FY 2012 Workplans
October 1, 2011 – September 29, 2012

Dry Grain Pulses
Collaborative Research Support Program
(CRSP)
FY 2012 Workplans
October 1, 2011 – September 29, 2012

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PII ISU-1
Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda

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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’ 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 for October 1, 2011 - September 28, 2012**

**Objective 1:** To Improve Harvested Bean Yield and Quality

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**Rationale**

Results of Phase 1 research activities prompted several adjustments in research and development activities in 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 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. Work under Objective 1a tests the hypothesis that incorporating varying amounts of inorganic phosphorous into the soil prior to planting will identify the level required to 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 inaccessible for most small-landholder farmers. Entomologists at Uganda’s National Crops Resources Research Institute have identified the major insect pests in beans. Controlled field trials are being conducted to determine specificity and effectiveness of methods for controlling 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 has been to establish a system for community-based production of quality seed. We have trained and supported six farmer groups committed to large-scale bean production in accordance with established seed quality standards. This will subsequently enable many other farmers to utilize quality seed. We are also piloting triple bagging as a seed storage method suitable for long-term (3-6 months) storage without loss of product quality. We are using participatory methods to engage farmers in this process and establish viable and sustainable protocols for seed production, harvesting, and storage. We are in the process of monitoring success to date and individual and group level factors that account for variation in the success of community based seed production efforts to date. We hypothesize that certain elements of group leadership and dynamics have a major impact on the success and sustainability of the production groups.

Numerous factors are known to affect the quality of seed 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 are continuing experiments that test the efficacy of airtight bagging to eliminate living insects from the stored grain. The triple bagging technique has numerous advantages, including flexible storage volume, re-usability of bags, and manageable volume of individual bags (50-100 kg). This flexible storage approach is being evaluated as a means of meeting the emerging need for bulk storage on farm or at community collection sites for collective marketing to increase 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 interventions will be analyzed.
- Exchange visits have been initiated to established seed production programs in central Uganda to facilitate learning and sharing of practices and technologies. These will be continued to central and western Uganda, as resources permit.
- Drying and storage techniques are being evaluated under various conditions and at various time intervals to determine their effectiveness in keeping out/killing pests and maintaining seed germination viability.
- Refinements in practices and technologies (land preparation, soil nutrient management, pest and disease control, harvest and storage) are being 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 existing bean varieties being promoted with selected traits (farmer selected varieties, high seed ferritin genotypes, early maturation, good yield, disease resistance) will be tested under farmers’ cropping system conditions - monocropping and intercropping with maize and/or bananas.

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 amendments.

3. Evaluate appropriate cultural/agronomic methods to control pests/diseases (intercropping, and crop rotation).

4. Promote adoption and use of key management practices and technologies.

Benchmarks

- Variety performance, fertility response, and agronomic/cultural controls analyzed

Apr. – Sept. 2012
- Assessment by farmers/farmer groups of new variety acceptability completed
- Report to bean breeders on variety performance and farmer acceptance completed

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

1. Strengthen 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

- Strategies for profitability and sustainability of seed production assessed
- Extension guide for CBSP of beans finalized

Apr. – Sept. 2012
- Achievements and lessons learned from the CBSP documented and shared
- Assess impact of CBSP on seed systems within Kamuli district
- Successful strategies for seed production business promoted
**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 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 (‘solarization’ and ‘triple bagging’), and identify and address barriers to farmers’ adoption.

5. Train farmers in technical, organizational, and financial management aspects of bulking facilities.

6. Assess adoption of drying, threshing, and storage techniques through interviews and focus group discussions.

**Benchmarks**


- Extension materials for drying, threshing, and storage finalized
- Barriers to adoption of storage techniques identified and addressed
- Follow up training on solarization and new storage techniques carried out

**Apr. – Sept. 2012**

- Farmers’ long-term adoption of new drying, threshing, and storage techniques assessed

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

1. Share and disseminate information through farmer field days at research/demonstration sites and regional/national agricultural shows, 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**


- Training of trainers in bean production initiated
- Training modules (production, drying, storage, and management of bulked bean grains and seeds) compiled into a comprehensive document and published
Apr. – Sept. 2012

- Final training of all trainers conducted – including farmers from other districts for scaling up and scaling out
- Two farmer field days held (one in each sub-county)
- Project findings shared with stakeholders through workshop and publications
- Status of bean production, constraints faced and resources needed for scaling up determined

**Target Outputs and Developmental Outcomes**
We will document and publicize the contributions of production factors to increased yield, reduced loss 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 NaCRII 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 – directly and indirectly - 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.

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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 three core elements. The first element involves 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, in order 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.

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 were developed in a participatory, community based competition and field day in 2010.

We hypothesize that availability of acceptable alternative ways of preparing beans will result in increased bean consumption. The central hypothesis regarding farmers’ adoption, adaptation and sustained use is that a coordinated strategy of technological innovation to facilitate ease of utilization of bean-based foods and ongoing evidence of nutritional and economic benefits of beans are likely to create sustainable increased consumption of beans within communities.

Phase I results indicate that new high yielding bean varieties were not necessarily of optimal nutrition and consumer acceptability. This clearly indicated a disparity between breeding for agronomic hardiness versus end user requirements. Thus, Phase II of this project is bridging the gap between breeders and consumers 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.

Besides utilization by communities, the project will continue to 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 are being 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 entrepreneurs with a supportive environment.
to help establish and develop their projects (Lalkaka 1996). It is hypothesized that by providing services (product refinement/optimization, upscaling, test 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 establishment and growth prospects of bean processing enterprises in their early stages of development. Private sector partners will be linked to farmer organizations for maximum trickle-down effect of value addition returns. We will also test two additional hypotheses: (1) processing of beans significantly improves its acceptability and market potential; and (2) 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. Train rural populations (Rwanda, then Uganda) to process bean flour and utilize simple ‘cold extrusion’ technology (using hand-operated presses) at community level with processed (sprouted, fermented) beans and maize.

2. 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**


- IEC materials translated into local languages

Apr. – Sept. 2012

- Extension information, education, and communication approaches for popularization of bean products finalized

- Community-based dissemination field days held in Uganda and Rwanda

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

1. Analyze culinary properties of improved bean varieties in Uganda (NaCRRRI) and Rwanda (ISAR)

2. Analyze sensory characteristics (color, texture, taste, flavor, etc.) and consumer acceptability of improved bean varieties in Uganda (NaCRRRI) and in Rwanda (ISAR)

3. Liaise with national bean breeding programs to match consumer requirements with culinary and sensory characteristics of new varieties
Benchmarks
- Culinary traits and sensory characteristics of improved bean varieties documented
- Communicate culinary traits and sensory characteristics results to national breeding programs

Apr. – Sept. 2012
- Strategy to promote current and improved varieties developed with national breeding programs
- Strategy to promote 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 for including the weaning food/school feeding product).
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
- Infrastructure to support commercialization of bean products at Makerere University developed
- Developed protocols for value-added bean products up-scaled in partnership with private sector
- Marketing strategies for processed bean products developed and evaluated

Apr. – Sept. 2012
- Process to document industrial adoption and market performance of bean based value added products initiated
- Process to evaluate impact of industrial adoption of value added bean products on farmers’ livelihoods 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. 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.

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**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 can obtain good prices, they increase marketing. Further, when farmers add value, they can achieve even higher prices. 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. Transaction 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 add value to product and for their marketing efforts. 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, and addressing the requirements of women who may market in small quantities or specialize in small-scale, value added services. 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

- n/a (being completed during FY11)

Apr. – Sept. 2011
- n/a (being completed during FY11)

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

- Farmers trained in developing business plans, pricing, packaging and record keeping
- Market information system enhancements initiated

Apr. – Sept. 2012
• Progress of farmer groups in collective marketing evaluated  
• Comprehensive business plans developed  
• Strategic value chain partnerships established  

**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

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- Mark Westgate, Department of Agronomy, westgate@iastate.edu
- Suzanne Hendrich, Department of Food Science & Human Nutrition, shendric@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
• Inter-organizational learning fostered

Apr. – Sept. 2012
• Training M.S. students at Makerere University completed
• Training M.S. student in Food Science & Technology from Rwanda on-going
• Training Ph.D. at Iowa State University completed
• 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) of leveraged funds: Iowa State University
Amount Budgeted in Workplan, if providing full or partial support: $19,033
Direct cost: $15,715
Indirect cost: $3,318
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: Manju Reddy and 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) of leveraged funds: Iowa State University
Amount Budgeted in Workplan, if providing full or partial support: $14,658
Direct cost: $12,019
Indirect cost: $2,639
U.S. or HC Institution to receive CRSP funding for training activity: Iowa State University

Trainee #3
First and Other Given Names: Joseph Deng
Last Name: Malual
Citizenship: U.S.
Gender: Male
Degree Program for training: Ph.D.
Program Areas or Discipline: Sociology
Host Country Institution to Benefit from Training: VEDCO
University to provide training: Iowa State University
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID? No
Supervising CRSP PI: Robert Mazur
Start Date: July 2011
Projected Completion Date: May 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds: Iowa State University
Amount Budgeted in Workplan, if providing full or partial support: $19,263
Direct cost: $15,674
Indirect cost: $3,589
U.S. or HC Institution to receive CRSP funding for training activity: Iowa State University

Trainee #4
First and Other Given Names: Grace
Last Name: Nkundabombi
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 2011
Project Completion Date: August 2013
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 2010
Project completion date: May 2012
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: Extension & Innovation Studies
Host Country Institution to benefit from training: Makerere University, Uganda
University to provide training: Makerere University
Supervising CRSP PI: Dorothy Nakimbugwe
Start date: August 2010
Project completion date: August 2012
Type of CRSP Support (full, partial or indirect): Partial

Trainee #7
First and given names: Doreen
Last name: Alupo
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 2011
Project completion date: May 2013
Type of CRSP Support (full, partial or indirect): Partial
Contribution of Project to Target USAID Performance Indicators

- Seven scientists will undergo degree training (three female, four male) during this period at Makerere University (four M.S.) and Iowa State University (three Ph.D.).
- We expect 400 farmers (300 female) to participate in training regarding production, harvesting, and post-harvest methods in Uganda.
- Important technologies and management practices under research and 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 developed, 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 information and protocols 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 400 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 100 acres will be cultivated using improved technologies 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 Community Based Trainers, 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, we are linking work done by NaCRII 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
- 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
Performance Indicators

**Dry Grain Pulses CRSP**  
*Research, Training and Outreach Workplans*  
 *(October 1, 20011 - September 28, 2012)*

**FY 2012 PERFORMANCE INDICATORS**  
*for Feed the Future*

**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

<table>
<thead>
<tr>
<th></th>
<th>2012 Target</th>
<th>2012 Actual (October 1, 2011-Sept 28, 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree Training:</strong> Number of individuals enrolled in long-term degree training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Short-term Training:</strong> Number of individuals who received short-term training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

### Technologies and Policies

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Number of technologies and management practices under research</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under field testing</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices made available for transfer</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Number of policy studies undertaken</td>
<td>1</td>
<td></td>
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### Beneficiaries:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
<td>720</td>
<td></td>
</tr>
<tr>
<td>Number of agriculture-related firms benefiting from CRSP supported interventions</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Number of trade and business associations receiving technical assistance</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Number of community-based organizations receiving technical assistance</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Number of partnerships formed as a result of CRSP assistance</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
<td>4</td>
<td></td>
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</table>

### Developmental outcomes:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Number of additional hectares under improved technologies or management practices as a result of CRSP technical assistance</td>
<td>350</td>
<td></td>
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</table>
## Budget Summary

### Dry Grain Pulses CRSP: THIRD PERIOD (FY12)

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

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISU</td>
<td>$11,237.00</td>
<td>$14,309.00</td>
<td>$16,775.00</td>
<td>$4,400.00</td>
<td>$13,200.00</td>
<td>$4,125.00</td>
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<tr>
<td></td>
<td>$1,151.00</td>
<td>$1,903.00</td>
<td></td>
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<tr>
<td>Fringe Benefits</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>$28,050.00</td>
<td>$12,350.00</td>
<td>$4,875.00</td>
<td>$7,810.00</td>
<td>$2,500.00</td>
<td>$2,563.00</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Equipment ($5000 Plus)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td></td>
<td>$5,254.00</td>
<td>$0.00</td>
<td>$2,250.00</td>
<td>$2,000.00</td>
<td>$11,252.00</td>
<td>$4,500.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Training</td>
<td>$1,869.00</td>
<td>$4,822.00</td>
<td>$8,750.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Other</td>
<td>$250.00</td>
<td>$0.00</td>
<td>$3,500.00</td>
<td>$900.00</td>
<td>$250.00</td>
<td>$750.00</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>g. Total Direct Cost</td>
<td>$47,811.00</td>
<td>$33,384.00</td>
<td>$38,150.00</td>
<td>$15,110.00</td>
<td>$27,202.00</td>
<td>$11,938.00</td>
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<tr>
<td>h. Indirect Cost</td>
<td>$11,945.00</td>
<td>$7,426.00</td>
<td>$3,615.00</td>
<td>$1,511.00</td>
<td>$2,720.00</td>
<td>$1,194.00</td>
</tr>
<tr>
<td>i. Indirect Cost on Subcontracts (First $25000)</td>
<td>$11,945.00</td>
<td>$7,426.00</td>
<td>$3,615.00</td>
<td>$1,511.00</td>
<td>$2,720.00</td>
<td>$1,194.00</td>
</tr>
<tr>
<td>j. Total Indirect Cost</td>
<td>$11,945.00</td>
<td>$7,426.00</td>
<td>$3,615.00</td>
<td>$1,511.00</td>
<td>$2,720.00</td>
<td>$1,194.00</td>
</tr>
<tr>
<td>Total</td>
<td>$59,756.00</td>
<td>$40,810.00</td>
<td>$39,765.00</td>
<td>$16,621.00</td>
<td>$29,922.00</td>
<td>$13,132.00</td>
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<tr>
<td>Grand Total</td>
<td>$200,008.00</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total direct cost budgeted for U.S. institution(s)</td>
<td>$47,811.00</td>
</tr>
<tr>
<td>Total direct cost budgeted for H.C. institution(s)</td>
<td>$123,784.00</td>
</tr>
</tbody>
</table>

### Cost Share

<table>
<thead>
<tr>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$23,621.00</td>
<td>$11,945.00</td>
<td>$3,615.00</td>
<td>$1,511.00</td>
<td>$2,720.00</td>
<td>$23,621.00</td>
</tr>
</tbody>
</table>

**Total** $23,621.00

### Attribution to Capacity Building

<table>
<thead>
<tr>
<th>Percentage of effort</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>91.59%</td>
<td>$54,730.02</td>
<td>$36,134.46</td>
<td>$13,870.22</td>
<td>$23,545.09</td>
<td>$12,069.62</td>
<td>$186,190.01</td>
<td></td>
</tr>
</tbody>
</table>

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

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Dry Grain Pulses CRSP

FY 12 10-01-11 - 09-30-12

25
**BENCHMARKS**

**Dry Grain Pulses CRSP**
Research, Training and Outreach Workplans
(October 1, 2011 – September 28, 2012)

**FY 2012 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

<table>
<thead>
<tr>
<th>Objective</th>
<th>Improve Bean Yield and Quality</th>
<th>Enhance the Nutritional Value and Appeal of Beans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Analyzed variety perform., fertility respon., agron./cultural controls</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1b. Assessment by farmers of variety acceptability completed</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1a. Report to breeders on variety performance &amp; farmer acceptability</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1b. Strategies for seed production profitability &amp; sustainability assessed</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1b. Extension guide for CBSP of beans finalized</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1b. Achievements and lessons learned from CBSP shared</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1b. Assess impact of CBSP on seed systems in Kamuli district</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1b. Successful strategies for CBSP profitability &amp; sustainability promoted</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1c. Extension materials for drying, threshing, and storage finalized</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1c. Barriers to adoption of storage techniques identified &amp; addressed</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1c. Follow up training on solarization &amp; new storage techniques</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1c. Adoption of drying, threshing, and storage techniques assessed</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1d. Training-of-trainers in bean production initiated</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1d. Training modules compiled into a document and published</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2a. IEC materials translated into local languages</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2a. Extension info., education, &amp; communic. approaches finalized</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2a. Community-based dissemination field days held</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2b. Culinary traits &amp; sensory char. of improved varieties documented</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2b. Communicate culinary traits &amp; sensory char. to breeders</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2c. Strategy developed to promote varieties w/ breeding programs</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2b. Strategy initiated to promote improved bean varieties with public</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2c: Infrastructure to support commercializ. of products at Makerere developed</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Abbreviated name of institutions**

<table>
<thead>
<tr>
<th>Iowa State</th>
<th>Makerere</th>
<th>NaCRRI</th>
<th>VEDCO</th>
<th>KIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/1/12</td>
<td>9/28/12</td>
<td>4/1/12</td>
<td>9/28/12</td>
<td>4/1/12</td>
</tr>
</tbody>
</table>

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26
<table>
<thead>
<tr>
<th>Objective 3</th>
<th>Increase Marketing and Consumption of Beans and Bean Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>3a. Developed protocols up-scaled with private business sector</td>
<td>X</td>
</tr>
<tr>
<td>3b. Marketing strategies for bean products developed and evaluated</td>
<td>X</td>
</tr>
<tr>
<td>3c. Process to document industrial adoption &amp; market perform. initiated</td>
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</tr>
<tr>
<td>3d. Process to eval. impact of indust. adocpt. on farmer livelihoods initiated</td>
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<td>4a. Training M.S. students (FTN &amp; Extension-Innov.) at MAK completed</td>
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<td>4b. Training M.S. student in FST from Rwanda on-going</td>
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<td>4c. Training Ph.D. students at Iowa State University completed</td>
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<tr>
<td>4d. Inter-organizational learning fostered</td>
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<tr>
<td>4e. Results disseminated (conferences, publications, websites)</td>
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<thead>
<tr>
<th>Name of the PI responsible for reporting on benchmarks</th>
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<tr>
<td>Robert Mazur</td>
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<tr>
<td>Dorothy Nakimbugwe</td>
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<tr>
<td>Michael Ugen</td>
</tr>
<tr>
<td>Henry Kizito Musoke</td>
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<td>Hilda Vasanthakaalam</td>
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</tbody>
</table>
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 US and Host Country PIs and Institutions
George Abawi, Cornell; Eduardo Peralta, INIAP-Ecuador; Luis Butare, ISAR-Rwanda; and Sieglinda Snapp, MSU

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 for FY 2012

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 diseases in contrasting bean growth habits for distribution and testing in the highlands of Ecuador, Rwanda and the Midwestern U.S.

Collaborators
Louis Butare and Augustine Musoni – 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-interchange.
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. Initiate selection for diseases resistance under screenhouse inoculation condition at Rubona.
8. 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.
9. Initiate characterization of biofortified lines for Fe and Zn for use as parents in Ecuador and in Rwanda.
10. Evaluate lines and varieties for canning industry in both the field and lab in Ecuador.
11. Continue seed increase of most promising lines in all three countries.
12. Expand on farm trials with advanced lines in Rwanda and Ecuador.
13. 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 from other sources (determined).
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, greenhouse and MAS.
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. Compare and contrast advanced line selection practiced by breeders and farmers in mid-altitude and high agroecological regions in Rwanda
   - Plan genotype by environment farmer participatory assessment of advanced lines within intercrops and sole crops, initiate trials in 2011 and terminate in 2012.
   - On-farm assessment of promising lines conducted in sole crop and intercrop on-farm trials at 8 sites in 2011/12.
2. Evaluation of 17 tests with 17 CIALs each growing cycle in Ecuador.
3. Expand non-conventional and conventional seed production in Ecuador and Rwanda.
4. Release two bush beans and one climbing bean in Ecuador using farmer participatory approach.
5. Continue to provide seed of elite and new varieties for post harvest quality evaluation at KIST.
6. Continue with farmer participatory approaches to identify appropriate and cost-effective innovations for staking climbing beans that would enhance the adoption in Rwanda.
7. 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).
8. Initiate interchange of experience in Rwanda on participatory methods and seed production for local community use with smallholder farmer members anticipated date Feb 2012. Training of trainers (extension, research technicians, NGO staff, expert farmers, seed company technicians) on seed and farming system production, and work with progressive farmers.
9. Draft a manuscript by August 2012 for review at Rwanda workshop and circulate for comment and input by collaborators. Based on initial on-farm assessment in Rwanda and literature review outlining strengths and challenges associated with sole crop vs. intercrop bean based cropping systems, in terms of plant breeding approaches and addressing farm family nutrition.

