers, University of California, Riverside, USA
Philip A. Roberts, University of California, Riverside, USA
Boukar Ousmane, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria
Davies Lungu, University of Zambia, Lusaka, Zambia

Approaches and Methods: This objective will help determine the mode of inheritance and the extent of genetic associations of key bioactive traits in cowpea. This will open opportunities for genetic selection and improvement efforts as well as using modern molecular techniques to develop specific specialty cowpea lines for targeted health benefits.

We will continue genetic studies involving parents, F1s, F2s, and backcrosses. F3 seed will be obtained, F2 seeds will be backcrossed during this period. Crosses will also be made among popular national varieties in Zambia with lines identified to have high levels of phytochemicals and raise F1s. (**Texas A&M/University of Zambia**)

Objective 4: Establish strong linkages with HC policymakers and other stakeholders, and develop outreach strategies that will lead to long term increase in cowpea consumption for health and food security.

Collaborators
Gary J. Wingenbach, Texas A&M University, USA
Ruth Oniang'o, Rural Outreach Program (ROP), Nairobi, Kenya
Stephen Muliokela, Golden Valley Agricultural Research Trust (GART), Zambia
Paul Kapotwe, Program Against Malnutrition (PAM), Zambia
Fredie Mubanga, Nutrition, Food and Nutrition Commission (NFNC), Lusaka, Zambia

Approaches and Methods: Each HC PIs in collaboration with US PIs will organize a 1 day training workshop for key stakeholder representatives from the government ministries and research institutions, local NGOs and women organizations. The US PI will participate in the workshops. The aim of the workshops will be threefold; 1) Train the stakeholder representatives on how to interpret nutrition research findings and accurately convey the message to a lay audience, and also use it to influence policymakers, 2) Integrate preliminary findings into dissemination strategies developed in the first year, and 3) Establish networks among stakeholder and researchers that will lead to long term collaborations and development efforts. It is anticipated that each HC workshop will involve 15-20 stakeholder representatives. HC education and extension specialists will be engaged as consultants. The HC USAID country representatives will be invited to these workshops. From the workshops, a training manual and brochure for use by stakeholder representatives will be developed in Year 3. (**University of Zambia/Egerton**)

Objective 5: Strengthen cowpea nutrition research in Kenya and Zambia

Collaborators
Gary J. Wingenbach, Texas A&M University, USA
Donna Winham, Arizona State University Polytechnic, USA
Fredie Mubanga, Nutrition, Food and Nutrition Commission, Zambia

Approaches and Methods: Human capital development and strengthened host country research institutions are keystones to sustainable development and income generation.

Elevating nutrition research profile through capacity building is especially critical to enable the nutritionists to influence policy and programs that will lead to development outcomes. Through Prof. A. Minnaar and her colleagues at the University of Pretoria (Dr. K.G. Duodu and Prof A. Oelofse), we will work closely with lead investigators in HC to provide training on cowpea health benefits and design public education material to promote cowpea as a healthy and nutritious food crop. University of Pretoria has exceptional facilities and is educating a large number of young scientists from Sub-Saharan Africa.

Graduate training (long term)
Each of the two HC graduate students will continue their training at University of Pretoria, South Africa. The two HC graduate trainees will spend 5 months at Texas A&M (July – November) for research and training using advanced instruments and techniques not readily available in Africa. They will conduct research on specific aspects of Objective 2 while at Texas A&M, while also learning other techniques, like purification and chemical characterization by LC-MS^n and NMR techniques. The students will also have an opportunity to establish relationships and networks with international researchers that will help them succeed in their careers. They will be expected to participate in a national scientific conference while at Texas A&M.

Short term training
Each HC PIs in collaboration with US PIs will organize a 1 day training workshop for key stakeholder representatives from the government ministries and research institutions, local NGOs and women organizations. The US PI will participate in the workshops. The aim of the workshops will be threefold; 1) Train the stakeholder representatives on how to interpret nutrition research findings and accurately convey the message to a lay audience, and also use it to influence policymakers, 2) Integrate preliminary findings into dissemination strategies developed in the first year, and 3) Establish networks among stakeholder and researchers that will lead to long term collaborations and development efforts. It is anticipated that each HC workshop will involve *15-20 stakeholder representatives*. HC education and extension specialists will be engaged as consultants.

Contribution of Project to Target USAID Performance Indicators
Degree training – 3 PhD students (2 directly benefiting HC research capacity)
Short term training – 30-40 stakeholders training via workshops in HC
New nutrition research techniques will be available to the HC institutions
Host country partner institutions will directly benefit: University of Zambia, Zambia Agriculture Research Institute, Egerton University

Target Outputs
Associations between phenotype, chemical composition and bioactive properties determined.
Ability of elite cowpea cultivars to influence cancer initiation and growth determined.
Ability of elite cowpea lines to regulatory inflammation established.
Ability of elite cowpea lines to influence cardiovascular markers established.
F2 seeds obtained, filed crosses performed in Zambia and at TAMU.
F1 and F2 seeds characterized for heritability of key bioactive traits.

30-40 stakeholders from HC trained on nutritional/health benefits of cowpea and the role cowpea can play in ensuring food security and overall health.
Three graduate student trainees make progress towards graduation (2 from HC at University of Pretoria and 1 at Texas A&M).
Research findings published in scientific journals – at least 2.