**Objective:** Institutional Capacity Building (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.

**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 2012
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: September 2012
Type of CRSP Support (full, partial or indirect): Full
If providing Indirect Support, identify source(s) of leveraged funds: U. S. Department of Education's Fulbright-Hays Doctoral Dissertation Research Abroad (DDRA)
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: Short term training for two Nicaraguan trainees in bean breeding at MSU. An invitation has been forwarded to ICTA (att: Aurelio Llano) in Nicaragua to identify two field technicians in the bean program who would benefit from hand-on field selection and harvest of bean breeding trials in Michigan during fall 2011.
Workshops on participatory plant breeding and marker assisted selection (MAS) in Rwanda. The participatory plant breeding workshop will be offered in 2012 upon conclusion of field work in Rwanda by Krista Isaacs in. Dr. Snapp will oversee the workshop.
Description of training activity: Molecular Marker workshop in Rwanda has been delayed due to slow process of procuring lab equipment. It is expected that the lab equipment (thermal cycler, gel boxes, power packs, etc) will be installed in the new germplasm facility at Rubona when it arrives. We propose that Gerardine Mukeshimana could work with Dr. Theodore ASIIMWE the head of Biotechnology unit to conduct the workshop at the lab in Musanze when she returns to Rwanda to conduct field trials. Suggestions on participants would need to be provided by ISAR.
Location: Rubona or Musanze, Rwanda
Duration 4 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:
Equipment: Equipment items for Rwanda and Ecuador may be added if needs arise.
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 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.

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 and reduced 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.


Engagement of USAID Field Mission(s)

Networking Activities with Stakeholders
ISAR, Government Extension, Farmers cooperatives and seed production agencies, radio and TV.
NGOs 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 Borozí Muhanga (IABM) (South), RADA (Development Authority- Country-wide), District and local Government Extension Agents (Country-wide), Musasu Watershed (south), Sogwe Watershed farmers Cooperatives (South), Gakiragi Watershed Cooperative (East), Umutara Polytechnic University (East), IMBARAGA (Umbre area 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.
NGOs 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 HarvestPlus 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).
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<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
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<tbody>
<tr>
<td>Degree Training: Number of individuals who have received degree training</td>
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<tr>
<td>Number of women</td>
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<tr>
<td>Number of men</td>
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<tr>
<td>Short-term Training: Number of individuals who have received short-term training</td>
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<tr>
<td>Number of men</td>
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<tr>
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<tr>
<td>Number of technologies and management practices under research</td>
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<tr>
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<td>Number of policy studies undertaken</td>
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<tr>
<td>Beneficiaries</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
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<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
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<td>Number of producer organizations receiving technical assistance</td>
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<td>Number of trade and business associations receiving technical assistance</td>
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<tr>
<td>Number of community-based organizations receiving technical assistance</td>
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<td>Number of women organizations receiving CRSP technical assistance</td>
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<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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<td>Number of HC partner organizations/institutions benefiting</td>
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**Developmental outcomes:**

| Number of additional hectares under improved technologies or management practices | 27000 |
## Dry Grain Pulses CRSP: THIRD PERIOD

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

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<thead>
<tr>
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<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<td>Cornell Univ.</td>
<td>Ecuador</td>
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### a. Personnel Cost

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### d. Supplies

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### g. Total Direct Cost

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### i. Indirect Cost on Subcontracts (First $25000)

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### j. Total Indirect Cost

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### Total

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<td>$63,077</td>
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### Grand Total

<table>
<thead>
<tr>
<th>Item</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$205,200</td>
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</table>

### Cost Share

<table>
<thead>
<tr>
<th>Item</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-kind</td>
<td>$10,000.00</td>
<td>$8,250.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
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<tr>
<td>Cash</td>
<td>$1,328.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>$10,000.00</td>
<td>$8,250.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
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</table>

### Attribution to Capacity Building

<table>
<thead>
<tr>
<th>Item</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of effort</td>
<td>50.00%</td>
<td>100.00%</td>
<td>25.00%</td>
<td>25.00%</td>
<td>25.00%</td>
<td></td>
</tr>
<tr>
<td>Amount corresponding to effort</td>
<td>$23,938.48</td>
<td>$32,124.00</td>
<td>$8,750.00</td>
<td>$8,750.00</td>
<td>$10,000.00</td>
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</tbody>
</table>

### Total Budget Justification (additions)

Travel for J.D. Kelly and G.S. Abawi to attend the Global PI Meeting in E. Africa in 2012
Non degree field training of two Nicaraguan technicians from INTA at MSU for 1 month

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

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**Objective 1**

<table>
<thead>
<tr>
<th>Andean bean nursery-Increase</th>
<th>x</th>
<th>x</th>
<th>x</th>
<th>x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Andean nursery</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Selection parental lines</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Selection elite lines</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Crossing</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Canning and quality evaluation</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>On farm trials</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Objective 2**

<table>
<thead>
<tr>
<th>Advanced Population development</th>
<th>x</th>
<th>x</th>
<th>x</th>
<th>x</th>
<th>x</th>
<th>x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other population development</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Evaluation for drought and root rot</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Characterize germplasm to root pathogens</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Objective 3**

| Characterize root rot isolates | x | x | x | x | x | x |
| Root Pathogen x germplasm interaction | x | x | x | x | x | x |
| Race characterization-foliar pathogens | x | x | x | x | x | x |
| Complete root rot surveys      | x | x | x | x |
| Greenhouse screening to evaluate pathogenic variability and | |

**Objective 4**

<p>| Evaluation of elite lines in CIALs | x | x |
| Variety releases in Ecuador       | x | x |
| Evaluation of climbing beans      | x | x | x | x |
| Variety releases in Michigan      | x | x | x | x |
| Evaluation of advanced and elite lines with farmer communities in Rwanda | x | x |
| High yield and marketable climbing beans released in Rwanda | x | x |
| Farmer participatory training workshop | x |
| Final report publications, and outreach | x | x | x | x | x |</p>
<table>
<thead>
<tr>
<th>Name of the PI responsible for reporting on benchmarks</th>
<th>James D. Kelly</th>
<th>George Abawi</th>
<th>Louis Butare</th>
<th>Eduardo Peralta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature/Initials:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td></td>
<td></td>
<td></td>
<td>15-Jun-11</td>
</tr>
</tbody>
</table>
PII-MSU-2

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

Lead U.S. Principal Investigator
Richard H. Bernsten, Cynthia Donovan, and Eric Crawford Michigan State University

Collaborating Scientists
David Kiala, University Jose Eduardo dos Santos (formerly known as 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, but 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 risky. 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. More research is needed for cowpeas to understand market effectiveness and efficiency. Initial work indicates low price in the market and low quantity marketed making it less competitive.

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 and cowpeas 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 smallholder farmers in the Planalto region lack marketing strategies to reach those markets and trade organization appears weak, implying high transaction costs. Approximately 36% of households in a recent survey indicated that common beans were the most important source of cash income from crops, with about two-thirds of household production sold, for those households growing beans. There are three key marketing months for beans: January, February and June, while cowpeas seasonality varies. Research is needed to track the beans and cowpeas 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 for beans only. It was not possible to include cowpeas. 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.

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1 At the recommendation of the TMAC, project components in Honduras end September 30, 2011, so there are no FY2012 activities with Honduran colleagues.
Mozambique: In Mozambique, both cowpeas and common beans are marketed 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 FY2011 and then into FY2012.

Some common bean traders have demonstrated innovations to gain efficiencies in their trading, using cell phones and automatic 24-hour banking machines. It is our understanding that these innovations linked with new and traditional marketing channels 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.

Planned Project Activities for FY 2012

Overview: This research will seek to continue our research on markets and the potential for market enhancements for smallholders in Angola and Mozambique. A key aspect will be establishing a data bank with information on beans and cowpeas. In Angola, cowpea information is scarce and will continue to be a challenge.

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.

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2 Bean Task Force may seem a misnomer as it includes cowpeas and common beans, but in Portuguese, it is *Grupo de trabalho de feijão*. The Mozambican phrase for cowpea is *feijão nhemba* and for common bean, the phrase is *feijão manteiga*. 

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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, 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 of beans and cowpeas and leverage points to increase farmer profits and trader volumes.

**Collaborators**
David Tunga, Food Security Department, MINAGRI; Moises Lima and Fabio da Cruz, World Vision PRORENDA project, Huambo.

**Approaches and Methods:** Our Pulse CRSP efforts will focus on understanding the market efficiency within current bean and cowpea 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. This research has focused on common beans as almost no farmers grew cowpeas or marketed cowpeas in the Planalto survey. We will continue to include cowpeas in the market research.

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. A student has been identified that is working in other provinces on cowpeas, since Huambo Province is not a major cowpea production zone. Donovan will lead the market research, and both Kiala and Donovan will participate with an Angolan research assistant and students as well as collaborators in implementing the survey and analyzing the results. Collaboration with other CRSP projects working on varietal development will be developed to help identify market linkages with varieties of high agronomic potential.

**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 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, in collaboration with the PSU team and their IIAM researchers. Development of the Bean Task Force is a critical component to taking the research to the stakeholders and jointly developing value chain modifications to meet market demand. The Bean Task Force will include representatives large scale traders, potential processors (no existing processing in Mozambique), small scale traders, farmer associations, and producers.

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 and Isabel Cachomba, IIAM/CESE; Billy Mwiinga, WFP Mozambique P4P coordinator; Cuan Opperman, TradeHub (USAID/Southern Africa Region); Randy Fleming, Agrifuturo (USAID/Moz).

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. By “action research”, we use the definition provided by Reason and Bradbury (2001): “a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview. It seeks to reconnect action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people” (p.1). To complement the farmer-level research methods used in the Pulse CRSP project, this Phase 2 research makes use of trader interviews. To complement the PSU project with their 8 sites, we will be developing trader research associated with the seed distribution system. 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, as well as to assist other bean-related activities of Pulse CRSP and IIAM researchers, we have assumed that the vehicle for the Northwest Zonal Research Station will be in place for FY2012, to relieve the extreme transport constraints and dispersed production zones and markets.

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) as well as PSU project research with farm communities. 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 radio and cell phone may increase their use, and we will work with the Penn State CRSP project on this aspect.

**Objective 3: Capacity Building**

**Angola:** Estevao Chaves, graduate of UAN, is expected to finish his thesis in late 2011.

Donovan with a CESE staff member from Mozambique will conduct additional training for students at UAN/Huambo as well as IIA concerning partial budgeting. Eric Crawford will conduct a cost/benefit training course for students/faculty.

Two UAN staff/students will travel Mozambique to for training courses on partial budgeting, as well as work with SIMA/CESE on price collection while learning about the MIS system in place.

**Mozambique:** CESE staff member Ana Lidia Gungulo is anticipated to finish her thesis by late 2011 and return to Mozambique.

Staff members of the Center for Socio-Economic Studies (CESE) will receive additional training on data analysis, including household survey analysis with TIA data. Survey research methods and cost benefit courses will be directed to CESE staff members to ensure their ability to respond to needs in bean and other research, but will include Directorate of Economics Staff and possibly other collaborators where appropriate.

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

**Capacity Building: Communication Technology (stemming from extra capacity building funding in FY2011)**

Both Mozambique and Angola have benefited from the Capacity Building project which was developed for computers, cameras, microphones and Camtasia software. Sostino Mocumbi of IIAM and Guilherme Eculica of UAN (UJES) will continue to support enhancement of skills with the technology, as each moves forward developing didactic materials. There is no FY 2012 funding for this area of effort.

**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 will 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 market price system will enable private sector producers, traders, and processors to access current and useful information using cell phone technology.
The policy research will target trade and investment policy actions to improve the efficiency of bean trading as we present the key cost aspects of the trade and identify ways to minimize them.

**Target Outputs**

**Mozambique**

1) Farmers and traders in Mozambique in bean/cowpea marketing zones of Mozambique will have access to market information via radios and cellphones. Working with NGOs including World Vision and ADRA in Zambezia, at least 4,000 farmers will have access by the end of FY2012.

2) Availability of improved seeds and their use will be enhanced through improved communication of seed supply availability using MIS systems.

**Angola**

In Angola, farmers in the Planalto zone working with World Vision extension agents will have access to market price information through cell phones and radios, where possible. Expected population affected would be at least 20% of World Vision’s 27,000 farmers in the Planalto region. Farmers will increase the volume of sales through marketing channels identified as higher price channels.

**Engagement of USAID Field Mission(s)**

**Angola**: The host country and US PI has met and will continue to 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 and staff are invited to outreach activities.

**Mozambique**: The host country and US PI has met and will continue to meet with staff at USAID/Mozambique 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, as well as network effectively with other USAID projects in the region.

**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 (including one women’s based producer association) in the Planalto Region of Angola. Discussions are ongoing with the Farmer to Farmer program sponsored by USAID/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 “Feijão” Task Force moving forward to help develop knowledge on the supply and demand of beans and cowpeas. This Task Force will include work with Agrifuturo (USAID/Mozambique)

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3 The word Feijão in Portuguese covers both beans and peas.
and TradeHub (USAID/Southern Africa). It will also help research to identify the key cropping area and associated varieties for promotion to meet market demands.

**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, as well as training facilities. 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 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.
Training/Capacity Building Workplan

**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 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: IIAM
Thesis Title/Research Area: Expanding Pulse Supply in Mozambique: Identifying Constraints and New Strategies
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 Jose Eduardo dos Santos, Angola
Thesis Title/Research Area: price transmission for common beans in Mozambique: A study of spatial market integration
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: 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 2012
Participants/Beneficiaries of Training Activity: 1 Anticipated numbers of Beneficiaries (male and female) 1 female
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.

Type of training: Price analysis and market efficiency analysis
Description of training activity: Participants will work with data from market rapid appraisal to understand analytical methods and research issues related to marketing costs and margins
Location: Huambo, Angola
Duration: 1 week
When will it occur? January 2012
Participants/Beneficiaries of Training Activity: 12 (12 from UAN/Angola)
Anticipated numbers of Beneficiaries (male and female) 6 women and 6 men
PI/Collaborator responsible for this training activity: Donovan
List other funding sources that will be sought (if any):
Training justification: the training will enable researchers to use the available information to look at markets and margins, and will help design the coming market research. It will provide empirical methods in basic price analysis that can also be used by students in the UAN Program in Angola, as they conduct market research.

Type of training: Partial Budgeting of Agricultural Technologies
Description of training activity: Based on existing training materials, participants will work with examples and complete analysis to understand analytical methods to compare new and existing technologies based on partial budgeting methods
Location: Huambo, Angola
Duration: 1 week
When will it occur? April 2012
Participants/Beneficiaries of Training Activity: 20 (15 from UAN and 5 from IIA)
Anticipated numbers of Beneficiaries (male and female) 10 women and 10 men
PI/Collaborator responsible for this training activity: Donovan with CESE analyst
List other funding sources that will be sought (if any): IIA collaboration in local logistics
Training justification: The analytical approach to technology evaluation will be able to assist IIA in future technology development choices, as well as provide an empirical method appropriate for students in the UAN Program.

Type of training: Partial Budgeting of Agricultural Technologies
Description of training activity: Based on existing training materials, participants will work with examples and complete analysis to understand analytical methods to compare new and existing technologies based on partial budgeting methods
Location: Nampula, Mozambique
Duration: 2 weeks
When will it occur? August 2012
Participants/Beneficiaries of Training Activity: 12 (10 from Northeast Zonal Center and 2 from SPER- Nampula)
Anticipated numbers of Beneficiaries (male and female) 2 women and 10 men
PI/Collaborator responsible for this training activity: Donovan with CESE analyst
List other funding sources that will be sought (if any): IIAM collaboration in local logistics; MSU FSG to share costs
Training justification: The analytical approach to technology evaluation will be able to assist IIAM researchers and extension officials in future technology development choices.

Type of training: Introductory Cost Benefit Analysis for Agricultural Research
Description of training activity: Participants will work with examples and complete analysis to understand analytical methods of cost benefit analysis
Location: Maputo, Mozambique
Duration: 2 weeks
When will it occur? May 2012
15 (CESE and DAP staff members)
Anticipated numbers of Beneficiaries (male and female) 6 women and 9 men
PI/Collaborator responsible for this training activity: Crawford
List other funding sources that will be sought (if any): MSU FSG project
Training justification: Knowledge of the analytical approaches of CBA are valuable tools to assist IIAM analysts in technology evaluation.

Type of training: Market efficiency analysis
Description of training activity: Participants will work with data from market rapid appraisal to understand analytical methods and research issues related to marketing costs and margins
Location: Maputo, Mozambique
Duration: 1 week
When will it occur? January 2012
Participants/Beneficiaries of Training Activity: 17 (2 from UAN/Angola, 10 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 information to look at markets and margins, and will help design the coming market research. It will provide empirical methods that can also be used by students in the UAN Program in Angola, as they conduct market research.

Type of training: Survey research methods (delayed from FY2011)
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 2012
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

Equipment (costing >$5,000): None
### Output Indicators

<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
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<tbody>
<tr>
<td>(Oct 1 2011 - Sept 28, 2012)</td>
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<tr>
<td><strong>Degree Training: Number of individuals who have received degree training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>1</td>
<td></td>
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<tr>
<td>Number of men</td>
<td>1</td>
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<tr>
<td><strong>Short-term Training: Number of individuals who have received short-term training</strong></td>
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<tr>
<td>Number of men</td>
<td>30</td>
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<tr>
<td><strong>Technologies and Policies</strong></td>
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<tr>
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<tr>
<td>Number of technologies and management practices under field testing</td>
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<td>Number of technologies and management practices made available for transfer</td>
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<tr>
<td>Number of policy studies undertaken</td>
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<tr>
<td><strong>Beneficiaries:</strong></td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
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<tr>
<td>Number of agriculture-related firms benefiting from CRSP supported interventions</td>
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<tr>
<td>Number of producer organizations receiving technical assistance</td>
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<tr>
<td>Number of trade and business associations receiving technical assistance</td>
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<tr>
<td>Number of community-based organizations receiving technical assistance</td>
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<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
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<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
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<tr>
<td><strong>Developmental outcomes:</strong></td>
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<td></td>
</tr>
<tr>
<td>Number of additional hectares under improved technologies or management practices</td>
<td>100</td>
<td></td>
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## Dry Grain Pulses CRSP: SECOND PERIOD

**Project Title:** Project Title: Expanding Bean Supply & Demand in Africa & Latin America  
**Period:** 10/01/11 - 09/30/12

<table>
<thead>
<tr>
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<th>MSU</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>HC or U.S. Institution (5)</th>
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<tr>
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<td>Salaries</td>
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<td>d. Supplies</td>
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<td>e. Training</td>
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<td>$6,619</td>
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<td>f. Other</td>
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<td>g. Total Direct Cost</td>
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<td>$3,000</td>
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<td>h. Indirect Cost</td>
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<td>i. Indirect Cost on Subcontracts (First $25000)</td>
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<td>$0</td>
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<td>j. Total Indirect Cost</td>
<td>$16,777</td>
<td>$1,560</td>
<td>$0</td>
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<td>$4,560</td>
<td>$20,260</td>
<td>$36,040</td>
<td>$0</td>
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<td>$6,538</td>
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<td>Grand Total</td>
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<td>$101,720</td>
<td>$101,720</td>
<td>$101,720</td>
<td>$40.6%</td>
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<tr>
<td>Total direct cost budgeted for H.C institution(s)</td>
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<td>$21,337</td>
<td>$21,337</td>
<td>$21,337</td>
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<td>40.7%</td>
<td>59.3%</td>
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### Cost Share (25% MSU)

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<th>Cost Share (25% MSU)</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>HC or U.S. Institution (5)</th>
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<td>In-kind</td>
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<td>$12,260</td>
<td>$12,260</td>
<td>$12,260</td>
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<tr>
<td>Cash</td>
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<td></td>
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<td></td>
<td>0</td>
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<tr>
<td>Total</td>
<td>$12,260</td>
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<td>$12,260</td>
<td>$12,260</td>
<td>$12,260</td>
<td>$12,260</td>
<td>$12,260</td>
<td>$12,260</td>
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</table>

### Attribution to Capacity Building

| Percentage of effort | 10.0% | 100.0% | 43.0% | 52.0% | 100.0% | 100.0% | 40.7% |
| Amount corresponding to effort | $4,904 | $4,560 | $6,712 | $18,741 | $0 | $6,619 | $6,538 | $50,074 |

Total Cost Share: 25% MSU = $12,260

Total Attribution to Capacity Building: 10.0% = $4,904

Total Amount Corresponding to Effort: 40.7% = $50,074
Dry Grain Pulses CRSP  
Research, Training and Outreach Workplans  
(October 1, 2011 -- September 28, 2012)

FY 2012 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

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

<table>
<thead>
<tr>
<th>Identify Benchmark Indicators by Objectives</th>
<th>Abbreviated name of institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MSU</td>
</tr>
<tr>
<td></td>
<td>4/1/12</td>
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</tbody>
</table>

Objective 1: Angola

Specific Obj: 1. Identify efficiency in marketing channels & leverage points to increase farmer profits & trader volumes

<table>
<thead>
<tr>
<th></th>
<th>MSU</th>
<th>UJES (UAN)</th>
<th>IIAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid appraisal field research in common bean markets conducted with students</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>Rapid appraisal field research in cowpea markets conducted with students</td>
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<td></td>
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<tr>
<td>Common bean market efficiency report drafted and distributed</td>
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<tr>
<td>Outreach with farmer associations and local agencies</td>
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Objective 2: Mozambique

Specific Obj 1. Identify efficiency in marketing channels & leverage points to increase farmer profits & trader volumes

<table>
<thead>
<tr>
<th></th>
<th>MSU</th>
<th>UJES (UAN)</th>
<th>IIAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report on Rapid Appraisal Survey 2012 finalized and distributed</td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>Outreach on Rapid Appraisal Survey 2012 results with NGOs and farmer orgs.</td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>Market efficiency report drafted and distributed</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outreach to Bean Task Force on marketing efficiency preliminary results</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Specific Objective 2. Develop cellphone-based information system for beans, to link farmers & traders to market prices & availability

<table>
<thead>
<tr>
<th></th>
<th>MSU</th>
<th>UJES (UAN)</th>
<th>IIAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell phone system training for bean producer groups</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary assessment of use of cell phone system</td>
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<td>x</td>
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Objective 4: Capacity Building

Angola
<table>
<thead>
<tr>
<th>Activity</th>
<th>Mozambique</th>
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<tbody>
<tr>
<td>MS thesis finalized</td>
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<tr>
<td>Outreach on MS thesis research</td>
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</tr>
<tr>
<td>Students trained on price and market analysis</td>
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</tr>
<tr>
<td>Students trained on partial budgeting analysis</td>
<td>x</td>
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</table>

CESE staff trained on:
- Survey research
- Market efficiency analysis
- Partial budgeting analysis
- Cost Benefit analysis

CESE staff completes Intensive English course: x

**Name of the PI responsible for reporting on benchmarks**

<table>
<thead>
<tr>
<th>Donovan</th>
<th>Donovan-Kiala</th>
<th>Donovan-Mazuze</th>
</tr>
</thead>
</table>

**Signature/Initials:**

**Date:**
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 and Institutions
Kathleen Brown, PSU, USA
Rowland 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 for FY 2012**

- **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
Rowland 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 FY11, including the testing of a set of small red inbred backcross (IB) lines (Amadeus 77 background) in farmer’s fields to validate the multiline approach and the value of specific root traits under low fertility and drought conditions. The results of field trials conducted in FY11 will be used to determine if single lines or multiline will provide better yield stability under a varying drought/low fertility conditions encountered by small farmers in Central America.

A second year of testing for BNF of a set of drought/low fertility tolerant lines at Zamorano, including three *Rhizobium* inoculated treatments with strains CIAT 899 (*R. tropici*), CIAT 632 (*R. etli*) and UPR201 (*R. leguminosarum*), and an uninoculated treatment, will be conducted to determine the relationship of greater nodulation and nitrogen fixation with specific root traits, plant growth and seed yield under stressed field conditions.

During FY12 new 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 in at least six countries members of the CA/C Bean Research Network. In addition, promising tolerant lines identified in previous years will be validated and released in Honduras and at least one additional country during FY12.

A set of IB small red lines with Amadeus type developed for Central America will be tested by IIAM researchers using the multiline approach. PVS approaches will be used for testing of promising lines with active participation of farmer groups and assistance from Zamorano. Validation trials with superior IB lines developed in crosses with four different landraces (Paraisito, Cincuenteño, Marciano and Rojo de Seda) will be continue in FY12, and at least one IB line will be released as improved landrace cultivar. These IB lines have the superior adaptation to drought and low fertility conditions from their elite recurrent parents (Amadeus 77, Tio Canela 75, DEORHO and others), and the desirable small red seed type from their donor landrace cultivars. Some of these lines will be tested in on-farm validation trials in Nicaragua and El Salvador.

Collaboration with researchers from the UPR/Beaver DGPC breeding project and CIAT bean breeder (S. Beebe) and physiologist (I. Rao) will continue to be very active thru the distribution and exchange of improved germplasm through the CA/C Bean Research Network under EAP leadership. Participation of Zamorano as the Central America-HC in the UPR/Beaver DGPC project will continue during FY12. Collaboration with CIAT will be as members of the Bean Research Network, and under ongoing and future research projects to be initiated during FY12. During FY12, Zamorano will continue to prepare and distribute the ERSAT trials (one small red and one small black) which include the best drought, heat and low fertility cultivars and advanced lines developed in collaboration with the National Bean Research programs, CIAT and the UPR/Beaver DGPC project.

Mozambique
1) Evaluation and selection of bean genotypes
In 2012 we will continue field testing of P efficient and drought tolerant genotypes identified previously for yield performance and adaptability. Results from the 2011 experiments will be used to select superior genotypes or lines for advanced trials and evaluations under farmer’s conditions in different bean growing sites.

The F6 lines derived from F5 and other F4, F5 lines will be tested for yield performance and adaptability in different locations and to confirm results from previous year. At this point promising lines will be identified and distributed to our collaborators (NGOs and Extension services, farmer groups and associations) for evaluation using PVS approach. The National common bean program will also have access to promising lines for on-farm testing in other relevant bean growing sites.

In addition, we will continue to evaluate (2nd year) bean genotypes that will receive from our project collaborators from Honduras, Angola, Puerto Rico and Ecuador. The bean genotypes to be evaluated included small blacks, red mottled, lines developed for drought tolerance, low P and low N conditions and disease resistance.

2) Development of bean genotypes and introgression of root traits suitable for low P and drought conditions
In FY 2012 we will continue conducting crosses using parents with root traits suitable for low P soils and tolerance to drought that will be identified in 2011. The root traits under consideration for parent selection include root whorl number, basal root number, basal root angle, adventitious root number and length, and primary root length. The other trait used in previous crosses was root hair, and if we identify superior lines with seed traits preferred by farmers we will include this group of lines as well.

3) Advance generations of populations created in 2011
Populations developed from different crosses in 2011 will be advanced for next generations. The offspring that will be generated from crosses of parents contrasting in number of whorl and basal roots as well other root traits referred previously will be advanced for F2 generation. The late generations will be evaluated for selection of genotypes with root traits adapted to low P. These selected genotypes will then be evaluated yield performance. We will also have crosses to develop bean genotypes adapted to drought tolerance with deeper roots. The developed populations will also be advanced to F2, and advanced populations or lines will be screened for root traits adapted to drought and evaluations for yield performance of advanced generations will be conducted under drought stress in Chokwe.

4) Seed increase/multiplication
Seed increase is a routine activity to maintain the germplasm and guarantee availability of seed of selected genotypes and promising lines. After selection of superior lines we will need to increase their seed to be distributed to our research collaborators for testing with farmers. We will increase seed of selected genotypes and promising lines for on-farm evaluations in different bean growing locations.

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 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 Chówke 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 Conduct, in Sussundenga, Gurue and Lichinga, a multiple-season field experiment to determine available P release from rock P and lime effects, and incubation time effects on bean growth and yield. These experiments will use the indicative results from pot experiments from 2011 results. It is well known that the RP effects on crop growth and yield are not immediate. Therefore, research on the efficacy of RP requires 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 an alternative for P amendment to improve yields. These experiments are expected to continue beyond 2012. The results of our work may create business opportunities for rock P mining and marketing since the fertilizers are not available in remote areas due to poor infrastructure.

2.6 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 Continue to 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.

3.2 Conduct farm household surveys among men and women farmers, across research sites at Gurue, Angonia, Lichinga and Sussundenga. (This activity will be conducted as early as possible, potentially starting in year 1).

3.3 Code and clean *ex post* data.

3.4 Conduct statistical and multivariate analyses and simulations of impacts. Draft papers, including policy paper on seed systems.

**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**

*Formal M.S. degree training for two IIAM (Mozambique) scientists 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 lab equipment crucial for tissue analysis at Sussundenga research station. In the next phase, we plan to acquire several lab equipment and 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 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 Research programs of Central America, the Caribbean and Ecuador, as part of the previous Bean/Cowpea CRSP and the current DGPC. 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 inoculants 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, the 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:**

Seed of the multiline with Amadeus 77 type is distributed for commercial testing in Honduras.

At least one small red IB line tolerant to drought and low fertility will be released as cultivar in Honduras and/or other CA country during FY12.

In collaboration with the UPR/Beaver DGPC project, *Rhizobium* inoculation and organic fertilizer will be used by small farmers from CIALs in Honduras to improve their bean crop nutrition and seed yield. Drought/low fertility tolerant and disease resistance IB lines from other commercial small reds (DEORHO, Cardenal) and blacks (Aifi Wuriti, Azabache 40) cultivars are developed for testing based on the results obtained from the Amadeus multilines.

At least 15 drought/low fertility tolerant advanced lines developed for the project in collaboration with the UPR/Beaver DGPC and CIAT breeding programs, other than those included in FY11, 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 additional promising lines and germplasm from EAP, UPR/Beaver DGPC and CIAT will be sent to researchers of IIAM for testing in Mozambique.

**Mozambique:**

At least 20 bean lines with root traits adapted to low P conditions and tolerant to drought will be identified.

At least 5 bean lines tolerant to drought and 5 lines adapted to low P conditions and adapted to Mozambique will be identified, and the seed of these lines will be multiplied. Potential lines to be released as new varieties will be identified.

Seed of early and advanced generations of crosses different crosses will be increased and new crosses with other parents selected in 2011 will be performed.

Seed of promising bean genotypes will be multiplied and made available for our local collaborators.

**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: Additional PVS conducted across research sites.
Completion of ex post survey.
Coded and cleaned survey data set available.
Completion of report on farmer preferences, constraints, impacts.
Completion of report comparing ex ante/ex post situations.
Simulation of total impacts in bean-growing regions, under alternative scenarios.
Policy paper on seed systems submitted to journal.
Economic and social network paper(s) submitted to journal(s).

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 is in Maputo we will attempt to meet with USAID staff to brief them of our activities and progress, annually if their availability and interest permits.

Networking Activities with Stakeholders
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, 12 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 2011-12.

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 local 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 technologies. 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.

**Outreach/Impact in Mozambique:** 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 Nampula, 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.

The project will also encourage farmers to organize 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

**PERFORMANCE INDICATORS/TARGETS for FY 12**  
*(October 1, 2011 -- September 30, 2012)*

<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>PII-PSU-1</th>
<th>2012 Target</th>
<th>2012 Actual</th>
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<tr>
<td><strong>Degree Training: Number of individuals who have received degree training</strong></td>
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<td></td>
</tr>
<tr>
<td>Number of women</td>
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<tr>
<td>Number of men</td>
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<td><strong>Short-term Training: Number of individuals who have received short-term training</strong></td>
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<td>Number of men</td>
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<td><strong>Technologies and Policies</strong></td>
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<td>Number of technologies and management practices under field testing</td>
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<td>Number of technologies and management practices made available for transfer</td>
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<td>Number of policy studies undertaken</td>
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<tr>
<td><strong>Beneficiaries:</strong></td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
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<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
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<td>Number of producer organizations receiving technical assistance</td>
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<td>Number of trade and business associations receiving technical assistance</td>
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<td>Number of community-based organizations receiving technical assistance</td>
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<td>Number of women organizations receiving CRSP technical assistance</td>
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<td>Number of HC partner organizations/institutions benefiting</td>
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<td><strong>Developmental outcomes:</strong></td>
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<tr>
<td>Number of additional hectares under improved technologies or management practices</td>
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<td>5125</td>
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</tbody>
</table>

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## Dry Grain Pulses CRSP

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

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>EAP</th>
<th>IIAM</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<td><strong>c. Equipment ($5000 Plus)</strong></td>
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<td><strong>f. Other</strong></td>
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<td><strong>i. Indirect Cost on Subcontracts (First $25000)</strong></td>
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<td><strong>j. Total Indirect Cost</strong></td>
<td>$15,615.73</td>
<td>$23,211.27</td>
<td>$4,000.00</td>
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<td><strong>Total</strong></td>
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<td><strong>Grand Total</strong></td>
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| Total direct cost budgeted for U.S. institution(s) | $48,148.51 |
| Total direct cost budgeted for H.C institution(s) | $144,311.05 |

### Cost Share

<table>
<thead>
<tr>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>EAP</th>
<th>IIAM</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tbody>
<tr>
<td><strong>In-kind</strong></td>
<td>$83,491.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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<tr>
<td><strong>Cash</strong></td>
<td>$0.00</td>
<td>$63,491.00</td>
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<td><strong>Total</strong></td>
<td>$83,491.00</td>
<td>$63,491.00</td>
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</table>

### Attribution to Capacity Building

<table>
<thead>
<tr>
<th>Percentage of effort</th>
<th>80.00%</th>
<th>100.00%</th>
<th>50.00%</th>
<th>50.00%</th>
<th>50.00%</th>
<th>80.00%</th>
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<tbody>
<tr>
<td>Amount corresponding to effort</td>
<td>$38,518.61</td>
<td>$38,518.61</td>
<td>$15,000.00</td>
<td>$13,750.00</td>
<td>$0.00</td>
<td>$154,079.86</td>
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U.S Institution PI: Jonathan P. Lynch

Authorized Institutional Approval:
**Project Title:** Improving bean production in drought-prone, low fertility soils of Africa and Latin America - An integrated approach.

<table>
<thead>
<tr>
<th>Identify Benchmark Indicators by Objectives</th>
<th>EAP</th>
<th>IIAM</th>
<th>PSU</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>4/1/12</td>
<td>9/28/12</td>
<td>4/1/12</td>
</tr>
</tbody>
</table>

**Objective 1: Breeding**

**Honduras**

- Testing IB lines- Drought/low P: x x
- Testing lines/cultivars- BNF: x x
- Tolerant lines in regional trials: x x
- Develop new improved lines: x x
- Conduct on-farm trials: x x
- Lines sent to IIA: x

**Mozambique**

- Evaluation and selection of bean genotypes: x x
- Development of bean genotypes and introgression of root traits: x x
- Introgression of root traits: x
- Advance generations of populations created in 2011: x x
- Seed increase/multiplication: x x

**Objective 2: Integrated Crop Management**

- Obtain and grind local RP: x
- Field study: moisture conservation/drought tolerant genotypes: x
- On farm demo of moisture conservation/new genotypes: x
- Pot evaluation of RP: x
- Field evaluation of RP: x

**Objective 3: Socioeconomics**

- Conduct PVS: x
- Farm household surveys: x
- Code and clean ex post data: x
- Analyze data: x
## Objective 4: Capacity building

<table>
<thead>
<tr>
<th>Activity</th>
<th>S Camilo</th>
<th>Venancio Salagua</th>
<th>PVS and MAS at EAP</th>
<th>IIAM</th>
<th>EAP</th>
<th>Root research methods</th>
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<tr>
<td>MS degree training</td>
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<tr>
<td>nondegree training</td>
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<td>strengthen research infrastructure at IIAM</td>
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<tr>
<td>strengthen research and training capacity at EAP</td>
<td>x</td>
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<tr>
<td>multilingual web delivery of root research methods</td>
<td>x</td>
<td></td>
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### Name of the PI responsible for reporting on benchmarks

<table>
<thead>
<tr>
<th>J.C. Rosas</th>
<th>M Miguel</th>
<th>JP Lynch</th>
</tr>
</thead>
</table>

### Signature/Initials:

<table>
<thead>
<tr>
<th>JCR</th>
<th>JPL</th>
</tr>
</thead>
</table>

### Date:

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

Lead U.S. Principle Investigator and University:
Philip Roberts - UC-R

Collaborating Host Country and U.S. PIs and Institutions:
Ndiaga Cisse, ISRA, Senegal
Jeff Ehlers, UC-R, U.S.
Issa Drabo, INERA, Burkina Faso
António Chicapa Dovala, IIA, Angola

I. 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 Cotonou, 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).

II. Planned Project Activities for October 1, 2011 - September 28, 2012

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). Results from yield tests conducted during the 2010 growing season
indicated that all-white line 07-11-557 yielded as well and possibly better than standard varieties
CB46 and CB50 and we plan to move forward with development of pure Breeder Seed of 07-11-557
during the current workplan period. The performance of P-87 was less impressive in both
2009 and 2010 and we are not intending to release it at this time. Similarly, persistent green line
03-11-350 had yields significantly lower than standard check variety CB46 and other advanced
blackeye breeding lines so also does not appear to warrant release. Fortunately a new series of
advanced blackeye and persistent green lines developed by this project are being evaluated in
preliminary trials during the 2011 field season (discussed below).

Table 1. Varietal candidate lines

<table>
<thead>
<tr>
<th>Candidate Line</th>
<th>Developing Institution</th>
<th>Releasing Institution</th>
<th>Type</th>
<th>Steps Needed in Workplan Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-11-557</td>
<td>UCR</td>
<td>UCR</td>
<td>All-white</td>
<td>On-farm tests; Breeder and Foundation Seed increase</td>
</tr>
<tr>
<td>IT98K-1111-1</td>
<td>IITA</td>
<td>INERA</td>
<td>White</td>
<td>On-farm evaluation final tests</td>
</tr>
<tr>
<td>KVx 442-3-25G</td>
<td>INERA</td>
<td>INERA</td>
<td>White</td>
<td>Release</td>
</tr>
<tr>
<td>KVx 775-33-2</td>
<td>INERA</td>
<td>INERA</td>
<td>White</td>
<td>Release</td>
</tr>
<tr>
<td>ISRA-3211, ISRA-3217, ISRA-3178, ISRA-3201</td>
<td>ISRA-UCR</td>
<td>ISRA</td>
<td>White, large seeded; early–medium maturing</td>
<td>Demonstration farm-trials with 4 selected lines</td>
</tr>
</tbody>
</table>
In Burkina Faso, field demonstrations of the new released lines indicated in Table 1 will be conducted in the main regions of cowpea production during FY12. In Senegal, the indicated ISRA lines, focused on large-seeded types, will be grown in 20 demonstration trials during FY11, and this will be repeated for a second year of on-farm demonstration trials in main season FY12. This should complete the performance data required for the formal release. 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 m²) to allow mechanical planting. Yield, diseases and insects incidence will be recorded.

In Angola, cowpea field evaluations have been and will be conducted at 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 2010 trials include 28 CRSP core entries, plus 10 local cowpea types, from which a subset of 15 were chosen for further evaluations. The set of 36 Angolan cowpea selections being evaluated by Angolan student Antonio David in Puerto Rico with Drs Beaver and Porch will be included in future 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. Plantings of these CRSP Core and local genotypes are planned for both 2011 and 2012 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). Current 2011 trials of the 15 selected CRSP Core materials from UCR are being damaged by Ascochyta diseases and pests in Humpata, Cela, Alto Capaca, Mazozo and Calussinga field sites. For the FY12 workplan, new plantings are planned for July in Mazozo, August in Chianga and Cela, and October in Alto Capaca Humpata, Calussinga and Chitembo/Bié. 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 2011 at the start of the FY12 workplan period, to aid in the coordination of these activities. Under the current 2011 workplan, the Angolan materials have been 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, all-white line (07-11-557) was/is being tested in on-station trials in 2010 and 2011. If yields in the FY11 trials continue to be in line as current check blackeye varieties, large-scale strip trials will be conducted in 2012 and we will move forward with plans to release this line. A ‘fast-track’ release protocol will be followed to accommodate the needs of potential licensees for this variety to make it available as quickly as possible (Table 1). We will be able to do this because this variety represents a new grain type that does not have existing standard varieties for comparison in the formal release process. In anticipation of release, the initial purification and multiplication of Breeder Seed of 07-11-557 will be produced by the end of the workplan period.

Also, the highest performing lines from among 20 new advanced dry-green breeding lines being evaluated in FY11(Table 2) and 3 all-white lines will be evaluated in large-scale replicated trials at two locations. Earlier generation lines (F5) selected in 2010 that are derived from 26 new crosses involving the 12 promising green lines (see Table 3), will be evaluated in nurseries and
selections made for replicated testing in 2012. Now that the high-throughput marker genotyping capability is developed, a promising planned approach to expedite selection will include 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 being tested in replicated on-station trials in 2011, and, for the best performers, in 2012. Many of these have also been used in crosses to generate new lines.