Engagement of USAID Field Mission(s)
Both the US and HC PIs have communicated with the HC USAID Missions and they have expressed their support for the project. The US and corresponding HC PI plan to meet with the USAID Mission representatives in Zambia and Kenya during the US PI visits to the host country projects. We will discuss project goal and approaches in detail with the Mission representative and seek their input in fine tuning approaches if necessary to achieve maximum impact. We will also seek their input in leveraging other resources locally and internationally to improve overall project success and impact. Networking opportunities with key stakeholders will also be discussed with the country Mission Representatives.

Networking Activities with Stakeholders
In Zambia, we will meet with the head of Legume Program at Zambia Agriculture Research institute (Dr Kennedy Kanenga), along with Dr D. M. Lungu of University of Zambia to discuss progress and seek input on future efforts. We will also meet with representatives from the Food and Nutrition Commission (NFNC) in the Ministry of Health, and Program Against Malnutrition (PAM) (an NGO involved in community nutrition based interventions) to discuss the long term project goal and plan outreach strategies that would be locally suitable to influence policymakers and benefit vulnerable groups. The training workshop will also provide an opportunity to network with stakeholders.

In Kenya, we will continue to work Kenya Agricultural Research Institute (KARI) at Katumani to include local lines that meet nutritional quality criteria in local field testing. We will also meet with local government representatives from Ministries of Education, Public Health, and Agriculture, and discuss project progress and opportunities for future efforts, as well as strategies to disseminate findings. We will especially discuss with the stakeholders strategies to use the findings to develop nutrition-based interventions that can produce broad impact. We will continue invloving local NGOs representatives, like Peter Mwangi of World Vision International, and Ruth Oniang'o of Rural Outreach Program. The training workshop will also provide an opportunity to network with stakeholders.

Leveraging of CRSP Resources
We plan to use data from this work to seek additional funding from NIH National Cancer Institute, American Institute for Cancer Research, and USDA-AFRI programs, as well as other international organizations like the Bill and Melinda Gates Foundation, and the McKnight Foundation.

Training/Capacity Building Workplan Format

Degree Training:

PhD Student 1:
First and Other Given Names: Twambo
Last Name: Hachibamba
Citizenship: Zambia
Gender: Female
Training Institution: University of Pretoria
Supervising CRSP PI: Amanda Minnaar, Gyebi Duodu
Degree Program for training: PhD
Program Areas or Discipline: Food Science and nutrition
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: University of Zambia
Thesis Title/Research Area: TBD
Start Date: June 2010
Projected Completion Date: 2013*
Training status (Active, completed, pending, discontinued or delayed): Pending
Type of CRSP Support (full, partial or indirect) for training activity: Full

PhD Student 2:
First and Other Given Names: Alice
Last Name: Nderitu
Citizenship: Kenya
Gender: Female
Training Institution: University of Pretoria
Supervising CRSP PI: Amanda Minnaar, Gyebi, Duodu
Degree Program for training: PhD
Program Areas or Discipline: Food Science and nutrition
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Egerton University
Thesis Title/Research Area: TBD
Start Date: June 2010
Projected Completion Date: 2013*
Training status (Active, completed, pending, discontinued or delayed): Pending
Type of CRSP Support (full, partial or indirect) for training activity: Full

PhD Student 3:
First and Other Given Names: TBD
Last Name: TBD
Citizenship: TBD
Gender: TBD
Training Institution: Texas A&M University
Supervising CRSP PI: Joseph Awika, Susanne Talcott
Degree Program for training: PhD
Program Areas or Discipline: Nutrition and Food Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: TBD
Thesis Title/Research Area: TBD
Start Date: August 2009
Projected Completion Date: Dec 2012
Training status (Active, completed, pending, discontinued or delayed): Pending
Type of CRSP Support (full, partial or indirect) for training activity: Partial

Short-term Training:
Type of training: Workshops
Description of training activity: Stakeholders will be invited to 2 day workshops on how to interpret nutrition research findings and accurately convey the message to a lay audience, and also use it to influence policymakers
Location: University of Zambia; Egerton University, Kenya
Duration: 1 day
When will it occur: June-July 2011
Participants/Beneficiaries of Training Activity: Government representatives, NGO representatives, community leaders, research center representatives.
Anticipated numbers of Beneficiaries (male and female): 15 male, 15 female
PI/Collaborator responsible for this training activity: Chitundu Kasase, Abdul Faraj, Joseph Awika
List other funding sources that will be sought (if any): N/A
Training justification: 1) Train the stakeholder representatives on how to interpret nutrition research findings and accurately convey the message to a lay audience, and also use it to influence policymakers, 2) Integrate preliminary findings into dissemination strategies developed in the first year, and 3) Establish networks among stakeholder and researchers that will lead to long term collaborations and development efforts.
*Extension will likely be requested due to delayed project start date.