<table>
<thead>
<tr>
<th>No.</th>
<th>Line</th>
<th>Pedigree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>08-11-49</td>
<td>01-11-880/01-11-941</td>
</tr>
<tr>
<td>2</td>
<td>08-11-78</td>
<td>01-11-900/01-11-846</td>
</tr>
<tr>
<td>3</td>
<td>08-11-91</td>
<td>CB27/00-11-426-2</td>
</tr>
<tr>
<td>4</td>
<td>08-11-103-1</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>5</td>
<td>08-11-103-2</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>6</td>
<td>08-11-103-3</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>7</td>
<td>08-11-112</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>8</td>
<td>08-11-128</td>
<td>04087F$_{3}$-2-1-2/CB27</td>
</tr>
<tr>
<td>9</td>
<td>08-11-140</td>
<td>03-15-293-1-3/03-15-263-1-4</td>
</tr>
<tr>
<td>10</td>
<td>08-11-149-1</td>
<td>03-11-77-2-3/03-11-25-2-6</td>
</tr>
<tr>
<td>11</td>
<td>08-11-149-2</td>
<td>03-11-77-2-3/03-11-25-2-6</td>
</tr>
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<td>12</td>
<td>08-11-149-3</td>
<td>03-11-77-2-3/03-11-25-2-6</td>
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<td>08-11-149-4</td>
<td>03-11-77-2-3/03-11-25-2-6</td>
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<td>03-11-77-2-3/03-11-25-2-6</td>
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<td>15</td>
<td>08-11-153</td>
<td>03-15-293-1-3/03-15-263-1-4</td>
</tr>
<tr>
<td>16</td>
<td>08-11-187-1</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>17</td>
<td>08-11-187-2</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>18</td>
<td>08-11-187-3</td>
<td>01-11-880/01-11-100</td>
</tr>
<tr>
<td>19</td>
<td>08-11-70-1</td>
<td>00-11-426-2/00-11-762-6</td>
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<tr>
<td>20</td>
<td>08-11-70-2</td>
<td>00-11-426-2/00-11-762-6</td>
</tr>
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</table>
Table 3. Crosses made and advanced for selection of improved dry green varieties

<table>
<thead>
<tr>
<th>Number</th>
<th>Cross Number</th>
<th>Pedigree</th>
<th>Type</th>
<th>Current Generation</th>
<th>2011</th>
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</thead>
<tbody>
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<td>1</td>
<td>2009-013</td>
<td>08-11-70-1 x 08-11-154</td>
<td>Green x Green</td>
<td>F₃</td>
<td>F₄</td>
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<tr>
<td>2</td>
<td>2009-014</td>
<td>08-11-111 x 08-11-154</td>
<td>Green x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>3</td>
<td>2009-015</td>
<td>08-11-153 x 08-11-110</td>
<td>Green x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>4</td>
<td>2009-016</td>
<td>08-11-187-3 x 08-11-65</td>
<td>Green x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>5</td>
<td>2009-017</td>
<td>CB46 x 07-11-350</td>
<td>Blackeye x Green</td>
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<td>F₄</td>
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<tr>
<td>6</td>
<td>2009-018</td>
<td>CB46 x 08-11-70-1</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
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<td>7</td>
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<td>CB46 x 08-11-91</td>
<td>Blackeye x Green</td>
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<td>F₄</td>
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<tr>
<td>8</td>
<td>2009-020</td>
<td>CB46 x 08-11-187-2</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>9</td>
<td>2009-021</td>
<td>07-11-350 x CB46</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>10</td>
<td>2009-023</td>
<td>CB50 x 08-11-49</td>
<td>Blackeye x Green</td>
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<td>F₄</td>
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<td>11</td>
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<td>F₄</td>
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<tr>
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<td>F₄</td>
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<td>F₄</td>
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<tr>
<td>14</td>
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<td>CB50 x 08-11-140</td>
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<td>F₄</td>
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<tr>
<td>15</td>
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<td>CB50 x 08-11-186</td>
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<td>F₄</td>
</tr>
<tr>
<td>16</td>
<td>2009-029</td>
<td>08-11-70-1 x CB50</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>17</td>
<td>2009-030</td>
<td>08-11-78 x CB50</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>18</td>
<td>2009-031</td>
<td>08-11-103 x CB50</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>19</td>
<td>2009-032</td>
<td>08-11-106 x CB50</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>20</td>
<td>2009-033</td>
<td>08-11-187-3 x CB50</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>21</td>
<td>2009-034</td>
<td>CB46 x 02053F1</td>
<td>Blackeye x Green</td>
<td>BC₁F₃</td>
<td>BC₁F₄</td>
</tr>
<tr>
<td>22</td>
<td>2009-035</td>
<td>CB50 x 02053F1</td>
<td>Blackeye x Green</td>
<td>BC₁F₃</td>
<td>BC₁F₄</td>
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<tr>
<td>23</td>
<td>2009-036</td>
<td>02053F1 x 07-11-350</td>
<td>Blackeye x Green</td>
<td>BC₁F₃</td>
<td>BC₁F₄</td>
</tr>
<tr>
<td>24</td>
<td>2009-037</td>
<td>02053F1 x 02082F1</td>
<td>Blackeye x Green</td>
<td>BC₁F₃</td>
<td>BC₁F₄</td>
</tr>
<tr>
<td>25</td>
<td>2009-038</td>
<td>CB46 x G7471</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
<tr>
<td>26</td>
<td>2009-040</td>
<td>CB50 x G749-1</td>
<td>Blackeye x Green</td>
<td>F₃</td>
<td>F₄</td>
</tr>
</tbody>
</table>

In California: Continued development and testing of new elite blackeye lines. Replicated trials will be conducted with approximately 8 new advanced blackeye breeding lines that will be selected from among lines being tested in replicated preliminary trials during the 2011 season (Table 4). These breeding lines were derived from selections among F₇ breeding lines made in 2009, originally being derived from crosses between selected promising breeding lines and CB46, CB50, and/or cultivar CB27 (Table 4). We are also breeding an improved version of CB46 with greater resistance to root-knot nematodes derived from IITA breeding line IT84S-2049 (Table 4). Line CB46-57Rk² is an advanced (BC₆) backcross-derived breeding line closely...
resembling CB46 that has greater resistance to root-knot nematodes, but that has smaller grain size than CB46. In trials conducted in 2010, this line had equal or greater yields than CB46. A breeding nursery with several hundred F5 generation blackeye breeding lines will also be conducted with early generation lines developed from crosses between blackeyes and advanced lines in the current preliminary yield trial (Table 5). One or more of these varieties may be advanced to candidacy for release by the end of the workplan period if their performance justifies release.

Table 4. New advanced blackeye breeding lines included in replicated preliminary tests being conducted during the 2011 season. Selected lines will be included in replicated tests in 2012.

<table>
<thead>
<tr>
<th>2010 Selection</th>
<th>2009 Origin</th>
<th>Pedigree</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-4</td>
<td>09Sh13-2</td>
<td>CB27/CB50</td>
<td>Yield, grain quality, resistance to Races 3 and 4 Fusarium wilt</td>
</tr>
<tr>
<td>2010-10</td>
<td>09Sh13-4</td>
<td>CB27/CB50</td>
<td>Yield, grain quality, resistance to Races 3 and 4 Fusarium wilt</td>
</tr>
<tr>
<td>2010-19</td>
<td>09Sh13-9</td>
<td>CB27/CB50</td>
<td>Yield, grain quality, resistance to Races 3 and 4 Fusarium wilt</td>
</tr>
<tr>
<td>2010-23</td>
<td>09Sh13-11</td>
<td>CB27/CB50</td>
<td>Yield, grain quality, resistance to Races 3 and 4 Fusarium wilt</td>
</tr>
<tr>
<td>2010-25</td>
<td>09Sh31-1</td>
<td>Sh 65/UCR53</td>
<td>Long maturity, extra high yield</td>
</tr>
<tr>
<td>2010-27</td>
<td>09Sh31-8</td>
<td>Sh 65/UCR53</td>
<td>Long maturity, extra high yield</td>
</tr>
<tr>
<td>2010-29</td>
<td>09Sh31-9</td>
<td>Sh 65/UCR53</td>
<td>Long maturity, extra high yield</td>
</tr>
<tr>
<td>2010-35</td>
<td>09Sh34-2</td>
<td>Sh 65/UCR53</td>
<td>Long maturity, extra high yield</td>
</tr>
<tr>
<td>2010-77</td>
<td>Greenhouse</td>
<td>CB27/CB5//CB5^2-7-2-3</td>
<td>CB5-type with resistance to Fusarium wilt Races 3 and 4</td>
</tr>
<tr>
<td>2010-83</td>
<td>Greenhouse</td>
<td>CB27/CB5//CB5^2-9-1-1</td>
<td>CB5-type with resistance to Fusarium wilt Races 3 and 4</td>
</tr>
<tr>
<td>2010-115</td>
<td>Greenhouse</td>
<td>CB27/CB5//CB5^2-70-1-1</td>
<td>CB5-type with resistance to Fusarium wilt Races 3 and 4</td>
</tr>
<tr>
<td>2010-121</td>
<td>Greenhouse</td>
<td>CB27/CB5//CB5^2-7-2-4</td>
<td>CB5-type with resistance to Fusarium wilt Races 3 and 4</td>
</tr>
<tr>
<td>CB46Rk2</td>
<td>Prelim. Test</td>
<td>CB46/IT84S-2049//CB46^6</td>
<td>CB46-type with improved root-knot nematode resistance and small grain size</td>
</tr>
</tbody>
</table>
Table 5. Crosses for development of high yielding, pest resistant blackeye cowpea cultivars.

<table>
<thead>
<tr>
<th>Cross No.</th>
<th>Blackeye Crosses</th>
<th>Current Generation</th>
<th>Generation in 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-066</td>
<td>CB46 x 09Sh-3-2</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-067</td>
<td>CB46 x 09Sh-3-4 sps</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-068</td>
<td>CB46 x 09Sh-3-6sp</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-069</td>
<td>CB46 x 09Sh-13-6</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-070</td>
<td>CB46 x 09Sh-36-2</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-071</td>
<td>CB46 x 09Sh-93-3</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-072</td>
<td>CB46 x 09Sh-105-2</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-073</td>
<td>CB46 x 09Sh-112-6</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-074</td>
<td>CB27 x 09Sh-13-6</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-075</td>
<td>09Sh-93-3 x CB27</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-076</td>
<td>09Sh-113-6 x CB27</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-077</td>
<td>524B x 09Sh-13-1</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-078</td>
<td>524B x 09Sh-13-6</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-079</td>
<td>524B x 09Sh-31-1</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-080</td>
<td>524B x 09Sh-36-8</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-081</td>
<td>524B x 09Sh-113-10</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-082</td>
<td>09Sh-95-8 x 09Sh-13-7</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-083</td>
<td>09Sh-36-6 x 09Sh-109-2</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-084</td>
<td>09Sh-95-8 x 09Sh-113-12</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-085</td>
<td>09Sh-113-4 x 09Sh-95-8</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-086</td>
<td>09Sh-113-4 x 09Sh-3-6 sps</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-087</td>
<td>09Sh-113-5 x 09Sh-13-6</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-088</td>
<td>09Sh-113-5 x 09Sh-31-10</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-089</td>
<td>09Sh-113-5 x 09Sh-36-6</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-090</td>
<td>09Sh-113-4 x 09Sh-93-1</td>
<td>F₃</td>
<td>F₅</td>
</tr>
<tr>
<td>2010-091</td>
<td>09Sh-113-1 x 09Sh-93-3</td>
<td>F₃</td>
<td>F₅</td>
</tr>
</tbody>
</table>

In California - Development of lygus bug and aphid resistant varieties: New lygus resistant breeding lines have been developed that are being tested in trials with insect protected and unprotected treatments in FY11 (Table 6). In FY12, a subset of these lines will be selected based on their performance in the lygus screening trials conducted in 2011, and evaluated for grain yield and grain damage under lygus protected and unprotected conditions at the UC Kearney Research Station. We initiated a new round of crosses in 2010 for breeding varieties with increased resistance to lygus and high quality grain, because while current lygus resistant lines, including 07KN-46 and 07KN-76, combine very high yield potential and resistance to lygus bug, slight improvement in grain quality is still needed to meet market expectations. The F₂ generation populations from these crosses will be screened in an unprotected nursery at Kearney
under strong selection for resistance to lygus and for desirable grain quality. As described earlier, line CB46-57Rk is an advanced (BC6) backcross derived breeding line closely resembling CB46 that has greater resistance to root-knot nematodes (Table 9) but smaller grain size than CB46. This line will be crossed with CB46 in FY11 to create the BC7F1 and inbred BC7F2 lines for evaluation in FY12. These will be evaluated for resistance to nematodes in laboratory growth pouch assays and resistant lines increased in the greenhouse to obtain sufficient seed for agronomic testing. For aphid resistance, breeding lines including 07KA-34 and 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 2011, the most resistant lines will be crossed with CB46 and CB50 as part of the process of transferring aphid resistance to adapted varieties. In FY12, 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. Selected F3 families will be re-screened at Kearney in FY12 for resistance to aphids, and single plant selections made to develop a series of putative resistant families. If there is a high level of confidence that strong aphid resistance has been transferred to these materials, crosses of these lines will be made to CB46 and CB50 as part of the process of transferring aphid resistance into an adapted background.

Table 6. Promising lygus resistant lines currently in 2011 replicated trials with lygus bug-protected (P) and unprotected (U) treatments, and projected ‘Trial Status’ in 2012 if selected.

<table>
<thead>
<tr>
<th>Line</th>
<th>Status in 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>07KN-46</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>07KN-74</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>09KLN-1-35</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>09KLN-1-38</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>09KLN-1-9</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>09KLN-2-27</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>09KLN-2-30</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
<tr>
<td>09KLN-2-164</td>
<td>Advanced Trials – P/U treatments</td>
</tr>
</tbody>
</table>

P/U = Protected with Temik/Unprotected 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. To enhance productivity and be accepted by farmers, 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 with molecular markers in some cases. The selected varieties being improved by this approach are given in Tables 7-9.

**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 7. For introgressing Striga resistance, Yacine was crossed with a more recent line (IT90K-76) for Striga resistance and Suvita 2 for Macrophomina resistance. In FY12, these crosses will be advanced to the BC3F4 and F6-F7 generations and introduced in replicated yield trials at Bambey and Thilmakha.

**Table 7.** Senegal varieties being improved by introgression of specific traits by backcrossing.

<table>
<thead>
<tr>
<th>Recurrent Parent</th>
<th>Trait donor parent</th>
<th>Institution</th>
<th>Trait introgressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yacine</td>
<td>IT93K-503-1</td>
<td>ISRA</td>
<td>Macrophomina resistance</td>
</tr>
<tr>
<td>Yacine</td>
<td>Suvita2</td>
<td>ISRA</td>
<td>Macrophomina resistance</td>
</tr>
<tr>
<td>Yacine</td>
<td>58-77</td>
<td>ISRA</td>
<td>Flower thrips resistance</td>
</tr>
<tr>
<td>Yacine</td>
<td>IT90K-76</td>
<td>ISRA</td>
<td>Striga resistance</td>
</tr>
<tr>
<td>Mouride</td>
<td>Montiero derived line</td>
<td>ISRA</td>
<td>Large grain</td>
</tr>
<tr>
<td>Melakh</td>
<td>IT97K-499-39</td>
<td>ISRA</td>
<td>Striga resistance</td>
</tr>
<tr>
<td>Melakh</td>
<td>UCR 03-11-747</td>
<td>ISRA</td>
<td>Green grain</td>
</tr>
</tbody>
</table>

**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 8. 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 8: Burkina Faso varieties being improved by introgression of specific traits by backcrossing.

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

During the FY12 workplan period the Senegal and Burkina Faso recurrent backcross populations will be advanced and inbred such that they are all at the BC2F5 stage by the end of the 2012 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 multiple 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 and their current status are summarized in Table 9. Depending on the stage of backcrossing and inbreeding, these materials will either be backcrossed or tested for yield performance during FY12 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.

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 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 and grain evaluation. Seed multiplication will be conducted in the 2011-12 off-season. Yield trials will be repeated in main season 2012 in 4 row plots with 4 reps. These trials will be located at Saria, Pobe, and Kamboinse in Burkina Faso and at Bamby and Thilmakha in Senegal. Individuals from the most drought tolerant lines will be used for crossing to improved lines developed under the backcrossing program described earlier (also Tables 7-8).

Table 9. California blackeye lines being improved by introgression of specific traits using backcrossing at UCR.

<table>
<thead>
<tr>
<th>Recurrent Parent Line</th>
<th>Trait donor parent</th>
<th>Trait being introgressed</th>
<th>Status at start of FY11 Workplan</th>
<th>FY12 action plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB5</td>
<td>CB27</td>
<td>Fusarium wilt</td>
<td>BC₂F₂; Replicated preliminary yield trials</td>
<td>Retest advanced lines in replicated tests</td>
</tr>
<tr>
<td>CB46</td>
<td>UCR 03-11-747</td>
<td>Green grain</td>
<td>BC₄F₁₀</td>
<td>Evaluate new BC₅F₂ lines in field tests; large-scale replicated tests of BC₄ lines</td>
</tr>
<tr>
<td>CB46</td>
<td>IT84S-2049</td>
<td>Root-knot nematodes</td>
<td>BC₆F₆; Advanced yield trials</td>
<td>Continue performance tests of advanced BC₆ line CB46-57Rk²; advance to BC₇F₂</td>
</tr>
<tr>
<td>CB46</td>
<td>Bambey 21 (Senegal)</td>
<td>All-white grain</td>
<td>Replicated performance tests of advanced lines,</td>
<td>Replicated performance tests of advanced lines, if needed, make BC₃F₁ and inbreed if justified</td>
</tr>
<tr>
<td>CB46</td>
<td>IT97K-556-6 &amp; UCR</td>
<td>Aphid resistance</td>
<td>BC₁F₆</td>
<td>Evaluate BC₂F₂ lines in field for aphid resistance, select resistant</td>
</tr>
</tbody>
</table>
**Shuttle breeding to speed delivery of improved lines:** 38 new crosses were made in 2010 between broadly adapted elite cowpea lines (Table 9). The F₂ seed of these populations will be produced and planted in a drought screening nursery in California and selection practiced for productivity under post-flowering drought stress in 2011. F₃ lines developed from this program will be re-evaluated in 2012 in California under imposed post-flowering drought, and selected lines distributed to NARS partners for additional selection and evaluation. Numbers of F₃ families already generated in FY11 and available to the NARS are given in Table 10. These progenies will be particularly helpful in jump-starting the new breeding program being established in Angola.

### Table 9. Shuttle breeding populations developed for improvement of drought tolerance and biotic stress tolerance traits for Senegal, Burkina Faso and Angola.

<table>
<thead>
<tr>
<th>Cross No.</th>
<th>Pedigree</th>
<th>Current Generation</th>
<th>Anticipated Generation in 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2010-015 IT00K-1263 x IT95K-1491</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>2</td>
<td>2010-018 IT89KD-288 x IT00K-1263</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>3</td>
<td>2010-019 IT97K-499-39 x IT00K-1263</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>4</td>
<td>2010-022 IT84S-2246 x IT89KD-288</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>5</td>
<td>2010-023 IT84S-2246 x IT93K-503-1</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>6</td>
<td>2010-025 IT84S-2246 x IT97K-499-35</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>7</td>
<td>2010-026 IT84S-2246 x IT98K-1111-1</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>8</td>
<td>2010-027 IT84S-2246 x Mouride</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>9</td>
<td>2010-028 IT84S-2246 x SuVita 2</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>10</td>
<td>2010-029 IT95K-1491 x IT84S-2246</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>11</td>
<td>2010-030 IT95K-1491 x Melakh</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>12</td>
<td>2010-031 IT95K-1491 x Mouride</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>13</td>
<td>2010-032 IT95K-1491 x SuVita 2</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>14</td>
<td>2010-033 IT99K-241-2 x IT95K-1491</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>15</td>
<td>2010-034 IT89KD-288 x IT84S-2049</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>16</td>
<td>2010-035 IT89KD-288 x IT83D-442</td>
<td>F₂</td>
<td>F₄</td>
</tr>
<tr>
<td>17</td>
<td>2010-036 IT89KD-288 x IT93K-503-1</td>
<td>F₂</td>
<td>F₄</td>
</tr>
</tbody>
</table>
### Table 10. Indicated number of F<sub>3</sub> families generated in FY11 from biparental and 4-way crosses among elite parents and available to NARS partners.

<table>
<thead>
<tr>
<th>Cross No.</th>
<th>Pedigree</th>
<th># F&lt;sub&gt;3&lt;/sub&gt; Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-012</td>
<td>CB27 / IT97K-499-35-1-1</td>
<td>498</td>
</tr>
<tr>
<td>2010-013</td>
<td>CB46 / IT97K-499-35-1-1</td>
<td>295</td>
</tr>
<tr>
<td>2010-019</td>
<td>IT97K-499-39 / IT00K-1263</td>
<td>263</td>
</tr>
<tr>
<td>2010-020</td>
<td>Suvita 2 / IT00K-1263</td>
<td>290</td>
</tr>
<tr>
<td>2010-051</td>
<td>IT97K-499-35 / IT93K-503-1</td>
<td>461</td>
</tr>
<tr>
<td>2010-057</td>
<td>Suvita 2 / IT97K-499-35</td>
<td>296</td>
</tr>
<tr>
<td>2011-001</td>
<td>CB27 / IT82E-18 // IT89KD-288 / IT84S-2049</td>
<td>330</td>
</tr>
<tr>
<td>2011-002</td>
<td>Suvita 2/IT00K-1263//IT84S-2246/IT93K-503-1</td>
<td>330</td>
</tr>
</tbody>
</table>

**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 11. 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 F$_3$ families were screened for performance under post-flowering drought conditions and the seed-bulked. The 32 top performing bulks were re-evaluated in a 4-replicate trial in California at Coachella in Fall 2010. Seed of the best 50% of these lines 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. Single plant selections will be made within promising families. In 2012, these families will be field-tested for performance in small replicated plots (2 rows x 3 reps) at two locations in Burkina Faso (Saria and Pobe) and Senegal (Bambey and Thilmakha). 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 F$_6$ generation in 2011, with selection based on grain quality and SNP markers for drought, thrips and Macrophomina resistance. During the off season 2012 these F$_7$ seeds will be multiplied and introduced in preliminary yield trials during the main season at Bambey and Thilmakha using 2 rows and 3 reps.

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, located at Saria, Pobe, and Kamboinse in Burkina Faso, and at Bambey and Thilmakha in Senegal. In 2012 the best lines (10) selected in 2011 will be introduced in advanced yield trials using 4-row plots, 5 m long and 4 reps, at these Senegal and Burkina Faso sites.

Table 11. Crosses made and advanced to F$_6$ 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.

<table>
<thead>
<tr>
<th>Cross</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuVita2/Mouride</td>
<td>Elite Drought Tol. x Elite Drought Tol.</td>
</tr>
<tr>
<td>IT93K-503-1/IT84S-2246</td>
<td>Elite Drought Tol. x Elite Drought Tol.</td>
</tr>
<tr>
<td>Mouride/IT84S-2246</td>
<td>Elite Drought Tol. x Elite Drought Tol.</td>
</tr>
<tr>
<td>IT97K-503-1/IT97K-556-6</td>
<td>Elite Drought Tol. x Elite Drought Tol.</td>
</tr>
<tr>
<td>Mouride/Apagbaala</td>
<td>Elite Drought x Elite Heat Tolerant</td>
</tr>
<tr>
<td>KVx61-1/Mouride</td>
<td>Elite x Elite Drought Tolerant</td>
</tr>
<tr>
<td>IT93K-503-1/UCR 779</td>
<td>Elite Drought Tolerant x Drought Tolerant and aphid resistant landrace</td>
</tr>
<tr>
<td>Apagbaala/IT82E-18</td>
<td>Elite Heat Tolerant x Elite</td>
</tr>
<tr>
<td>IT97K-819-45/Ein El Ghazal</td>
<td>Elite x Elite Drought Tolerant</td>
</tr>
<tr>
<td>Ein El Ghazal/KVx544-6-151</td>
<td>Elite Drought Tolerant x Elite</td>
</tr>
<tr>
<td>IT98K-558-1/Mouride</td>
<td>Elite x Elite Drought Tolerant</td>
</tr>
<tr>
<td>Apagbaala/IT98K-558-1</td>
<td>Elite Heat Tolerant x Elite</td>
</tr>
<tr>
<td>IT95K-1479/Mouride</td>
<td>Elite x Elite Drought Tolerant</td>
</tr>
</tbody>
</table>
In California: Pigeonpea

Twenty selections from the GA-1 population (supplied from Dr. Sharad Pathak at the University of Georgia) made in FY10 at UCR will be tested in replicated trials in 2011 and repeated in FY12. Engagement with local farm advisors will be done to optimize a production package for this new crop. In addition, 0.5 ha 2011 selection nurseries have been planted at UCR and the UC Kearney Research Station where selections will made for grain quality and productivity. These selections will be included in a nursery in FY12.

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 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 continue to produce Foundation Seed and Certified Seed of 6 newly released varieties (IT98K-205-81, Melakh, KVx421-2J, KVX442-3-25G, KVX442-3-25, KVx771-10, 33-2d 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). At least 400 Kg of Foundation Seed of each variety will be produced at Saria, Kamboinse and Pobe. At least 200 T of Certified Seed will be produced at Sourou, Bulkiamde, Sandie, Passore, Zandoma, Sanmatenga and Oubritenga provinces by trained farmers. Breeder Seed will be produced in the off-season for seven varieties (IT98K-205-8, Melakh, KVX421-2J, KVX414-22-2, Gorom Local, KVx775-33-2, KVx 442-3-25) on 2500 m² 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 50 T of Foundation Seed. This will address the estimated 10% shortage of Foundation Seed, thereby expanding the self-sustaining seed production system. Training of farmers as Certified Seed producers will be done in three new provinces (Zandoma, Sahel and Sangue). A total of 100 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, as in 2011, in 2012 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 5 locations (Thilmakha region, Merina district, Mekhe, Dahra, 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 efforts in the FY10 and FY11 periods.

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 FY12, in which we will coordinate with the Pulse CRSP bean breeding project of Drs. Beaver and Porch. The return from UPR of CRSP student Antonio David to Angola at the start of FY12 will also aid in these efforts. 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.
Dr. 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 FY12, Breeder Seed of seven improved cowpea varieties (IT98K-205-8, Melakh, KHX421-2J, KHX414-22-2, KHX442-3-25, KHX775-33-2, 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 four locations (Reo, Kaya, Ouahigouya and Djibo), during the period April – May, 2012. This activity will train 80 farmers, of which at least 30 will be women. The 80 trained farmers also will be guided in producing Certified Seed of the INERA improved cowpea varieties. Each farmer will plant 1 ha starting at the end of June 2012. This activity is estimated to generate 30 T of Certified Seed produced on a total area of 40 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 (5 ha at SARIA, Koudougou) and Foundation (30 ha at Saria, Kamboinse and Pobe) Seed of the seven varieties will also be produced during the 2012 growing season (June–September). This is estimated to yield 50 kg of Breeder Seed of each variety and a total of 25 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 2012) under irrigation to complement the Foundation Seed obtained during the rainy season of 2011. The project team will work with the National Extension Service (ANCAR) and 80 farmer organizations at 6 locations (Thilmakha, Merina, Mekhe, Tivaouane, 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 for Certified Seed, with the goal of scaling up in future years. During
the 2011 growing season 2-3 T of Foundation Seed will be produced at the ISRA Bambey Research Station for the 2012 Certified Seed production effort. 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 2012 in Mali (with Dr. Toure, IER) and in Niger (with Dr. Moutari, INRAN) to review 2011 performance data and to deliver planting seed of improved Senegal and Burkina Faso cowpea varieties. The two best performing varieties chosen for Mali and Niger expansion in 2011 will be grown on multiple farm sites in 2012 for additional performance data and for farmer and seed producer demonstration.

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 MS training will be completed during FY11. However, we plan to engage him in CRSP cowpea breeding activities on his return to Angola, with the potential for continuing on to PhD degree training. 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. Mame Penda Sarr has finally been accepted in the PhD program at Dakar University (UCAD), Senegal. 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 and deepen the 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 projected to computers with conference discussion of data. During site visits to the Host Countries planned in FY 11 and FY12, 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.

III. Contribution of Project to Target USAID Performance Indicators
The Performance Indicators to be presented as 2012 workplan targets will be 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.

IV. 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.

**Developmental outcomes** 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.

**Impact Assessment:** In collaboration with the Dry Grain Pulses CRSP project led by Drs. Mywish Meridia and Eric Crawford at MSU, we have budgeted for funding for Dr. Cisse in Senegal and Dr. Drabo in Burkina Faso to collect requisite data for impact assessment of previous and current cowpea varieties released through the CRSP-supported cowpea breeding programs in those Host Countries.

V. 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 programing 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.

VI. 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 and farmers’ cooperatives 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.

VII. 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.

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 analysis 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.

VIII. Contribution of Project to target USAID Performance Indicators:
FY12 form attached.

IX. Project Benchmarks (Semi-annual indicators of progress):
FY12 form attached

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 (likely Arsenio Ndeve)
Citizenship: African country (likely 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 (Mozambique)
Thesis Title/Research Area: Genetic analysis of cowpea resistance to biotic/abiotic stress
Start Date: September, 2011
Projected Completion Date: October 2015
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 of 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

Student #4
First and Other Given Names: Mouhamadou Moussa
Last Name: Diangar
Citizenship: Senegal
Gender: Male
Training Institution: University of Ouagadougou
Supervising CRSP PI: Ndiaga Cisse
Degree Program for training: MS
Program Areas or Discipline: Plant Breeding
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID? No
Host Country Institution to Benefit from Training: Senegal
Thesis Title/Research Area: Striga resistance
Start Date: October, 2010
Projected Completion Date: June 2012
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 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 projected 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. Supplemental funding is being requested for supporting this training in FY12.
## Dry Grain Pulses CRSP

**PERFORMANCE INDICATORS/TARGETS for FY 12**

(October 1, 2011 -- September 28, 2012)

<table>
<thead>
<tr>
<th>PII-UCR-1</th>
<th>2012 Target</th>
<th>2012 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output Indicators</strong></td>
<td>(Oct 1 2011-Sept 28, 2012)</td>
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</tr>
<tr>
<td>Degree Training: Number of individuals who have received degree training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Short-term Training: Number of individuals who have received short-term training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>140</td>
<td></td>
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<tr>
<td>Technologies and Policies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under research</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under field testing</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices made available for transfer</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Number of policy studies undertaken</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Beneficiaries:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
<td>16000</td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
<td>12000</td>
<td></td>
</tr>
<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td><strong>Number of trade and business associations receiving technical assistance</strong></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Number of community-based organizations receiving technical assistance</strong></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>Number of women organizations receiving CRSP technical assistance</strong></td>
<td>18</td>
<td></td>
</tr>
<tr>
<td><strong>Number of public-private partnerships formed as a result of CRSP assistance</strong></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Number of HC partner organizations/institutions benefiting</strong></td>
<td>27</td>
<td></td>
</tr>
<tr>
<td><strong>Developmental outcomes:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of additional hectares under improved technologies or management practices</strong></td>
<td>37200</td>
<td></td>
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</table>
## Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the U.S.

### Second period (12 months) 10/01/11 - 9/28/2012

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UC Riverside</td>
<td>Training</td>
<td>Burkina Faso INERA</td>
<td>Senegal ISRA</td>
<td>Angola IIA</td>
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### a. Personnel Cost

<table>
<thead>
<tr>
<th></th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>$31,084.50</td>
<td>$14,000.00</td>
<td>$14,000.00</td>
<td>$14,000.00</td>
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<tr>
<td>Fringe Benefit</td>
<td>$8,109.00</td>
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### b. Travel

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<tr>
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<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tbody>
<tr>
<td>Travel</td>
<td>$4,055.00</td>
<td>$2,000.00</td>
<td>$2,000.00</td>
<td>$2,000.00</td>
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### c. Equipment ($5000 Plus)

<table>
<thead>
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<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tr>
<td>Supplies</td>
<td>$1,802.00</td>
<td>$4,000.00</td>
<td>$4,000.00</td>
<td>$4,000.00</td>
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### e. Training

<table>
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<tr>
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<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
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<th>HC or U.S. Institution (3)</th>
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<tbody>
<tr>
<td>Degree</td>
<td>$47,925.00</td>
<td></td>
<td></td>
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<tr>
<td>Non-Degree</td>
<td>$12,000.00</td>
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### f. Other - Impact Survey

<table>
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<tr>
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<th>U.S. Institution</th>
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<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tr>
<td>Other Impact Survey</td>
<td>$3,450.00</td>
<td>$28,604.00</td>
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### g. Technology Dissemination

<table>
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<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tr>
<td>Technology Dissemination</td>
<td>$16,250.00</td>
<td>$18,750.00</td>
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### h. Total Direct Cost

<table>
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<tr>
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<th>U.S. Institution</th>
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<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tbody>
<tr>
<td>Total Direct Cost</td>
<td>$45,050.50</td>
<td>$59,925.00</td>
<td>$39,700.00</td>
<td>$67,354.00</td>
<td>$20,000.00</td>
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### i. Indirect Cost

<table>
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<tr>
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<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tr>
<td>Indirect Cost</td>
<td>$22,525.25</td>
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### j. Indirect Cost on Subcontracts (First $25000)

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<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tbody>
<tr>
<td>Indirect Cost on Subcontracts</td>
<td>$22,525.25</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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### k. Total Indirect Cost

<table>
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<tr>
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<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tbody>
<tr>
<td>Total Indirect Cost</td>
<td>$22,525.25</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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<table>
<thead>
<tr>
<th></th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tr>
<td>Total</td>
<td>$67,575.75</td>
<td>$59,925.00</td>
<td>$39,700.00</td>
<td>$67,354.00</td>
<td>$20,000.00</td>
<td>$0.00</td>
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<tr>
<td>Grand Total</td>
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### Amount Percentage

<table>
<thead>
<tr>
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<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total direct cost budgeted for U.S. institution(s)</td>
<td>$50,050.00</td>
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<td></td>
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<tr>
<td>Total direct cost budgeted for H.C institution(s)</td>
<td>$186,979.00</td>
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### Cost Share

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<tr>
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<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
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<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>Total</th>
</tr>
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</table>

|                      |                  |                       |                            |                           |                           |       |
|                      |                  |                       |                            |                           |                           |       |
|                      |                  |                       |                            |                           |                           |       |
|                      |                  |                       |                            |                           |                           |       |
|                      |                  |                       |                            |                           |                           |       |
|                      |                  |                       |                            |                           |                           |       |
|                      |                  |                       |                            |                           |                           |       |

98
<table>
<thead>
<tr>
<th></th>
<th>In-kind</th>
<th>Cash</th>
<th>Total</th>
</tr>
</thead>
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<tr>
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<td>$16,893.75</td>
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<td>$16,893.75</td>
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<tr>
<td><strong>Total</strong></td>
<td>$16,893.75</td>
<td>$ -</td>
<td>$16,893.75</td>
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</tbody>
</table>

**Attribution to IEHA Objectives**

<table>
<thead>
<tr>
<th>Percentage of effort</th>
<th>75.00%</th>
<th>75.00%</th>
<th>75.00%</th>
<th>75.00%</th>
<th>75.00%</th>
<th>75.00%</th>
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</thead>
<tbody>
<tr>
<td>Amount corresponding to effort</td>
<td>$56,306.25</td>
<td>$44,943.75</td>
<td>$29,775.00</td>
<td>$50,515.50</td>
<td>$15,000.00</td>
<td>$196,540.50</td>
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</table>

**Attribution to Capacity Building (Theme "D")**

<table>
<thead>
<tr>
<th>Percentage of effort</th>
<th>35.00%</th>
<th>35.00%</th>
<th>35.00%</th>
<th>35.00%</th>
<th>35.00%</th>
<th>35.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount corresponding to effort</td>
<td>$26,276.25</td>
<td>$20,973.75</td>
<td>$13,895.00</td>
<td>$23,574.00</td>
<td>$7,000.00</td>
<td>$91,719.00</td>
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</tbody>
</table>

**Name of PI & Institutional Affiliation:** Phil Roberts, University of California, Riverside
**Dry Grain Pulses CRSP**  
Research, Training and Outreach Workplans  
(October 1, 2011 -- September 28, 2012)

**FY 2012 SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD**

**Project Title:**

<table>
<thead>
<tr>
<th>Identify Benchmark Indicators by Objectives</th>
<th>Abbreviated name of institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UCR</td>
</tr>
<tr>
<td></td>
<td>4/1/12</td>
</tr>
</tbody>
</table>

**Objective 1 - Breeding**

- Varietal test & release:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Germplasm seed increases:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Germplasm screening:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Variety candidate test - Angola:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Advance/test BC popns:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Advance/test elite popns:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- SNP genotyping:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

**Objective 2 - Improve Seed Systems**

- Breeder Seed production:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Foundation Seed production:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Certified Seed prodn. training:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Assess seed system - Angola:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

**Objective 3 - Seed Dissemination**

- Breeder’s Seed production:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Foundation Seed production:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Certified Seed production:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Certified Seed producer training:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Variety tests in Mali:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Variety tests in Niger:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

**Objective 4 - Training**

- MS Training Angola/UPR:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- PhD Training UCR:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

- Training - MAS with SNPs:  
  - UCR: x, x, x, x, x, x  
  - ISRA: x, x, x, x, x, x  
  - INERA: x, x, x, x, x, x  
  - IIA: x, x, x, x, x, x

**Name of the PI responsible for reporting on benchmarks**

- P. A. Roberts
- N. Cisse
- I. Drabo
- A. Chicapa

**Signature/Initials:**

**Date:**
**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 and developing 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. 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. Our previous years efforts have provided the necessary data for a model to develop an IRM plan for which a manuscript has been prepared for submission to a peer reviewed journal (Onstad et al., in preparation). Bt-cowpea, even if/when it becomes available to farmers, will only control one of many pests that attack cowpea. The second pest of cowpea, where a potentially new strategy for insect control exists, are thrips-resistant/tolerant 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, KVX404-8-1). We will continue our work with the aforementioned investigators, to investigate the interactions between thrips-resistant cowpeas and thrips in field experiments in Northern Nigeria, Niger, and Burkina Faso. Additionally, we will continue our work to develop, release, and document the impact of biocontrol agents on the population levels of pests of cowpea and the positive outcomes on cowpea crop production.

Although biocontrol agents, transgenic plants, and traditional plant breeding for insect resistant varieties are all potentially effective methods for controlling 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. The critical baseline data for *M. vitrata* was collected in the past years (for both the IPM-omics work and for the IRM analysis for Bt-cowpea) and we will continue to collect all the necessary data for the remaining pest species in FY12.

**Planned Project Activities for FY 2012**

**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. 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. Niango Malick Ba, INERA  
Dr. Ibrahim Baoua, INRAN  
Dr. Clémentine Dabiré, INERA  
Mr. Mamadou N'Diaye, IER  
Dr. Jeremy McNeil, UWO  
Dr. Manuele Tamò, IITA

**Approaches and Methods:** We will continue to characterize the life-history patterns of the aforementioned pests of cowpeas in Benin, Burkina Faso and Niger, 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. *In areas where bio-control agents have been released (in FY10 and FY11) we will determine the insect populations and presence of the bio-control agents.* 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 Benin, Burkina Faso and Niger already have expertise in working with these pests. Training sessions for research technicians will occur in Benin, Burkina Faso, Mali and Niger in order to build capacity and increase our own capacity to perform this project more successfully.

Insect populations will be collected in Benin, Burkina Faso and Niger, 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 (including possible diapause), will be performed. 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 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*, and *M. sjostedti*.

**Collaborators**
Dr. Manuele Tamò, IITA  
Dr. Brad Coats, University of Iowa  
Dr. Niango Malick Ba, INERA  
Dr. Ibrahim Baoua, INRAN  
Dr. Clémentine Dabiré, INERA  
Dr. George Czapar, UIUC
**Approaches and Methods:** We will use the polymorphic data generated from the large-scale 454 sequencing of *C. tomentosicollis*, *A. curvipes*, *A. craccivora*, and *M. sjostedti* to characterize West African insect populations using Sequenom® technology. Briefly, Sequenom® technology will be used to verify and to detect single nucleotide polymorphisms. We will 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 that we have collected in FY11. 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 in Benin, Burkina Faso and Niger and immediately transferred into vials with RNAlater (Ambion Inc.) and these materials will be shipped to UIUC for further analysis (using Sequenom® technology to investigate specific polymorphisms). The host country scientists will collect insects once per month (minimally) from a diversity of regions within their countries. Individual insects will be assessed in relation to where and when they have been found and what SNPs they contain. This will help us to understand the population patterns of the pest insects. We will use GIS data to super-impose the insect populations and polymorphisms over what is known about these general ecosystems. This will provide institutions in the region with information on pest populations beyond the scope of the current project. It will also allow groups beyond our CRSP group to use our data for making pest management decisions.

Once the insects arrive at UIUC, DNA will be extracted and purified for use in the Sequenom® experiments. We will use the same protocols as we have used for *M. vitrata*. This work will be done in collaboration with Brad Coates. We have completed a study on *M. vitrata* movement patterns in West Africa using just such an approach (Margam et al., In Press). A similar molecular approach will be applied to the other pest species of cowpea.

**Reference**
**Objective 3**: Development and deployment of extension materials for IPM of pests of cowpeas and assessment studies.