Equipment (costing >$5,000)**:** N/A

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 20010 -- September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Increasing utilization of cowpeas to promote health and food security in Africa
Lead U.S. PI and University: Joseph Awika, Texas A&M University
Host Country(s): Zambia, Kenya

Output Indicators	2011 Target (October 1, 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women	2	
Number of men	1	
Short-term Training: Number of individuals who received short-term training		
Number of women	15	
Number of men	15	
Technologies and Policies		
Number of technologies and management practices under research	4	
Number of technologies and management practices under field testing	1	
Number of technologies and management practices made available for transfer	0	
Number of policy studies undertaken	0	
Beneficiaries:		
Number of rural households benefiting directly	0	
Number of agricultural firms/enterprises benefiting	0	
Number of producer and/or community-based organizations receiving technical assistance		
Number of women organizations receiving technical assistance		
Number of HC partner organizations/institutions benefiting	3	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	0	

Dry Grain Pulses CRSP FY2011 Budget

Increasing utilization of cowpeas to promote health and food security in Africa

	10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	Texas A&M	Texas A&M	ZAMBIA	KENYA	S. AFRICA	
a. Personnel Cost						
Salaries	$29,521.00		$2,000.00			
Fringe Benefit	$5,180.00					
b. Travel	$5,900.00		$1,100.00	$500.00	$500.00	
c. Equipment ($5000 Plus)						
d. Supplies	$26,045.00		$17,300.00	$10,400.00	$0.00	
e. Training						
Degree	$8,759.00				$29,882.00	
Non-Degree		$27,000.00	$2,100.00	$1,890.00		
f. Other	$3,900.00					
g. Total Direct Cost	**$79,305.00**	**$27,000.00**	**$22,500.00**	**$12,790.00**	**$30,382.00**	**$0.00**
h. Indirect Cost	$32,804.00	$12,555.00	$3,375.00	$1,918.50		
i. Indirect Cost on Subcontracts (First $25000)	$6,153.00					
j. Total Indirect Cost	$38,957.00	$12,555.00	$3,375.00	$1,918.50	$0.00	$0.00
Total	**$118,262.00**	**$39,555.00**	**$25,875.00**	**$14,708.50**	**$30,382.00**	**$0.00**
Grand Total	$228,782.50					

	Amount	Percentage
Total direct cost budgeted for U.S. Institution(s)	$79,305.00	46.11%
Total direct cost budgeted for H.C Institution(s)	$92,672.00	53.89%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$42,984.00						$ 42,984.00
Cash							$ -
Total	$ 42,984.00	$ -	$ -	$ -	$ -	$ -	$ 42,984.00
Attribution to Capacity Building							
Percentage of effort		100.00%	50.00%	50.00%	95.60%		38.85%
Amount corresponding to effort	$0.00	$39,550.00	$12,937.50	$7,354.25	$29,045.19	$0.00	$88,886.94

U.S Institution PI: Joseph Awika

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

FY 2011 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: *Increasing utilization of cowpeas to promote health and food security in Africa*

	Abbreviated name of institutions							
Identify Benchmark	TAMU		UNZA		EGER		UP	
Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**
Objective 1								
Phytates		X						
Protein content					X			
Protein quality and digestibility				X				X
Screening backcrosses:								
Phenolic tests		X						
SET and HAT		X						
Objective 2								
Bile acid binding assay					X	X		
Inhibition of LDL oxidation							X	X
Glycemic Index			X	X				
Phase II	X	X						
Anti-proliferation		x						
Biomarkers for inflammation	X	X						
Antioxidant biomarkers		x						
Objective 3								
Perform relevant crosses	x		x					
Obtain F3 seed		x		x				
Conduct field trials	x	x	x	x				
Objective 4								
HC stakeholder workshops		x		x		x		
Graduate training (PhD)	x	x					x	x

Name of the PI responsible fo reporting on benchmarks	J Awika	C Kasase	A Faraj	A Minnaar
Signature/Initials:				

Date: _____

PIII-KSU-1 WORKPLAN

Pulse Value Chain Initiative—Zambia (PVCI-Z)

Lead U.S. Principal Investigator
Vincent Amanor-Boadu, Kansas State University

Collaborating Host Country and U.S. Scientists
Gelson Tembo, University of Zambia, Zambia
Mukwiti Mwiinga, University of Zambia, Zambia
Prisilla Hamukwala, University of Zambia, Zambia
Rebecca Lubinda, University of Zambia, Zambia
Tim Dalton, Kansas State University, U.S.
Allen Featherstone, Kansas State University, U.S.
Mahmud Yesuf, Kansas State University, U.S.

Project Problem Statement and Justification

Pulses are important in concentrated locations in Zambia. Zambian Central Statistics Office (CSO) data show while the Northern Province accounted for the majority of bean production (62 percent), the Southern Province accounted for the majority (58 percent) of cowpea production. The remainder of the top-four producing provinces for beans includes Northwestern (8 percent); Central (7 percent); and Luapala (6 percent). For cowpeas, the remaining of the top-four producing provinces are Central (11 percent), Northern (9 percent), and Lusaka (6 percent). Despite this concentration, pulses are also important to the Zambian food economy because they are planted in all provinces, probably because of their drought tolerance characteristics.