**Collaborators**
Dr. Niango Malick Ba, INERA  
Dr. Ibrahim Baoua, INRAN  
Dr. Julia Bello, UIUC  
Dr. Clémentine Dabiré, INERA  
Dr. George Czapar, UIUC  
Mr. Mamadou N'Diaye, IER  
Dr. Mohammad Ishiyaku, IAR  
Dr. Manuele Tamò, IITA  
Dr. Michelle Shumate, UIUC, U.S.A.  
Dr. Robert Mazur (P2-ISU-1), ISU, U.S.A. (sharing of animations)  
Dr. Mywish Maredia (P3-MSU-4), MSU, U.S.A.  
Dr. Cynthia Donovan (P2-MSU-2), MSU, U.S.A. (sharing of animations)

**Approaches and Methods**: We will continue to develop and deploy both our extension tools (e.g., animation videos and live recorded videos) for (i) Peace Corps volunteers in host countries, (ii) local extension services, (iii) farmer field-schools, and for (iv) training of scientists and technicians in pest control strategies. Based on their training in FY11, Drs. Tamò, Dabire, NDiaye, Ishiyaku, Ba and Baoua will continue, in collaboration with the UIUC team to produce and deploy extension materials using audio, video and where necessary printed materials. To date, we have created three animated videos with voice-overs in a diversity of West African languages appropriate for Benin, Burkina Faso, Mali, Niger, and Nigeria. All of these videos can be played on computer, the Internet and on cell phones. An independent assessment for Purdue University, in Niger, has shown that a significant percentage of farmers in Niger do have such appropriate cell phone. They performed an experiment where they loaded seven phones and observed how videos spread over a one-month period. They observed that the videos had spread to cell phones in 50 different villages in one month. They had used live action filming for their videos, a process which is ultimately much more expensive than animations, and unlike our animations they cannot easily do voice-overs in a series of other languages. However, their independent assessment shows the capacity for deployment of such videos and the feasibility of deploying educational materials through cell phones in West Africa.

The animation files can be easily transmitted from one cell phone to the next using Bluetooth® technology. Further voice-overs will be performed into the beginning of FY12. Such voice-overs have little to no extra cost, as they involve technicians and scientists in the host country recording the audio on a recorder purchased for these groups in FY11 and the audio files are simply overlaid on the animations using software on a PC computer. The videos can then be distributed in the local language. Additionally, seven insect pest training videos (live action filming) were produced by IITA and NARS collaborators in 2010 and will be fully available to the world online (e.g., YouTube and on the SusDeViKI system). These training videos are specifically for scientists and field extension agents who will be rearing parasitoids and will need to identify pest insects in the field. Thus, NARS researchers can download these videos onto their computers, and install them on their cell phones and on those of extension agents, to be
played back at a later date independently of the Internet. One such video contains a new ultra-
low cost methodology of rearing *M. vitrata* in the laboratory for the mass production of bio-
control agents. Thus, we have multiple systems in place to produce educational materials (that
can be taken across a diversity of language groups) at a low-cost and share these online in
manner in which cell-phone ready files can be made available for anyone who wants to
download them and use them. We have built capacity in our host country scientist to develop the
voiceovers in local languages and beyond the scope of the current project we would hope to
develop the skill sets in each of these countries to produce from scratch educational videos. The
production system for the animations has resulted in a UIUC initiative called Scientific
Animations Without Borders (SAWBO). SAWBO received a considerable amount of positive
media attention in 2011 (with upwards of 200,000 hits on the web at the peaks of the media
interest – some of the articles can be found at https://sib.illinois.edu/pittendrigh/sawbo/news) and
numerous volunteers have stepped forward to translate and voice overlay many of our videos in
major world languages in order to demonstrate the ease by which this technology can be used to
adapt educational materials into new languages. There was no cost to the CRSP for these non-
West African languages, but this has helped to increase the visibility of the project on the
Internet. We have finalized many African language voice-over videos for Mali, Niger, Burkina
Faso, Benin, and Nigeria and will complete more at the beginning of FY2012.

These materials have and will continue to be deposited in the SusDeViKI system for sharing
with the rest of the world. The SusDeViKI has a tracking system to follow when and where
content is being downloaded (general regions of the world). With this system anyone can
download these cell phone ready videos and then use them for deployment in the field. We will
also make available in FY12 versions of the videos can be given out for use in video viewing
clubs. Host country scientists will also hold workshops to train fellow researchers, extension
agents (both governmental and from NGOs), media outlets, local and national government
officials, in the use of this online extension sharing system. The will also be showed how they
can contribute new materials back into this extension sharing system dedicated to educational
videos that can be played on cell phones. It is envisaged to partner with regional (e.g., CORAF)
and international (FAO) organizations for wider awareness of the SusDeViKI system and its
sustainable use beyond the duration of this project. We have been in discussions with CORAF
since the beginning of FY2011 and will continue to build these collaborative links. In FY2012
we will continue to establish partnerships with local and regional organizations across West
Africa to deliver these materials both through the Internet and for on the ground deployment VIA
cell phone to cell phone transmission. All of this work will be done in addition and in
complementation with our traditional educational approaches of farmer field fora (schools).

We expect that these materials will be deployed in upwards of a hundred 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, extension presentations
and partnerships with NGO and other government organizations. We anticipate these materials
will be easily integrated with more traditional educational programs such as demonstrations and
farmer field fora. We also plan to work with two separate assessment groups (P3-MSU-4; Dr.
Mywish K. Maredia and Dr. Michelle Shumate at UIUC) to respectively investigate (1) impact
on farmers (details given in next paragraph) and (2) understanding the best deployment networks
in these countries to develop the most effective ways to deploy such educational programs.
Additionally, we are in the process of sharing these videos and doing voice overlays in languages useful for other DGP-CRSP projects (for example, but not limited to, ISU-1 and MSU-2).

**Baseline assessment of the economic effects of pest problems on cowpea growing areas in Burkina Faso** [Verbiage for the next two paragraphs is adapted from Dr. Mywish Maredia (PIII-MSU-4) with permission and is given in her FY12 workplan as well]. As part of this project’s workplan, we plan to collect baseline data towards assessment of the impact of bio-control research after several years of cumulative efforts by our team in Burkina Faso. In collaboration with the PIII-MSU-4 and the project team at INERA, we plan to conduct a baseline survey of cowpea producers in two provinces of Burkina Faso, which are targeted for the deployment of bio-control agents. The households to be included in the baseline survey will be selected based on a stratified random sampling method. The plan is to collect baseline data from 560 households from 56 villages across the north and central parts of Burkina Faso. A detailed survey instrument will be developed by the MSU and INERA socio-economist team with input from the PI-UIUC-1 project team members. The instrument will include questions related to household and farm characteristics, village level characteristics, cowpea production practices (including pest control strategies) and outcome indicators, detailed input cost data to estimate the farm-level budgets, and farmers’ perception on pest problems and its effects on yield and input use.

The data will be analyzed jointly by the INERA and MSU team and results will be documented in a baseline report to be submitted to the Management Office. The data and analysis of this baseline assessment will serve as the ‘before’ scenario which can be compared with an ‘after’ scenario where the same households could be re-visited after 4-5 years to conduct an ex-post impact assessment of bio-control research in Burkina Faso. The budget for data collection and field activities related to the planned survey is included in our project workplan/budget under INERA ($18,128) but the resources come from the PIII-MSU-4 team. Dr. Mywish Maredia has discussed this financial arrangement with the CRSP-MO.

**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 tend to use pesticide sprays to minimize pest populations in the attempt to intensify the cropping systems for improved food security. However, 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) and consume fresh leaves and pods as vegetables, (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 worldwide 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 Burkina Faso, Mali, and Niger. The group will develop effective rearing and release strategies for multiple pests of cowpeas, based on the successful example of the development and use, by the same team, of the parasitoid Habrobracon hebetor to control the millet head borer Heilocheilus albipunctella in the Sahelian zone. This rearing and release system is based on very simple and efficient techniques, from locally available material, and is one of the best examples of augmentative, farmer-participatory biological control project. Also, Dr. Tamò of IITA is collaborating on a project with AVRDC and icipe on the discovery of new and more efficient biocontrol agents against the pod borer (e.g. Therophilus marucae and Phanerotoma philippinensis), which were introduced from South-East Asia to Benin for initial testing during FY11.

In addition to the above efforts, genomics tools will be used to track the bio-control populations.

**Collaborators:**
Dr. Manuele Tamò, IITA  
Dr. Niango Malick Ba, INERA  
Dr. Ibrahim Baoua, INRAN  
Dr. Clémentine 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. Use of mass rearing technique for *M. vitrata* using germinating cowpea sprouts to rear *M. vitrata* populations for rearing and release of bio-control agents. Dr. Tamò at IITA will be responsible for the deployment of this technology to HC scientists and in FY12 the HC scientists will be using this approach for the rearing and release of bio-control agents against *M. vitrata*. 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 employing a mass rearing technique using nurseries of the host plant *Sesbania sp.* Drs. Tamò, Dabiré, Ba, and Baoua will perform these activities. Where resources and time permit we will extend these technologies to our colleagues in northern Nigeria and Mali. 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.* in all three host-countries.

2. Use of 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. Drs. Tamò, Dabire, Ba, and Baoua will perform these activities. Where resources and time permit we will extend these technologies to our colleagues in northern Nigeria and Mali.

It is important to note that in Benin, for thrips, we have three years of pre-release data and four years of post-release data on thrips larval abundance on wild legumes, showing a reduction of the population levels by 40% due to the impact of the parasitoids *Ceranisus femoratus*. Economic assessment models are being developed by IITA to estimate the economic impact on cowpea production.

In Burkina Faso and Niger we have accumulated three years of detailed field data of all the major cowpea pests (as both part of our previous Bean Cowpea CRSP grant and the current Dry Grains Pulses CRSP) (pre-bio-control release data). Additionally, we have collected information on the productivity of cowpea in these test plots. In FY2011 we have already begun to release parasitoids in Benin, Niger, Burkina Faso, and Nigeria, using novel release strategies developed by Dr. Tamo (which will continue in FY2012). We will begin to accumulate the post-release data on these insect populations in the same regions.

Additionally, we have already performed studies in controlled experiments in Benin, Niger, Nigeria, and Burkina Faso to test the impact of the viral-based sprays on *M. vitrata* populations. We have compared insect numbers, and will compare yield differences, between the control and treatment plots. We performed initial experiments in FY11 and we will repeat these experiments in FY12. Thus, the experiments will be properly controlled so that we can compare non-treated plots with treated plots (as this is a pilot experiment). In addition to this, in FY12 we will combine viral sprays with different aqueous formulations of neem products, in order to broaden the range of action of the biopesticides for the control of thrips, aphids and pod sucking bugs (whilst *M. vitrata* will be mainly controlled by the virus). In FY11 we observed that viral sprays
on their own resulted in >20% yield increase cowpea test plots and we expect that viral sprays combined with neem will result in ca. 50% increases in yield. The results of these experiments will be further validated in farmer-participatory trials in at least two other countries during FY12. The combination of neem sprays with viruses represent an extremely promising control practice as this combination is effective against all the pests of cowpeas and neem oils are becoming more common in the market place (women are selling this as form of income).

**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. Niango Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clémentine 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 *M. 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. In FY12 we will use Sequenom® technology to compare single nucleotide polymorphisms (SNPs), based SNPs discovered in the 454 runs in FY11.

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 FY12 for SNP detection to determine if the SNPs from our starting populations can be found in the field populations, in order to verify that our bio-control agents are the ones.

Drs. Tamò, Dabire, Ba, and Baoua will be responsible for the collection and shipping of insect samples found in the field to UIUC. Dr. Pittendrigh’s group will co-ordinate the SNP analyses in collaboration with several other US institutions (e.g., Dr. Brad Coats at Iowa).
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 developing simple and efficient rearing and delivery systems for field inoculations.

2. Following the latest developments on the AVRDC/icipe project (see Objective 4), there appears to be more efficient and specific parasitoids than the anticipated tachinid fly *Nemorilla maculosa* from Taiwan. Hence, we expect to have started developing and testing a rearing and delivery system for at least one of these novel biocontrol agents by FY12.

Against *C. tomentosicollis*:

The parasitoids *Gryon fulviventre*. This parasitoid is locally available in West Africa. We have in place a cheap and efficient rearing technique for its intended host *C. tomentosicollis* using dry or germinating cowpea seeds for continuous supply of host eggs. 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 in place in FY12.

**Objective 6**: Increase the capacity, effectiveness and sustainability of agricultural research institutions, in order to serve the cowpea sector in Benin, Burkina Faso, and Niger. 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. We will also share our extension materials with any and all other CRSP and non-CRSP groups interested in these materials.

**Collaborators**
Dr. Manuele Tamò, IITA
Dr. Niango Malick Ba, INERA
Dr. Ibrahim Baoua, INRAN
Dr. Clémentine Dabiré, INERA

**Approaches and Methods**
1) **Technician, Extension Agent, and NGO training programs.** We will hold seminars in Benin, Niger, Mali, and Burkina Faso to train technicians, extension agents, and where possible staff from other partner organizations (e.g., Peace Corps volunteers and local NGOs) in cowpea pest identification and pest control strategies, along with our online extension sharing system.

2) **Farmer Field Fora (school).** We will continue to perform farmer field fora in partnerships with other local extension organizations in the Burkina Faso and Niger in each of the countries in
FY12 an approximate 50%:50% mix of men and women. Each farmer field school will have a minimum of 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. 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 (SusDeViKI) for extension materials that will be available in FY12 and beyond the scope of this project for the use by host country scientists and extension agents. From FY11 we expect to have several of these videos in languages appropriate for other CRSP groups working Eastern and Southern Africa as well as Senegal. We have been in touch with three other DGPCRS programs in FY11 about development of these materials.

Based on our surveys from FY11 on the access of farmers to cell phone technologies with video and Bluetooth® capacity, their use of video viewing clubs, and the use of rural radio to make people aware of the videos we will refine our strategies for the best approach to deploy the videos that we have to train farmers in best insect control practices. To date, we have seven filmed videos and three cowpea appropriate animated videos (which can be voiced-over in local languages) that deal with respectively cowpea pests and non-pesticides methods of control of these pests. In FY11, we worked with Julienne Gue of INERA (a social scientist) and Dr. Michelle Shumate (Department of Communications at UIUC) on surveys to determine the access of men and women in Burkina Faso to Bluetooth®-ready cell phones and to determine how often they attend video viewing clubs. Radio can also be used to make people aware of these videos and in some cases the audio part of the videos can be played on the radio. At the time of writing of this document our initial feedback from fieldwork suggests that both strategies can be deployed simultaneously and in synergistic manner. Videos can be distributed on cell phone or through CDs (which can be used in video viewing clubs).

4) **Non-degree training.** Within Africa, the H.C. scientists and technicians 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.

5) **Degree Training.** Dr. Pittendrigh has a female Nigerian graduate student who will continue (and potentially complete) her studies doctoral studies at UIUC. Her work is focused on the molecular marker efforts outlined in the IPM-omics section and she has played an active role in the development of extension materials on the CRSP project. It is critical to note that 100% of her support comes from non-CRSP funds. Host country scientists will continue to train their graduate and undergraduate students throughout FY12. Dr. Shumate has four graduate students
from the Department of Communications who are working with us on assessment of impact of educational materials.

**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 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, 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) IITA is currently in a position to continually rear these bio-control agents (beyond the scope of 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 agents will be determined by surveys in the years that follow the release of the bio-control agents. Where feasible, molecular markers may be used to determine if the bio-control agent populations released are in fact the ones that have become 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 the SusDeViKI project, 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.

We have already had our first meeting (in FY2011) with a representative from CORAF, Prof. Sangare (the Biotechnology and Biosafety Program Manager). We have discussed and described the general features of our project and he has agreed to make further arrangements for a conference call with both him and his colleague working in areas pertinent to our project (e.g., Dr. Sanyang). We plan to interact with CORAF on the following aspects of the project: (1) bio-control, (2) deployment of cell phone videos, and (3) our SusDeViKI system. Additionally, our national programs are involved with CORAF activities and they will request CORAF’s involvement in our project.

**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) is 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 beta-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.

As already mentioned under Objective 4, Dr. Tamò is actively involved in the discovery of novel biocontrol agents (mainly hymenopteran parasitoids and entomopathogenic organisms) against the Maruca pod borer, with external funds from GIZ/BMZ through a collaborative project with AVRDC and icipe. These novel natural enemies will be tested and experimentally deployed within the current phase of the project.

INSTITUTIONAL CAPACITY BUILDING ACTIVITIES

Degree Training:

First and Other Given Names: Traore
Last Name: Fousseni
Citizenship: Burkina Faso
Gender: Male
Degree: PhD
Discipline: Entomology
Host Country Institution to Benefit from Training: INERA
Training Location: University of Ouagadougou
Supervising CRSP PI: Dabiré, Clémentine
Start Date: 09/10
Project Completion Date: 06/13
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: 12/10
Training Status: Completed
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.
**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).

HC scientists will continue to hold workshops to train technicians, NGOs, and government officials in various aspects of biological control strategies as well as how to retrieve and submit materials to our online extension sharing system, which will be accessible to anyone with access to the internet. 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.

**Equipment (costing > $5000):** None.
<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
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</thead>
<tbody>
<tr>
<td>(Oct 1 2011-Sept 28, 2012)</td>
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</tr>
<tr>
<td><strong>Degree Training: Number of individuals who have received degree training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
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<td></td>
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<tr>
<td>Number of men</td>
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<tr>
<td><strong>Short-term Training: Number of individuals who have received short-term training</strong></td>
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<tr>
<td>Number of women*</td>
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<td></td>
</tr>
<tr>
<td>Number of men*</td>
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<tr>
<td><strong>Technologies and Policies</strong></td>
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<tr>
<td>Number of technologies and management practices under research</td>
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</tr>
<tr>
<td>Number of technologies and management practices under field testing</td>
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</tr>
<tr>
<td>Number of technologies and management practices made available for transfer</td>
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<td></td>
</tr>
<tr>
<td>Number of policy studies undertaken</td>
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<tr>
<td><strong>Beneficiaries:</strong></td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
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<td></td>
</tr>
<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
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</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
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<tr>
<td>Number of trade and business associations receiving technical assistance</td>
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<tr>
<td>Number of community-based organizations receiving technical assistance</td>
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</tr>
<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
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<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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</tr>
<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
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</tr>
<tr>
<td><strong>Developmental outcomes:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of additional hectares under improved technologies or management practices +</td>
<td>5000</td>
<td></td>
</tr>
</tbody>
</table>

"**" includes impact of videos and "+" includes areas where biocontrol agents are deployed and have become endemic.
**Dry Grain Pulses CRSP: FY 2012**

(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**

10/01/11 - 09/28/12

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>HC or U.S. Institution (5)</th>
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<tr>
<td>In-kind</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

| a. Personnel Cost | | | | | | | |
| Salaries          | $30,900.00       | $2,000.00             | $8,000.00                   | $8,000.00                   | $2,700.00                   | $2,700.00                   |                             |
| Fringe Benefit    | $10,956.00       | $200.00               | $800.00                     | $800.00                     |                             |                             |                             |

| b. Travel (Visit Host Country Scientists) | $8,000.00       | $1,600.00             | $1,600.00                   | $2,200.00                   | $270.00                     | $270.00                     |                             |

<table>
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<tr>
<th>c. Equipment ($5000 Plus)</th>
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</table>

| d. Supplies | $12,947.55 | $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 - Funds from P2-MSU-4 | $16,480.00 | |

| g. Technology Dissemination | $19,294.00 | $24,000.00 | $18,000.00 | $16,450.00 | |

| h. Total Direct Cost | $82,097.55 | $0.00 | $30,000.00 | $52,480.00 | $34,450.00 | $6,000.00 | $6,000.00 | $6,000.00 | $6,000.00 | $6,000.00 | $6,000.00 | $6,000.00 | $6,000.00 | $6,000.00 |

| i. Indirect Cost | $45,153.65 | $6,120.00 | $5,248.00 | $3,445.00 | $900.00 | $900.00 | | | | | | |

| j. Indirect Cost on Subcontracts (First $25000) | $3,795.00 |

| k. Total Indirect Cost | $45,153.65 | $6,120.00 | $5,248.00 | $3,445.00 | $900.00 | $900.00 | $3,795.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 | $4,695.00 |

| Total | $127,251.20 | $0.00 | $36,120.00 | $57,728.00 | $37,895.00 | $6,900.00 | $6,900.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 | $10,695.00 |

| Grand Total | $276,589.20 | |

---

**Amount**

| **Total direct cost budgeted for U.S. institution(s)** | 43.00% |
| **Total direct cost budgeted for H.C institution(s)** | 57.00% |

**Cost Share**

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<tr>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<tr>
<td>In-kind</td>
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<tr>
<td>Total</td>
<td>Cash</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
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<tr>
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<table>
<thead>
<tr>
<th>Attribution to Capacity Building</th>
<th>Percentage of effort</th>
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<th>50.00%</th>
<th>60.00%</th>
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<tr>
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<td>$5,347.50</td>
<td>$149,284.22</td>
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**Research, Training and Outreach Workplans**
*(October 1, 2011 -- September 30, 2012)*

**SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD**

**Project Title:**

<table>
<thead>
<tr>
<th>Identify Benchmark Indicators by Objectives</th>
<th>Abbreviated name of institutions</th>
<th>UIUC</th>
<th>IITA</th>
<th>INERA</th>
<th>INRAN</th>
<th>IER</th>
<th>IAR</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>4/1/12</td>
<td>9/30/12</td>
<td>4/1/12</td>
<td>9/30/12</td>
<td>4/1/12</td>
<td>9/30/12</td>
</tr>
</tbody>
</table>

**Objective 1: Characterize life-history patterns of pests of cowpeas**

- Pod sucking-bugs
  - Collect insects necessary of use of the molecular marker tool: X
  - Finalize collection of insects: X
  - Use polymorphisms to understand insect populations: X
- Groundnut aphid
  - X
- Thrips
  - X
- Maruca (as associated with control strategies)
  - X

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

- Collect insects necessary of use of the molecular marker tool: X
- Finalize collection of insects: X
- Use polymorphisms to understand insect populations: X

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

- Develop videos for training in pest control technologies: X
- Further voice overs in languages - Niger, Benin, Burkina Faso & Mali: X
- Interact with partner organizations to distribute materials: X
- Investigate impact and impact pathways for the extension materials: X
- Base line studies for future impact assessment (collaboration with P3-MSU-4): X

**Objective 4: Integrated Pest Management Strategies**

- Viral cottage product systems developed and deployed: X
- Viral + Neem testing + HPR (to control key pests of cowpea)
  - Assessment of yield increases of control strategies: X
- Thrip parasitoid releases in *Tephrosia* nursery plots: X
- Pod sucking bug biocentral agent field testing
  - M. virata parasitoid release deployment system finalized: X
- Use of *M. virata* parasitoid release system: X
### Objective 5: Collect Biocontrol Agents for Sequencing and Development of IPM-omics

| Biocontrol agent polymorphism testing | X | X |  |  |  |  |
| Pipeline of discovery and deployment of other biocontrol agents | X | X | X | X | X | X |
| Completion of White paper for cowpea IPM-OMICS | X | X | X | X |

### Objective 6: Institutional capacity building

| Technician, Peace Corps, and NGO training programs | X | X | X | X | X | X | X | X | X | X | X | X |
| Farmer Field Fora / Cell phone videos |  | X | X |  |  |  |  |  |  |  |  | X |
| Audio and videos for control strategies for pests of cowpeas | 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: 31-May-11
PII-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.

Collaborating Scientists and Institutions
Juan Carlos Rosas, EAP, Honduras
António Chicapa Dovala, IIA, Angola
Consuelo Estevez de Jensen, UPR, U.S.

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, common blight 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 for FY 2012

Objective 1: Development, release and dissemination of improved common 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 and Gasner Demosthene, National Seed Program, Min. of Agriculture, Haiti
António Chicapa Dovala, António Francisco Castame and Monica Martins, 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 produce 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 to the NGO’s involved in the multiplication and dissemination of improved seed.

During FY11, Monica Martins and Antonio David are expected to complete M.S. degree training in plant breeding and genetics at the University of Puerto Rico and return to Angola. This is expected to strengthen the capacity to conduct collaborative research with the Legume Program of the Instituto de Investigação Agronómica (IIA) in Angola. The focus of the research in Angola during the past two years has been the development of populations and the selection of elite bean breeding lines. Bean lines from Central America, the Caribbean and the U.S. that performed well in preliminary trials conducted in Angola were used as parents in crosses with Angolan bean landrace varieties. Project personnel will visit Angola twice during FY12 to meet with António Chicapa Dovala, António Francisco Castame, and other members of the IIA Legume Program. The goal for FY12 is to identify a set of elite bean breeding that will be ready for on-farm evaluation in Angola. The elite bean breeding lines will have commercially acceptable seed types (cranberry, manteca, red kidney and yellow) and greater yield potential and disease resistance than local landrace varieties.

**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 Investigação 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 plan to conduct an additional cycle of recurrent selection to develop Mesoamerican breeding lines with greater adaptation to low soil N. Preliminary screening conducted in Honduras and Puerto Rico identified disease resistant bean breeding lines that were used to form the base population for the first cycle of recurrent selection. During FY12, the performance of F$_4$ lines from the first cycle of RS will be evaluated in low-N plots in Honduras and Puerto Rico. Crosses to initiate the second cycle of RS will be
conducted during the upcoming year. 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. Black bean lines developed at the UPR with enhanced levels of root rot resistance and adaptation to low N soils were screened using molecular markers for BGYMV and BCMV resistance. These lines will be evaluated during FY12 in low-N plots in Haiti, Honduras and Puerto Rico. 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 seed yield under low N soils due to increased nodulation by resident rhizobia. 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. Zamorano and UPR scientists have experience conducting strain selection and inoculation studies. Both laboratories maintain collections of bean rhizobia and have the expertise needed to conduct the multifaceted research related to biological nitrogen fixation. Results from preliminary trials with Rhizobium tropici CIAT 899 and Rhizobium etli UMR 1597 indicated that the red mottled line PR0737-2 had the upper most nodule position with CIAT 899, while inoculation with UMR 1597 resulted in the highest nodule number. The pink bean PR0401-259 produced the greatest number of nodules among 15 lines evaluated when inoculated with CIAT 899. Results from the inoculation experiments suggest a cultivar preference for nodulation. Two field inoculation trials using the same lines and strains will study additional traits related to biological nitrogen fixation. Knowledge of the compatibility of the Rhizobium strain with bean cultivars is needed to successfully utilize inoculant to increase biological nitrogen fixation of common beans. The strain x bean line trials will be repeated in Honduras and Puerto Rico during the upcoming year. On-farm trials using different Rhizobium strains will be conducted in Honduras. The root traits of bean lines with superior BNF capacity will be characterized at Zamorano. The project plans to conduct informal training activities to strengthen the capacity to produce Rhizobium inoculum in Central America, 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* using syringes 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 for lectin-like genes reported to confer bruchid resistance. During the upcoming year, we expect to have segregating populations that can be screened for resistance to bruchids, BCMV, BCMNV and BGYMV.

We plan to screen Andean and Middle American bean populations to evaluate the effectiveness of the *PveIF4E*² marker for identifying the *bc-3* gene for BCMV and BCMNV resistance. In Puerto Rico, there are plans to initiate the use of the SR21 marker for screening for the *bgm* resistance gene. The SR21 marker has been successfully used at Zamorano.

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 have collected and characterized morphological and agronomic traits of 55 Lima bean landrace varieties from Puerto Rico, the Dominican Republic and Haiti. Collaborators at the University of Puerto Rico (Dimuth Siritunga) has evaluated the Lima bean landraces with 24 SSR markers. Another collaborator at the University of Delaware (Emmalea Ernest) plans to evaluate the landraces for HCN concentration in the primary leaf and the seed. Passport data has been collected so that the Lima bean landraces can be included in the CIAT germplasm collection. 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. The performance of cowpea lines from the University of California, Riverside Dry Grain Pulse CRSP project, IITA, Puerto Rico and Angola were tested in Puerto Rico during two growing seasons as part of the M.S. degree research of Angolan graduate student Antonio David. During FY12, seed of the most promising cowpea lines from these trials will be tested in Haiti, Central America and Angola. 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.

Because the tepary bean (Phaseolus acutifolius L.) is tolerant to drought and heat, farmers on the Pacific coast of Central America produce this pulse crop. Tim Porch has developed breeding lines of larger-seeded tepary beans that will be available for testing in Honduras during FY12.

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

**Degree Training**

Trainee # 1
First and Other Given Names: TBN
Last Name: TBN
Citizenship: TBN
Trainee # 2

First and Other Given Names: TBN
Last Name: TBN
Citizenship: TBN
Gender: TBN
Degree Program for training: B.S.
Program Areas or Discipline: Plant Science
Host Country Institution to Benefit from Training: TBN
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: October 2012
Projected Completion Date: December 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds: TBN
Amount Budgeted in Workplan, if providing full or partial support:
  Direct cost: $ TBN
  Indirect cost: 0
U.S. or HC Institution to receive CRSP funding for training activity: Zamorano

Trainee # 3

First and Other Given Names: Abiezer
Last Name: González
Citizenship: U.S.
Gender: Male
Degree Program for training: M.S.
Program Areas or Discipline: Plant Breeding and Genetics
Host Country Institution to Benefit from Training: N/A
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: James
Start Date: October 2011
Projected Completion Date: December 2011
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(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: UPR

**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 2011-2012  
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:  
  This training activity will be conducted in collaboration with Dry Grain Pulse CRSP Technology Transfer project in Haiti

*Training activity # 2*
Type of training: Informal training for the production, storage and use of *Rhizobium* inoculum  
Consuelo Estevez de Jensen, Emmanuel Prophete, Gasner Demosthene, Antione Wesner  
Location: Haiti  
Duration: One week  
Scheduling of training activity: Winter months 2011-2012  
Participants/Beneficiaries of Training Activity: National Seed Service personnel and National University faculty and students  
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:  
  This training activity will be conducted in collaboration with Dry Grain Pulse CRSP Technology Transfer project in Haiti

*Training activity # 3*
Type of training: Biological nitrogen fixation workshop for Central America and the Caribbean researchers  
Consuelo Estevez de Jensen and Juan Carlos Rosas  
Location: Honduras  
Duration: One week  
Scheduling of training activity: November 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: $____ in funding from the MO from for strengthening HC institutions  
  Indirect cost: $0  
If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:  
  This training activity will be conducted in collaboration with Dry Grain Pulse CRSP Technology Transfer project in Haiti

*Training activity # 4*
Type of training: In service training for senior students from Zamorano at the University of Puerto Rico
Consuelo Estevez de Jensen, Timothy Porch and James Beaver

Location: Puerto Rico
Duration: Four months
Scheduling of training activity: Jan. to April 2012
Participants/Beneficiaries of Training Activity: National Seed Service personnel and National University faculty and students
Anticipated numbers of Beneficiaries (male and female): 2 people

Amount Budgeted in Workplan
- Direct cost: $2,000
- Indirect cost: $0

If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:
- The students are expected to pay for most of their expenses for this practical training.

**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 and reduce storage loss.

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 and Haiti plant small red, black or red mottled bean cultivars developed by the Bean/Cowpea and Dry Grain Pulse CRSP projects. Because additional small red, black and red mottled bean lines are in an advanced stage of development, it is expected that the project will continue to have significant impact in Central America and the Caribbean during the current period of funding from the Dry Grain Pulse CRSP. We expect to test and release at least two improved black bean cultivars 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 improved pink and white bean cultivars and germplasm. 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 Martíns and Antonio David at the University of Puerto Rico includes training in plant breeding, plant pathology, and molecular methods. Their return to Angola will strengthen the capacity of IIA to conduct collaborative 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, we expect to develop at least one bean germplasm line with greater adaptation to low N soils and at least one Middle American bean germplasm line with enhanced BNF capacity. We also expect to identify the most effective *Rhizobium* strain(s) for bean production in Central America and Haiti.

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 50 Lima bean landraces will be collected from Puerto Rico, the Dominican Republic 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 CIAT germplasm collection. 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. We expect to identify at least one cowpea breeding line that has superior performance in Central America and the Caribbean.

**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 bean breeding activities in Central America and the Caribbean. 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 coordinates 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 coordinates the evaluation of red mottled bean regional performance trials in the Caribbean. He has provided 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 provides 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 play an active role in supporting the activities of the USAID-funded Technology Transfer project in Central America and Haiti.
Dry Grain Pulses CRSP
PERFORMANCE INDICATORS/TARGETS for FY 12
(October 1, 2011 -- September 30, 2012)

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<th>Output Indicators</th>
<th>2012 Target</th>
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<tr>
<td>Beneficiaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

PII-UPR-1
<table>
<thead>
<tr>
<th>Number of trade and business associations receiving technical assistance</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of community-based organizations receiving technical assistance</td>
<td>2</td>
</tr>
<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
<td>1</td>
</tr>
<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
<td></td>
</tr>
<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
<td></td>
</tr>
</tbody>
</table>

**Developmental outcomes:**

| Number of additional hectares under improved technologies or management practices | 2000 |
## Dry Grain Pulses CRSP: FY12

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

### FY12 (12 months) 10/01/11 - 09/30/12

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. Personnel Cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$3,040.00</td>
<td></td>
<td>$18,000.00</td>
<td>$19,950.00</td>
<td>$7,125.00</td>
<td>$5,700.00</td>
</tr>
<tr>
<td>Fringe Benefit</td>
<td>$760.00</td>
<td></td>
<td>$3,800.00</td>
<td>$3,990.00</td>
<td>$2,375.00</td>
<td>$1,900.00</td>
</tr>
<tr>
<td><strong>b. Travel</strong></td>
<td>$11,100.00</td>
<td>$0.00</td>
<td>$8,000.00</td>
<td>$5,700.00</td>
<td>$2,850.00</td>
<td>$7,125.00</td>
</tr>
<tr>
<td><strong>c. Equipment ($5000 Plus)</strong></td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>d. Supplies</strong></td>
<td>$7,600.00</td>
<td>$5,875.00</td>
<td>$7,600.00</td>
<td>$7,125.00</td>
<td>$7,125.00</td>
<td></td>
</tr>
<tr>
<td><strong>e. Training</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td>$8,000.00</td>
<td>$0.00</td>
<td>$3,800.00</td>
<td>$3,800.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Non-Degree</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$3,800.00</td>
<td>$3,800.00</td>
<td>$2,500.00</td>
<td>$2,135.00</td>
</tr>
<tr>
<td><strong>f. Other</strong></td>
<td>$0.00</td>
<td>$11,825.00</td>
<td>$0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>g. Total Direct Cost</strong></td>
<td>$28,500.00</td>
<td>$0.00</td>
<td>$36,675.00</td>
<td>$56,665.00</td>
<td>$21,975.00</td>
<td>$23,985.00</td>
</tr>
<tr>
<td><strong>h. Indirect Cost</strong></td>
<td>$7,125.00</td>
<td>$4,075.00</td>
<td>$8,500.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>i. Indirect Cost on Subcontracts (First $39000)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>j. Total Indirect Cost</strong></td>
<td>$7,125.00</td>
<td>$0.00</td>
<td>$4,075.00</td>
<td>$8,500.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$35,625.00</td>
<td>$0.00</td>
<td>$40,750.00</td>
<td>$65,165.00</td>
<td>$21,975.00</td>
<td>$23,985.00</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$187,560.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total direct cost budgeted for U.S. institution(s)</td>
<td>$58,500.00</td>
</tr>
<tr>
<td>Total direct cost budgeted for H.C institution(s)</td>
<td>$105,460.00</td>
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</table>

### Cost Share

<table>
<thead>
<tr>
<th></th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In-kind</strong></td>
<td>$24,412.00</td>
<td>$45,000.00</td>
<td>$99,412.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cash</strong></td>
<td>$0.00</td>
<td>$10,700.00</td>
<td>$10,700.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$24,412.00</td>
<td>$55,700.00</td>
<td>$110,112.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Attribution to IEHA Objectives

| Percentage of effort | 10.00% | 100.00% | 20.00% | 100.00% | 43.38% |
| Amount corresponding to effort | $3,562.50 | $40,750.00 | $13,033.00 | $23,985.00 | $81,330.50 |

### Attribution to Capacity Building (Theme "D")

| Percentage of effort | 25.00% | 25.00% | 50.00% | 50.00% | 33.33% |
| Amount corresponding to effort | $8,906.25 | $10,167.50 | $32,582.50 | $11,392.50 | $63,688.75 |

Name of PI & Institutional Affiliation: James S. Beaver, Dept. of Agron. and Soils, Univ. of Puerto Rico, Mayaguez, PR 00681-8030
Budget narrative

**UPR**

1. Personnel ($3,800) - Funds for technical assistance to conduct field and greenhouse experiments

2. Travel ($11,100)
   - December 2011 - James Beaver - trip to Angola - $5,000
   - January 2012 - James Beaver - trip to Haiti - $1,100
   - Spring 2012 - James Beaver - airfare for the trip to PI meeting in Africa - $2,500
   - April 2012 - James Beaver - trip to Honduras and the PCCMCA - $2,500

3. Equipment (No funding)

4. Supplies ($7,600) - Materials and supplies needed to conduct field, greenhouse and laboratory experiments and for shipping seed to Haiti.
   
5. Training
   - Degree ($6,000) – Research assistantship for Abiezer González to help conduct research related to the DGP CRSP project
   - Non-degree (No funding)

6. Other (no funding)

7. Total direct costs ($28,500)

8. Total indirect costs ($7,125)

9. Total ($35,625)

**USDA-ARS**

1. Personnel ($16,800) - Funds for technical assistance to conduct field and greenhouse experiments

2. Travel ($14,000)
   - December 2011 – Tim Porch - trip to Angola - $7,500
   - Spring 2012 - Tim Porch - airfare for the trip to PI meeting in Africa - $4,000
   - April 2012 - Tim Porch – trip to the PCCMCA - $2,500

3. Equipment (No funding)

4. Supplies ($5,875) - Materials and supplies needed to conduct field, greenhouse and molecular marker experiments.

5. Training
   - Degree (No funding)
   - Non-degree (No funding)

6. Other (no funding)
7. Total direct costs ($36,675)
8. Total indirect costs ($4,075)
9. Total ($40,750)

EAP
1. Personnel ($23,940)
2. Travel ($5,700)
3. Equipment (No funding)
4. Supplies ($7,600)
5. Training
   Degree ($3,800)
   Non-degree ($3,800)
6. Other ($11,825)
7. Total direct costs ($56,665)
8. Total indirect costs ($8,500)
9. Total ($65,165)

Haiti
1. Personnel ($9,500) - Funds for technical assistance to conduct field trials and conduct informal training
2. Travel ($2,850)
   • October 2011 – Emmanuel Prophete - trip to attend the BIC and visit Puerto Rico - $850
   • Spring 2012 - Emmanuel Prophete - airfare for the trip to PI meeting in Africa - $2,000
3. Equipment (No funding)
4. Supplies ($7,125) – Materials and supplies needed to conduct field experiments and to conduct informal training
   •
5. Training
   Degree (No funding)
   Non-degree ($2,500) – Informal training of farmers dealing with seed production and storage methods
6. Other (No funding)
7. Total direct costs ($21,975)
8. Total indirect costs No funding)
   •
9. Total ($21,975)
**Angola**

1. **Personnel ($7,600)** – Funds for technical assistance to conduct field and greenhouse trials and conduct informal training activities

2. **Travel ($7,125)**
   October 2011 - Antonio Chicapa - trip to attend the BIC and visit Puerto Rico - $5,000
   Spring 2012 – Antonio Chicapa Dovola - airfare for the trip to PI meeting in Africa - $2,125

3. **Equipment (No funding)**

4. **Supplies ($7,125)** - Materials and supplies needed to conduct field experiments and for

5. **Training**
   - **Degree (No funding)**
   - **Non-degree ($2,135)** – Informal training of farmers dealing with seed production and storage methods

6. **Other (No funding)**

7. **Total direct costs ($23,985)**
   •

8. **Total indirect costs No funding)**
   •

9. **Total ($23,985)**
## Project Title:
Development, Testing and Dissemination of Genetically Improved Bean

### Benchmark Indicators by Objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Benchmark Indicators by Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective 1:</strong> Development, release and dissemination of improved bean cultivars.</td>
<td>Germplasm acquired for key abiotic and biotic stress factors of Angola</td>
</tr>
<tr>
<td></td>
<td>Germplasm tested in Angola</td>
</tr>
<tr>
<td></td>
<td>Breeding populations developed</td>
</tr>
<tr>
<td></td>
<td>Breeding populations tested</td>
</tr>
<tr>
<td></td>
<td>Advanced trials conducted</td>
</tr>
<tr>
<td></td>
<td>Promising lines validated on farm</td>
</tr>
<tr>
<td></td>
<td>Cultivar released</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Benchmark Indicators by Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate lines from the first cycle of recurrent selection for enhanced BNF</td>
</tr>
<tr>
<td>Study <em>Rhizobium</em> strain x bean line interaction</td>
</tr>
<tr>
<td>On-farm trials to evaluate the performance of different <em>Rhizobium</em> strains</td>
</tr>
</tbody>
</table>

### Objective 3: Develop molecular markers for disease resistance genes.

<table>
<thead>
<tr>
<th>Benchmark Indicators by Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify potential markers for ashy stem blight resistance</td>
</tr>
<tr>
<td>Study the inheritance of common blight resistance</td>
</tr>
<tr>
<td>Test the effectiveness of new markers for BCMNV and BGYMV resistance</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Benchmark Indicators by Objectives</th>
</tr>
</thead>
</table>

---

*(Tick mark the Yes or No column for identified benchmarks by institution)*
### Objective 4: Evaluation of other pulse crops for Central America and the Caribbean

<table>
<thead>
<tr>
<th>Activity</th>
<th>Complete</th>
<th>Incomplete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test the performance of tepary (P. acutifolius) lines</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Complete first year of field testing of cowpeas in PR, Haiti, and Central America</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Characterize the phenological, morphological, and agronomic traits of P. lunatus (Haiti, PR)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

### Objective 5: Increase the capacity, effectiveness and sustainability of agricultural research institutions that serve the