However, there is little or no information about the value chain economics associated with beans and cowpeas in Zambia. While there are anecdotal stories about Zambian pulse products flowing out of the country in regional trade, the quantity and value of this trade and their impact on producer income, food and nutrition security are unclear. It is also unclear what effect these have on the efficiency of current supply chains, the value they create and the distribution of that value against the costs incurred across the different supply chains used by producers to get product to market. Because the foregoing information is unavailable, it is impossible to identify the relationships among supply chain structure, conduct, and the characteristics of producers to determine how public and business policy changes may be constructed to alleviate poverty, increase producer incomes and increase food security.

The Pulse Value Chain Initiative—Zambia (PVCI-Z) vision is to contribute to poverty alleviation and improve food and nutrition security through research, education and engagement. This project works towards this vision by conducting research to address the identified knowledge gaps about bean and cowpea value chains in Zambia, determine the most efficacious value chains given producer and partner characteristics, and work with industry to develop and construct value chains that help increase producer incomes and improve food and nutrition security. These are in line with the Dry Grain Pulses CRSP overall goal of alleviating poverty and enhancing food and nutrition security. The lessons and tools emanating from this research will be applicable to other crops and other countries, allowing this project to contribute to the Global Hunger and Food Security Initiative of the USAID.

PVCI-Z initiatives are divided into two distinct but related categories: Category I (Development of Baseline Knowledge and Benchmark Metrics) and Category II (Exploration of Effects of Alternative Governance Systems on Value Creation). Under Category I, we seek to achieve the following objectives:

1. *Identify the different supply chains used by the Zambian pulse industry and describe the characteristics of those using them at the different loci of the supply chains.*
2. *Identify and estimate the effects of stakeholder characteristics on producers' supply chain participation decisions.*
3. *Describe and estimate the pecuniary and non-pecuniary value for different supply chain participants.*
4. *Identify the institutional and policy issues influencing value creation and determine if any effect differences exist by crop, location, gender and stage of the chain.*
5. *Based on the results from the foregoing, develop and deliver education and outreach programs targeting specific stakeholders and provide policy recommendations to facilitate solutions.*

Category II involves conducting supply chain management experiments to identify the factors that influence success in value creation. It involves the following specific objectives:

1. *Work with specific industry stakeholders to pilot different governance systems to identify the factors and participant characteristics influencing performance.*
2. *Use the results of the experiment to develop outreach programs, program advocates and program advisory support systems to help producers and their partners develop appropriate governance systems to improve their economic well-being.*

When PVCI-Z achieves the foregoing objectives by the end of the project, we will know and understand the structure, conduct and performance of supply chains in the Zambian bean and cowpea industry. We will know how the different players—farmers, traders, retailers, customers, etc.— in the market define and create value and identify how that value is distributed to the participants in the chain. We will be able to provide information on both the pecuniary and non-pecuniary components of value at each locus in the supply chain. Most importantly, we will know the relationships among producer characteristics and their performance in identified value chains. We will also know the preferences and participation challenges for producers, retailers, traders and their customers. This knowledge will help us work with our collaborators—government and public policymakers, industry and trade association, and NGOs and others seeking to help improve the wellbeing of African smallholder producers.

Planned Project Activities in FY 2011

Project Website Development

- Development and launching of Pulse Value Chain Initiative website (http://valuechains.k-state.edu (November 2010).

  A website to host reports and papers related to the research effort was developed. It has information about economics and value chain research on pulses Development and launching of Pulse Value Chain Initiative website (http://valuechains.k-state.edu and other industries in Africa and around the world. It also hosts a blog on all issues value chains and pulses written by the principal investigators in both the U.S. and Zambia. Its objective is to engage interested investigators and researchers in the discovery and development of opportunities to enhance understanding and appreciation of pulse economics as well as advance non-market valuation efforts in Africa. The PIs of MSU-II (Mozambique/Angola) will be invited to contribute to the website. The site also serves as a repository of raw data from the projects, literature database (Refworks and other data tracking tools) and reports and information for public education and engagement. The raw data are available only on the intranet for participating scientists and researchers.

- Populating the Project Website (Ongoing)

  Research briefs, papers, data and related information will be uploaded to the website as they are collected. Similarly, education and training programs

delivered will also be uploaded to the website. Some of the material (e.g., raw data) will be available only on the intranet so that only participating researchers will have access to them. The objective is to Development and launching of Pulse Value Chain Initiative website (http://valuechains.k-state.eduCollaborators

Dr. Vincent Amanor-Boadu will lead and oversee the development of the website and databases. Contributions to the site will involve all U.S. and HC PIs as well as participating students.

Recruitment of Students

- Complete the recruitment of 3 MAB students (by November 2010)

Collaborators

The MAB Office at K-State and HC PIs worked hard in identifying about a dozen potential participants, six of whom have submitted completed applications that being evaluated by the MAB Admissions Committee at the time of writing. Admission decisions should be completed by the first week of November. The MAB Office at K-State and the HC PIs will be responsible for helping the admitted students come to Manhattan, KS for their first of four on-campus one-week sessions in the program.[4]

Category I Objectives

- Continued development of survey instruments, training of enumerators and testing of instruments (October 2010 – November 2010).
- Producer Data collection (November 2010 – January 2011)

  The strategy is to begin data collection in districts with the highest proportion of national production of each crop, taking care to optimize the process and minimize data collection costs by reducing unnecessary backtracking.

  Our students will have their computers with them during the data collection process, and will be required to input their data as they collect them. They will transfer their data to the intranet for shared assessment and analyses, utilizing the Computer Assisted Field Entry (CAFÉ) data entry system that will be on each student's computer. This allows for PIs both in Zambia and the U.S. to assess data and provide feedback and/or correct any potential errors in situ instead of "cleaning the data" after the fact.

Collaborators

Dr. Amanor-Boadu and the HC team continued working on the survey instruments after the strategic planning session in Zambia. It is important to recognize Dr. Tembo's well-

[4] A description of the MAB program is presented in the Technical Proposal.

recognized skills in the production of survey tools that are structured in line with CSO formats. This is expected to facilitate ease of cross-comparisons as well as familiarity by respondents and enumerators.

Dr. Tembo and Ms. Mwiinga have identified a group of bean and cowpea growers in Kabwe and Monze to test the structured questionnaire developed for producers. The semi-structured questionnaires for traders, retailers and end users will be tested in and around Lusaka. The two HC PIs, Dr. Amanor-Boadu, and Dr. Allen Featherstone will analyze these test data to determine if indeed the instruments address all the objectives for which they were developed. Necessary changes and/or modifications will be made before final survey instruments are sent for printing.

Our students will be responsible for conducting the producer and trader surveys in the countryside. We are hiring three experienced CSO enumerators to work with our students (two students per enumerator) in the field. Additionally, Dr. Tembo and Ms. Mwiinga will visit each student during their field activity to observe and advice on performance. Dr. Tembo and Ms. Mwiinga will supervise their activities closely, evaluating their data as they upload them to the project's intranet. This will also allow Dr. Amanor-Boadu and Dr. Featherstone to participate in the assessment of the quality of the data. Dr. Amanor-Boadu and Dr. Tembo will maintain weekly management conversations to ensure effective flow of information as the data collection proceeds.

Dr. Tembo and Ms. Mwiinga will work with the MS students in interviewing industry stakeholders in hotels, restaurants and institutions as well other end users of beans and cowpeas. Dr. Tembo and Ms. Mwiinga will also work with the students directly in interviewing and collecting secondary data from industry associations, government and non-governmental agencies. Whenever feasible, Dr. Amanor-Boadu and the U.S. PIs will join these conversations by Skype or other online communication tool. This builds on shared knowledge across the team and contributes to helping with the analyses and interpretation of the results.

- Analyses of data and report writing begin (January/February 2011)

  The specific Category I objectives to be addressed with statistical and econometric analyses and hypotheses testing will begin as soon as a critical mass of data is available. The hypotheses of interest have been described in the Technical Report.

Collaborators

Students and faculty members will be assigned specific objectives to work on with Dr. Tembo and Dr. Amanor-Boadu maintaining overall responsibility for quality control and maintaining focus on the project. Each project student will have one of the HC PIs as their major advisor and at least one other HC PI on their supervisory committee. The

graduate students will have at least one U.S. PI on the supervisory committee. The allocation of students and coordination of student progress will be overseen by Dr. Tembo for the MS and 5th-Year Undergraduate students. Dr. Amanor-Boadu, Dr. Dalton and Dr. Featherstone will be responsible for supervising the MAB students' research and theses with support from Dr. Tembo.

Approaches and Methods

The approaches used in this segment of the project involve structured and semi-structured survey instruments to collect data from the bean and cowpea industry in Zambia. We employ statistical and econometric analyses as well as system dynamic simulations to address each of the five objectives in Category I of the project.

Contribution of Project to Target USAID Performance Indicators

To be added later.

Target Outputs

a. Recruited six 5th-year undergraduate students will complete their studies and graduate in May 2011. They will produce six theses based on project data. The students are organized into three groups of two, with each student in each group focusing on one of the two crops (beans or cowpeas) and each group looking at one of the following specific issue areas:
    - Gender and value chain participation
    - Marketing channel choice decisions
    - Estimation of value created and extracted by producers in their value chains
b. MS students will complete data collection from downstream supply chain stakeholders and develop three theses around the following areas with two being completed by May 2011:
    - Pecuniary and non-pecuniary value in pulse value chains
    - Institutions and policies influencing pulse industry economics in Zambia
    - Transaction costs in Zambian pulse value chains
c. PIs will produce one comprehensive project report and at least three journal articles on the structure, conduct and performance situation in the Zambian pulse industry, addressing the following within FY 2011:
    - The different supply chains used by the Zambian pulse producers and a description of the characteristics of those using them
    - The effects of stakeholder characteristics and operational environment on choice of supply chains
    - A description of the types of pecuniary and non-pecuniary value identified

by supply chain stakeholders and their monetary value to provide an estimate of total value in the supply chains and their distribution

- The institutional and policy issues that influence value creation in the Zambian pulse industry and the extent of differences resulting from the stage of the operation (farm, trader, end-user), region, and gender
- Gaps in stakeholder knowledge about value creation in supply chains and the solutions developed to address these gaps, including education and policy recommendations

d. Develop a system dynamic model that allows for simulation of alternative policy recommendations to assess their impact on producer incomes. Because of the graphical user interface architecture of the *iThink*® software used for these analyses, we will work directly with policy makers to "test fly" these simulations to help build better understanding and garner commitment to make the necessary changes to support producer income improvements. This is will presented both as an education and capacity-building tool and as report showing the effects of alternative policies on value creation and distribution in pulse value chains. This will be completed by the end of FY 2011.

Engagement of USAID Mission

We visited with Mr. Andrew Levin, the Economic Growth Team Leader and Mr. Mlotha Damaseke, a member of the Economic Growth Team at USAID in Lusaka during our strategic planning sessions in September/October 2010. HC PIs will maintain these engagements throughout FY 2011 as the project proceeds, inviting USAID officials to

meetings and engaging them in discussions about initiatives. U.S. PIs will also maintain a relationship with the Mission through email and physical meetings whenever they are in Zambia, informing them about their visit, arranging to spend some time during or outside office hours to discuss the project and its progress, seek advice on challenges, and identify loci for collaborations. We will provide Mission staff with students' theses and other project reports. Mission staff will also be invited to sit in on student theses seminars and whenever presentation requests are made, project PIs will endeavor to accommodate them.

Networking Activities with Stakeholders

The following organizations have been identified and recruited to collaborate with us on this project:

1. Zambian National Farmers Union

2. Central Growers Association
3. Zambian Agricultural Research Institute
4. Marketing Department, Ministry of Agriculture and Cooperatives
5. Central Statistics Office

Representatives from all these organizations were invited to participate in our project's strategic planning. Unfortunately, only two of the five groups were able to attend the planning session. Summary notes have been sent to all collaborators. HC PIs will endeavor to visit each collaborating organization in FY 2011 and the project director will maintain email and/Skype contact with them through the year.

HC PIs are scheduled to hold special meetings with Ministry of Agriculture and Cooperative officials to help the research team understand not only the government's pulse policies but also the intensions on supporting pulses as a principal crop in meeting the nutrition security of the population. As the research proceeds towards policy recommendations, these government collaborators will be consulted closely to ensure that the policy pipe is primed to support the implementation of solutions emanating from this project.

Leveraging CRSP Resources

The vision of this project is to contribute to food and nutrition security through research, education and engagement. Understanding the effect of economics on value chain participation and performance is critical to this vision. A number of organizations, including the Bill and Melinda Gates' Foundation Africa Initiative and World Vision are pursuing similar efforts. Our objective is to use the outcomes from FY 2011 activities to solicit support from these organizations to extend the project's reach and impact.

We have been approached in the last week by the Zambian representative of the Southern Africa Bean Research Network (SABREN) to collaborate with them on their value chain initiative. Throughout FY 2011, we will endeavor to work with SABREN given our shared vision of enhancing the role of pulses in the Zambian agri-food economy.

Training/Capacity Building Workplan

Degree Training:

First	Last	Citizenship	Gender	Program	Institution
Esther Tatenda	Zulu	Zambian	Female	5th -Year UG	UNZA
Agness	Myece	Zambian	Female	5th -Year UG	UNZA

First	Last	Citizenship	Gender	Program	Institution
Natasha	Chilundika	Zambian	Female	5th -Year UG	UNZA
Chimuka	Samboko	Zambian	Male	5th -Year UG	UNZA
Edna	Ngoma	Zambian	Female	5th -Year UG	UNZA
Chalwe	Sunga	Zambian	Female	5th -Year UG	UNZA
Susan	Chiona	Zambian	Female	MS	UNZA
Stephen	Kabwe	Zambian	Male	MS	UNZA
Maxwell	Choombe	Zambian	Male	MS	UNZA
*		Zambian		MAB	KSU
*		Zambian		MAB	KSU
*		Zambian		MAB	KSU

* At the time of writing, we have received five applications for the MAB program from Zambians Dr. Amanor-Boadu and Dr. Tembo visited with during Dr. Amanor-Boadu's visit to Zambia. These applications are currently being reviewed by the KSU MAB Program Admission Committee and as soon as a decision is made, the students will be informed. Their names will be supplied to the Management Office as an addendum to this Work Plan. Each of the applicants is also being screened for eligibility for Participant Trainee Status as described in ADS Chapter 253, pp. 10-11.[5]

Supervising CRSP PI for the 5th-Year Undergraduates: Ms. Mukwiti Mwiinga and Dr. Gelson Tembo

Supervising CRSP PI for the MS students: Dr. Gelson Tembo, with Dr. Vincent Amanor-Boadu
Supervising CRSP PI for the MAB students: Dr. Vincent Amanor-Boadu, Dr. Tim Dalton, Dr. Gelson Tembo

All the degrees will be in agricultural economics and agribusiness.

If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? : MAB students will be Participant Trainee as defined by USAID.

Host Country Institution to Benefit from Training Thesis Title/Research Area: University of Zambia; Zambian Pulse Industry; Zambian Agricultural Industry.

Start Date: June 2010 for the MS and 5th Year Undergraduate students and January 2011 for the MAB students.

[5] ADS Chapter 253: Participant Training for Capacity Development, Revision Date 04/13/2010.

Projected Completion Date:

- 5th Year Undergraduate students: April 2011
- MS students: April 2012
- MAB students: May 2013

Training status (Active, completed, pending, discontinued or delayed): Active

Type of CRSP Support (full, partial or indirect) for training activity:

- 5th Year Undergraduate students: Full
- MS students: Full
- MAB students: Full

Short-term Training

We have planned a short-term training program on each visit by U.S. PI to Zambia. In the September/October 2010 visit by Dr. Amanor-Boadu, he presented two sessions on international trade policy to MS students in the Department of Agricultural Economics Extension, and one session on Practicing Economics to participating undergraduate students.

For FY 2011 work plan period, the following short-term training programs are planned:

Training topic: *Econometric analysis for survey data*

Description: This is a refresher and an overview of the tools that may be used in analyzing survey data such as those we are collecting in this research.

Location: University of Zambia, Lusaka

Time and Duration: Spring 2011 for 3 days

Number of Beneficiaries: Minimum 12 students, 4 faculty members and we will invite collaborators from CSO, MSU FSRP and MACO to participate in the seminar. Additionally, the seminar will be advertised across the School of Agricultural Sciences to attract all students and faculty.

PI/Collaborator with Responsibility for Training: Dr. Gelson Tembo/Dr. Vincent Amanor-Boadu

Training Topic: Introduction to Governance Systems for Supply Chains

Description: An in-depth but simplified non-academic approach to understanding governance systems for supply chains

Locations: TBD but probably Kasama for beans and Choma for cowpeas

Time and Duration: Summer/Fall 2011 for 2 days

Number of Beneficiaries: Minimum 30—the participants in the pilot value chains, plus project students

PI/Collaborator with Responsibility for Training: Dr. Vincent Amanor-Boadu/Ms. Lubinda

Seminar: Alternative Policy Effects on the Pulse Value Chain
Description: A seminar highlighting the process and the results of the system dynamic modeling of alternative policies on the pulse value chain.
Location: Lusaka
Number of Beneficiaries: Minimum 10—government policymakers, students and faculty.
Time and Duration: Fall 2011; 2-hour seminar

Workshop- ***Value Chains***
We are investigating opportunities to conduct a joint workshop on value chains with MSU-II (Angola/Mozambique).
Location: TDB
Time and Duration: TBD.

TMAC EVALUATIONS AND RECOMMENDATIONS PLUS PI RESPONSES

Phase III Project: PIII-KSU-1, *Pulse Value Chain Initiative – Zambia*

Lead U.S. PI- Dr. Vincent Amanor, Kansas State University

A. Comments regarding Project Performance

1. The TMAC views this as an important project for the Pulse CRSP, with category I activities as the key to informing Pulse CRSP activities to have longer term impacts in Zambia and the region as a whole.
2. This is a new project and it can move forward quickly given the identification of the students and the presence on the ground .
3. The project focuses on Zambia and will benefit from keeping regional dynamics in mind into the future.

   PI Comment- Preliminary conversations with the industry suggests that these regional dynamics are real in the pulse industry. Therefore, we will endeavor to sustain them in all our conversations with producers and the downstream chain.

B. TMAC Recommendations

1. Given the lack of information on the value chain, the project leaders will need to keep an open mind on what may be the leverage points in the value chain that will have the greatest chance to have impact and be scalable. Category II activities will need to be revisited after Category I is completed.

   Response:

   We recognize the need to maintain an open mind about the mediating factors because of the absence of cogent information. Therefore, we are in agreement with the TMAC to proceed carefully and allow the incoming data to influence how we proceed to Category II. Indeed, we have already discovered the existence of a couple of interesting vertical relationships that may form a foundation for the case studies instead of reinventing the whole wheel. Furthermore, scalability is an integral aspect of the project if we are going to see the impacts we desire

2. The TMAC recommends that the project PI contact the Texas A&M Pulse CRSP PI to take advantage of the industry, ZARI and University of Zambia food science linkages of that project. For example, contact should be made with Chitundu Kasase in Department of Food Science, University of Zambia.

   Response:

   That has already been done. We believe that Dr. Kasase's research efforts become more relevant when we enter the consumer market space to assess determining for factors consumption and when we begin to investigate consumer market expansion strategies for the pulse value chain. We will

continue dialog with the Texas A&M team as we proceed.

3. The TMAC also recommends working with the MSU-2 project in Mozambique and Angola, particularly to see about developing research methods and instruments that would enable some comparability across the two projects. Both projects should consider holding a joint value chain workshop. Additional discussions with the MSU FSRP project and CSO agriculture sector specialists will also be valuable on survey design.

   Response:

   We have engaged the CSO already in our deliberations about survey techniques and are considering a joint seminar on bean and cowpea value chain situation analysis within the Zambian agriculture and food landscape somewhere in June 2010. While we have informed FSRP about this project, we have not yet engaged them in active conversation. That will be accomplished in due course. We will share our investigation and analytical methods with Dr. Donovan and the MSU-II Mozambique and Angola project and plan a joint workshop once we have some results from our study to facilitate such a workshop.

4. The market work will need to keep in mind the potential seasonality in marketing activities. In addition, the hospital, military and educational buyers should be clearly identified as key informants.

   Response:

   We are very cognizant of the seasonality of marketing. However, it is important to note that trading continues throughout the year as buyers travel to producing regions to procure stored products. We are hoping that we will get a sense of time effect on access and price and the nature of value chain relationships. The institutional buyers are major players in that they purchase large quantities at a time. We are, therefore, seeking to understand their role in the supply chain and assess their value creation and extraction in the chain. In other words, we want to determine the extent of their engagement without any a priori categorization of their roles in the chain.

5. For the triple bagging and storage issues, the University of Illinois Pulse CRSP project has information and training materials that may be of interest and the PI should be contacted.

   Response:

   The University of Illinois project could become an important partner in Category II after we find out the status quo activities and determine the gaps in factors that are adversely affecting value creation and extraction in the chain. Similarly, we would look to the breeders to provide support for appropriate technologies to enhance value creation after we have gathered the

baseline information on what contributes to value creation and extraction.

6. For the market work, prior to departure for field work, it is very important to ensure adequate training of the student researchers, as well as sufficient pre-testing of instruments. The distances between Lusaka and research sites will present difficulties for supervision, thus making training and communication critical.

   Response:

   Students are being trained extensively on data collection and enumeration. Our CSO partners are helping with this. Furthermore, we are employing three experience enumerators to travel with the students to supervise their activities in the field and help them if the need arises. To help with student education, they are intimately involved in the survey testing procedures.

7. Dr. Amanor should submit a FY 2011 Workplan and Budget to the Management Office following his visit to Zambia in September. The TMAC will then review the Workplan paying specific attention to responses to TMAC recommendations outlined here.

   Response:

   This document is being submitted as part of the FY 2011 Work Plan and Budget.

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 20010 -- September 30, 2011)

FY 2011 PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Pulse Value Chain Initiative - Zambia
Lead U.S. PI and University: Vincent Amanor-Boadu, Kansas State University
Host Country(s): Zambia

Output Indicators	2011 Target (October 1, 2010-Sept 30, 2011)	2011 Actual
Degree Training: Number of individuals enrolled in degree training		
Number of women	7	
Number of men	5	
Short-term Training: Number of individuals who received short-term training		
Number of women	15	
Number of men	30	
Technologies and Policies		
Number of technologies and management practices under research		
Number of technologies and management practices under field testing		
Number of technologies and management practices made available for transfer		
Number of policy studies undertaken	1	
Beneficiaries:		
Number of rural households benefiting directly		
Number of agricultural firms/enterprises benefiting	5	
Number of producer and/or community-based organizations receiving technical assistance		
Number of women organizations receiving technical assistance		
Number of HC partner organizations/institutions benefiting	6	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices		

Dry Grain Pulses CRSP

PULSE VALUE CHAIN INITIATIVE - ZAMBIA

	10/01/10 - 09/30/11					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	**K-State**	**Zambia**	**UNZA**			
a. Personnel Cost						
Salaries	$16,163.00		$28,767.00			
Fringe Benefit	$5,091.00					
b. Travel	$5,182.00	$24,300.00	$58,937.00			
c. Equipment ($5000 Plus)						
d. Supplies		$4,500.00	$800.00			
e. Training						
Degree		$39,150.00	$14,820.00			
Non-Degree						
f. Other	$2,500.00		$3,000.00			
g. Total Direct Cost	**$28,936.00**	**$67,950.00**	**$106,324.00**	**$0.00**	**$0.00**	**$0.00**
h. Indirect Cost	$13,889.00	$13,824.00	$10,632.00			
i. Indirect Cost on Subcontracts (First $25000)						
j. Total Indirect Cost	$13,889.00	$13,824.00	$10,632.00	$0.00	$0.00	$0.00
Total	**$42,825.00**	**$81,774.00**	**$116,956.00**	**$0.00**	**$0.00**	**$0.00**
Grand Total	**$241,555.00**					

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	**$42,826.00**	**17.73%**
Total direct cost budgeted for H.C institution(s)	**$198,730.00**	**82.27%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$13,498.00		$3,000.00				$ 16,498.00
Cash							$ -
Total	$ 13,498.00	$ -	$ 3,000.00	$ -	$ -	$ -	$ 16,498.00
Attribution to Capacity Building							
Percentage of effort	45.00%	100.00%	57.00%				69.43%
Amount corresponding to effort	$19,271.25	$81,774.00	$66,664.92	$0.00	$0.00	$0.00	$167,710.17

U.S Institution PI: Vincent Amanor-Boadu, Kansas State University

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2010 -- September 30, 2011)

FY 2011 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: *Pulse Value Chain Initiative - Zambia*

	Abbreviated name of institutions										
Identify Benchmark	KSU		UNZA								
Indicators by Objectives	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**	**9/30/11**	**4/1/11**
Objective 1											
Complete producer survey instrument	X		X								
Complete downstream interview guide	X		X								
Complete producer survey and data entry			X								
Complete downstream interviews and data entry			X								
Identify and classify the different types of supply chains used in the industry	X		X								
Identify and describe characteristics of stakeholders and their choice of supply chains	X		X								
Objective 2											
Conduct an econometric analysis of how supply chain participation decisions are influenced by stakeholder characteristics	X		X								
Specifically analyze differences between male and female stakeholders' supply chain participation decisions and their characteristics	X		X								
Specifically determine any location and crop effects on supply chain participation decisions	X		X								
Objective 3											
Describe the pecuniary value associated with beans and cowpeas at each stage in the different value chain		X		X							