<table>
<thead>
<tr>
<th>Activity</th>
<th>Complete</th>
<th>Incomplete</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-service training at the UPR of Zamorano students</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Workshop in Honduras concerning the production, storage and distribution of Rhizobium inoculum</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Informal training for seed production and storage on small farms</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

#### Name of the PI reporting on benchmarks by institution

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Beaver</td>
</tr>
<tr>
<td>Tim Porch</td>
</tr>
<tr>
<td>Juan Carlos Rosas</td>
</tr>
<tr>
<td>Antonio Chicapa</td>
</tr>
<tr>
<td>Emmanuel Prophete</td>
</tr>
</tbody>
</table>

**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.*
PIII-ISU-2

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

**Lead U.S. Principal Investigator and University:**
Mark E. Westgate  
Director, Center for Sustainable Rural Livelihoods  
Iowa State University  
110 Curtiss Hall  
Ames, IA  50011  
515-294-9106  
westgate@iastate.edu

**Collaborating Host Country and U.S. PIs and Institutions:**

**John Steven Tenywa:** Makerere University, Department of Soil Science. P.O. Box 7062, Kampala, Uganda. ph: +256-414-540-707, Cell: +256-772-487-404.  
istenywa@agric.mak.ac.ug

**Lynne Carpenter-Boggs:** Washington State University, BioAg Research Leader, Center for Sustaining Agriculture and Natural Resources, Dept. Crop and Soil Sciences, (509) 335-1553, lcboggs@wsu.edu

**Karen Cichy:** USDA-ARS, Sugarbeet and Bean Research Unit, East Lansing, MI, 48824-1325  
ph: 517-353-9262 ext. 4, Fax: 517-337-6782, karen.cichy@ars.usda.gov

**James D. Kelly:** Michigan State University, Department of Crop & Soil Sciences, East Lansing, MI 48824-1325.  
Ph: 517-355-0271 x 1181, Fax: 517-353-5174. kellyj@msu.edu

**Phillip Miklas:** USDA-ARS, Vegetable and Forage Crop Research, Prosser, WA 99350.  
ph: 509-786-9258; cell: 509-786-8492; Fax: 509-786-9277; phil.miklas@ars.usda.gov

**Henry Kizito Musoke:** Volunteer Efforts for Developmental Concerns, Kampala, Uganda. ph: +256-414-270-598, henrykizito@vedco.or.ug

**Susan Nchimbi-Msolla:** Crop Science and Production, Sokoine University of Agriculture, Morogoro, Tanzania, nchimbi@giant.suanet.ac.tz


**Augustine Musoni:** Institut des Sciences Agronomiques du Rwanda (ISAR), Nygatare Research Station, fmusoni@yahoo.com

**Michael Ugen:** National Crops Research Institute, Namulonge, Uganda. ph: +256-414-573-016, Fax: +256-752-726-554, michaelugen@yahoo.com

**Daniel Krohn:** (collaborator) Becker Underwood, Inc. 801 Dayton Avenue, Ames, IA. 50010. Ph: 515-956-2351, Cell: 515-509-1047. daniel.krohn@beckerunderwood.com

**Peg Armstrong-Gustafson:** (collaborator) amson technology l.c., 4010 University Avenue, Des Moines, IA 50311. Ph: 515-279-7767, Fax: 515-255-6101, peg@tmgmanagement.com
I. 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 a unique opportunity 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 N2 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.

II. Planned Project Activities in the Workplan Period (October 1, 2011 to September 28, 2012)

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-Objective 1a: To evaluate effectiveness of biologically stacked inoculants on local and improved germplasm.

We expect to:
1. Establish Field Trial 2 at HC field locations (NaCCRI, SUA, ISAR)
2. Test common bean varieties along with non-nodulating controls and high/low-N treatments at all HC trial locations (NaCCRI, ISAR, SUA)
3. Quantify yield advantage of inoculation for second cropping season (NaCCRI, SUA, ISAR)
4. Hold workshop for graduate students to share outcomes of research/training prior to 2012 CRSP meeting.
5. Attend Bean Improvement Cooperative Meeting in November 2011.

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

We expect to:
6. Complete analysis of plant/soil/weather data (ISU, Makerere, NaCCRI, SUA, ISAR)
   a. Initiate modeling studies of seasonal soil moisture profiles and bean yield
7. Confirm phenotype and yield response to inoculant x genotype x environment (ISU, Makerere, MSU, WSU, NaCCRI, SUA, ISAR)
   a. Incorporate new inoculants from Becker Underwood and local companies in field trials
   b. Quantify plant N, biomass, nodule classes, ureide levels prior to pod fill.
   c. Quantify yield, yield components, NUE, NHI.
   d. Quantify nodule classes and occupancy
8. Confirm indigenous rhizobia levels and relate to local environmental conditions (ISU, WSU, MSU, Makerere)

9. Confirm soil rhizobia soil populations and strain diversity at field sites
   a. Collect nodules, soil samples at field sites, store for analysis

10. Initiate root/nodulation study in greenhouse on selected lines (ISU, MSU, WSU)

11. Complete initial studies on strain x host interactions for BNF (WSU)

12. Identify most effective genotype-inoculant combinations for each eco-zone tested in HC (Makerere, NaCCRI, SUA, ISAR)

13. Calculate economic return for inoculation treatments for season 1 and 2 field trials (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](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 biomass, total plant N, petiole ureide levels prior to podfill, seed yield, seed N, and biomass 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:

14. Increase seed of BNF diversity panel lines in winter nursery.
15. Complete initial greenhouse screening on 50 selected lines for BNF response (WSU)
16. Evaluate correlative responses of BNF phenotypic characteristics in field and GH trials (ISU, MSU, WSU, NaCCRI, SUA, ISAR)
17. Confirm nodule rhizobia occupancy on selected lines from US and HC trials (WSU, SUA)
18. Test subset of BNF DP lines on low soil N +/- inoculants in HC field trials (MSU, WSU, NaCCRI, SUA, ISAR)
   a. Include high N treatment, non-nodulation lines for comparison

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

We expect to:

19. Characterize soil rhizobia soil populations and strain diversity at field sites
   a. Establish nodule rhizobia occupancy established on selected lines (WSU)
20. Confirm season 1 BNF phenotyping of selected populations [Bean CAP and South American Core]
   a. biomass, plant N, ureide levels prior to pod fill.
21. Conduct SNP analysis (SNP chip) on bean CAP and SA Core collection for association mapping with phenotype data (WSU, MSU).
22. Complete initial list of candidate genes associated with BNF for SNP associations (WSU, MSU).
23. Advance selected RILs to F3 (MSU, WSU)
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 increase seed of the BNF diversity panel (DP) consisting of 300+ Andean bean lines for evaluation. This panel will include lines from the current Bean CAP and South American Core collections, 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. A subset of 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).

Initial screening of selected lines will begin 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.

Initial phenotyping will focus on selected populations [Bean CAP and South American Core] for BNF response in US field sites. Data collected on each line/location will include biomass, plant N, ureide levels prior to pod fill. Ureide samples collected in the US will be analyzed at ISU. Samples collected in HC countries will be analyzed at NaCCRI. A mechanism will be established to correlate the phenotyping results of field and greenhouse trials.

The process of identifying genes associated with BNF response to inoculant will begin by collecting tissue samples from bean CAP and SA Core collections grown at WSU and/or MSU for SNP analysis (SNP chip). This approach will leverage SNP analyses currently being conducted by the bean CAP program. The primary constraint for utilizing these molecular markers effectively is collecting appropriate phenotype data to associate with the observed genetic variation. The phenotyping being conducted under this objective addresses this issue. Ultimately, phenotype data will be utilized for gene identification via association mapping as the gene sequence for Phaseolus becomes available in the near future.

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. We will continue to advance existing RIL populations for phenotyping 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. Given divergent
response for the parents the EP population will be tested at two sites (ARS-Prosser and -East Lansing) under low N.

**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:
24. Establish format for field demonstrations at HC research stations (ISU, MSU, WSU, VEDCO, Makerere, NaCCRI, SUA, ISAR)
25. Include information on N2 fixation and inoculation at research station/demonstration sites at (VEDCO, NaCCRI, SUA, ISAR)
26. Conduct field days in each HC to sensitize farmers and present research results (VEDCO, NaCCRI, SUA, ISAR)

Sub-objective 3b: *To conduct on-farm demonstrations comparing inoculant strategies*
We expect to:
27. Conduct on-farm trials initiated with selected farmer cooperators in all HC (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:
28. Create training materials to disseminate through PELUM farmer network
29. Conduct information dissemination meetings on BNF with PELUM-associated farmer groups in Rwanda, Tanzania, Uganda, and Kenya (VEDCO)
30. Incorporate research results into extension training programs, farmer advocacy meetings, and PELUM network website (VEDCO)
31. Determine potential for engaging international funding agencies to expand current technology transfer efforts (ISU, Makerere, VEDCO, NaCCRI, SUA, ISAR)
32. Conduct advocacy meetings with farmer groups and agribusiness interests (VEDCO)

**Collaborators:**
PELUM (Participatory Ecological Land Use Management Association) 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: “Increase 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.
Training/Capacity Building Workplan Format (January 1 to September 28, 2010)

This program includes formal training for seven MSc students and five undergraduate interns, and short-term training sessions for the entire BNF team on BNF protocols. 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. Graduate students will also be encouraged to attend a workshop to share research outcomes and training activities prior to the CRSP meeting in 2012

Degree Training:
Seven host country M.Sc. graduate students

<table>
<thead>
<tr>
<th>Name</th>
<th>Mercy Kabahuma</th>
</tr>
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<tbody>
<tr>
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<td>Iowa State University</td>
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<td>Mark Westgate</td>
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<td>If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID?</td>
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<tr>
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</table>
First and Other Given Names          Peter
Last Name                             Ssenyonga
Citizenship                          Uganda
Gender                               Male
Training Institution                 Makerere University
Supervising CRSP PI                  John Tenywa
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)   Active
Type of CRSP Support (full, partial or indirect) for training activity Full

First and Other Given Names          Kelvin
Last Name                             Kamfwa
Citizenship                          Rwanda
Gender                               Male
Training Institution                 Michigan State University
Supervising CRSP PI                  Kelley, Cichy
Degree Program for training          M.S.
Program Areas or Discipline          Plant Breeding/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           Genetic control of BNF
Start Date                           Fall 2010
Projected Completion Date            Summer 2012
Training status
(Active, completed, pending, discontinued or delayed)   Active
Type of CRSP Support (full, partial or indirect) for training activity Full

First and Other Given Names          Michael
Last Name                             Lege
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First and Other Given Names | Beatha |
---|---|
Last Name | Khafa |
Citizenship | Tanzania |
Gender | Female |
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 | Genotype evaluation for BNF |
Start Date | Summer 2010 |
Projected Completion Date | Summer 2012 |
Training status | Active |
Type of CRSP Support | full |

First and Other Given Names | Charles |
---|---|
Last Name | Komba |
Citizenship | Tanzania |
Gender | Male |
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) Active

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 management and benefits

Description of training activity: Participation in field operations

Location and farmers: Varied, depending on staff group locations

Duration: 8 weeks

When will it occur?: Summer 2012

Participants/Beneficiaries of Training Activity: Undergraduate students

Anticipated numbers of Beneficiaries (male and female): 1 male, 1 female

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 management and benefits

Description of training activity: Participation in field operations

Location and farmers: Varied, depending on staff group locations

Duration: 8 weeks

When will it occur?: Summer 2012

Participants/Beneficiaries of Training Activity: Undergraduate Students

Anticipated numbers of Beneficiaries (male and female): 2 female, 1 male student

PI/Collaborator responsible for this training activity ISAR, Musoni

Training justification:
Adaptation of new technology requires user understanding of
appropriate use, management, and pitfalls.

**VEDCO, NaCRRI, ISAR, SUA staff**

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<th>Staff and farmer education on inoculant technologies, management and benefits</th>
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<td>Description of training activity</td>
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<td>Training justification</td>
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### III. 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.

### IV. 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.
V. 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.

VI. 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 Institut 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.

VII. 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. Utilization of SNP analysis from the Bean CAP program represents a significant savings to the CRSP project as these data will be directly applicable for discovery of BNF-related genes and those regulating response to inoculation.

- 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.

VIII. Contribution of Project to Target USAID Performance Indicators:

(At this time—leave this field blank)

IX. Project Benchmarks (semi-annual indicators of progress):

(At this time –leave this field blank)
### Dry Grain Pulses CRSP

**PERFORMANCE INDICATORS/TARGETS for FY 12**
 *(October 1, 2011 -- September 30, 2012)*

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<td>Number of men</td>
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<td>Number of men</td>
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<td>Technologies and Policies</td>
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<td>Number of policy studies undertaken</td>
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<td><strong>Beneficiaries:</strong></td>
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<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
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<td>Number of producer organizations receiving technical assistance</td>
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<td>Number of trade and business associations receiving technical assistance</td>
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<td>Number of community-based organizations receiving technical assistance</td>
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<td>Number of women organizations receiving CRSP technical assistance</td>
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<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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<td>Number of HC partner organizations/institutions benefiting</td>
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<td>Number of additional hectares under improved technologies or management practices</td>
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PII-UPR-1
## Dry Grain Pulses CRSP: THIRD PERIOD

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

10/01/11 - 09/30/12

### Cost Share

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<tr>
<th>Institution Name</th>
<th>ISU</th>
<th>MSU/Kelly</th>
<th>ARS/Cichy</th>
<th>WSU/Boggs</th>
<th>ARS/Miklas</th>
<th>Makerere U</th>
<th>VEDCO</th>
<th>NaCCRI</th>
<th>ISAR, Rwanda</th>
<th>Sokoine Univ</th>
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- Total: $45,006.00
- U.S. for Host Country: $6,369.00
- U.S. Institution 1: $0.00
- U.S. Institution 2: $3,659.00
- U.S. Institution 3: $0.00
- U.S. Institution 4: $0.00
- U.S. Institution 5: $0.00
- U.S. Institution 6: $0.00
- U.S. Institution 7: $0.00
- U.S. Institution 8: $0.00
- U.S. Institution 9: $0.00

### Cash

- Total: $45,006.00
- U.S. for Host Country: $6,369.00
- U.S. Institution 1: $3,659.00
- U.S. Institution 2: $0.00
- U.S. Institution 3: $0.00
- U.S. Institution 4: $0.00
- U.S. Institution 5: $0.00
- U.S. Institution 6: $0.00
- U.S. Institution 7: $0.00
- U.S. Institution 8: $0.00
- U.S. Institution 9: $0.00

### Total

- Amount: $54,370.00

### Attribution to Capacity Building

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<tr>
<td>0.00%</td>
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</table>

### Totals

- Total direct cost budgeted for U.S. Institution(s): $146,181.00
- Total direct cost budgeted for U.S. Institution(s): $163,374.00
- Percentage of effort: 47.22%
- Percentage of effort: 52.78%
## Objective 1

**Quantified yield advantage of inoculation for second HC field season**

- Analysis of soil/weather data completed
- Confirmed phenotypic and yield responses to inoculant X Gen X Env.
- Confirmed indigenous rhizobia levels related to environmental conditions
- Root/nodulation study initiated
- Confirmed soil rhizobia populations and strain diversity
- Identified most effective genotype-inoculant combinations for each eco-zone
- Determined economic return for inoculation treatments at all yield levels
- Held BNF-CRSP team meeting
- Held workshop for graduate students on research results
- Attend Bean Improvement Cooperative Workshop

## Objective 2

**Tested subset of BNF panel lines in low N soil +/- inoculants in HC**

- Increased seed of BNF diversity panel lines
- Evaluated correlative response of BNF phenotype characteristics
- Characterized soil rhizobia populations and strain diversity at field sites
- Completed initial list of candidate genes for BNF response
- Advanced selected RILs to F3

## Objective 3

**Established format for field demonstrations at HC stations**

- Included information on N2Fixation and inoculation at demonstration sites
- Conducted field days in each HC to sensitize farmer on BNF
- Created training materials to disseminate through PELUM network
- Incorporated research results into extension training programs, farmer advocacy meetings, and PELUM network website
- Determined potential for engaging international funding agencies to expand current technology transfer efforts
- Conducted advocacy meetings with farmer groups and agribusiness interests

## Objective 4

**Graduate students identified**

- Graduate research programs initiated
- Undergraduate student interns identified
- Undergraduate student projects initiated

---

### Abbreviated names of institutions

<table>
<thead>
<tr>
<th>Abbreviated name of institutions</th>
<th>ISU</th>
<th>MSU</th>
<th>WSU</th>
<th>VEDCO</th>
<th>NaCCRI</th>
<th>SUA</th>
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<tr>
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<tr>
<td><strong>Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania</strong></td>
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### Semi-Annual Indicators of Progress by Institutions and Time Period

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<th>4/1/12</th>
<th>9/30/12</th>
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<td>Analyzed soil/weather data completed</td>
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<tr>
<td>Confirmed phenotypic and yield responses to inoculant X Gen X Env.</td>
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<tr>
<td>Confirmed indigenous rhizobia levels related to environmental conditions</td>
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<tr>
<td>Root/nodulation study initiated</td>
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<tr>
<td>Confirmed soil rhizobia populations and strain diversity</td>
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<tr>
<td>Identified most effective genotype-inoculant combinations for each eco-zone</td>
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<tr>
<td>Determined economic return for inoculation treatments at all yield levels</td>
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<tr>
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<tr>
<td>Held workshop for graduate students on research results</td>
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<td>Increased seed of BNF diversity panel lines</td>
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<tr>
<td>Characterized soil rhizobia populations and strain diversity at field sites</td>
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<td>Completed initial list of candidate genes for BNF response</td>
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<td>Advanced selected RILs to F3</td>
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### Name of the PI responsible for reporting on benchmarks

- Westgate
- Cityy
- Mikias
- Musoke
- Ugen
- McInnbi
- Bekunda
- Musoni

### Signature/Initials

<table>
<thead>
<tr>
<th>Name of the PI responsible for reporting on benchmarks</th>
<th>Westgate</th>
<th>Cityy</th>
<th>Mikias</th>
<th>Musoke</th>
<th>Ugen</th>
<th>McInnbi</th>
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Improving Nutritional Status and CD4 Counts in HIV-Infected Children Through Nutritional Support

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

Collaborating Host Country and U.S. PIs and Institutions: Theobald Mosha, Sokoine University of Agriculture, Tanzania; Henry Laswai, Sokoine University of Agriculture, Tanzania; Elizabeth Ryan, Colorado State University; Reuben Kadigi, Sokoine University of Agriculture, Tanzania.

I. Project Problem Statement and Justification:
The overall goal of the research is to determine if eating beans or cowpeas will improve the immune status of HIV-infected children more than if fish is consumed. 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 and 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.
II. Planned Project Activities in the Workplan Period

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

Approaches and Methods:
1. Purchase ingredients, cook and package food supplements, transport and distribute food supplements to 400 subjects.
2. Every three months collect and analyze blood samples from approximately 400 subjects; therefore 1,660 blood samples will be analyzed for CD4, CD8, CD3 and total lymphocyte counts.
3. Train two M.S. students to assist in research.
4. Provide field practical training in community nutrition and health for 10 undergraduates.

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

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 and cowpea-maize supplements and thin porridge from the supplements.
3. Determine costs associated with preparation of the fish-maize supplement and thin porridge from the supplement.

Objective 3: Determine if eating the bean-based and cowpea-based supplements improve 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

Approaches and Methods:
1. Analyze approximately 800 dried blood samples shipped from Tanzania for HIV load, selected pro-inflammatory cytokines, and R16s (a marker of bacterial translocation).
2. Develop a rodent model to study bacterial translocation from the intestine into tissues and blood. A bean-based diet is expected to reduce bacterial translocation and release of pro-inflammatory cytokines. The effectiveness of cowpeas will also be tested in this model.
3. Correlate changes in pro-inflammatory cytokines, and R16s in the human feeding study with the changes observed in the rodent model to help establish a mechanism of how feeding beans (maybe cowpeas) can improve immune status of HIV-infected children.
**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 students in Nutrition 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? No
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: N.
Last Name: Amos
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: 2011
Projected Completion Date: September, 2012
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: 2011
Projected Completion Date: September, 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:

Two short term training opportunities (HACCP training or attendance at a workshop related to public health and HIV) are being considered by the co-PIs Mosha and Laswai. Originally HACCP training was to be obtained by Drs. Mosha and Laswai, but the course at MSU was not offered. Alternative options are being considered; funds allocated to FY2010 would be used for this training.
**Equipment** (costing >$5,000): none

Specific Type of Equipment to be purchased:
Justification for equipment to achieve workplan objectives.
Institution to benefit from equipment:
Institution to purchase equipment:
Amount budgeted for equipment item:

III. Contribution of Project to Target USAID Performance Indicators:
Two women enrolled in doctoral programs will have received partial support and they will complete or be close to the end of their Ph.D. programs. Two women are expected to complete their M.S. programs. 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

IV. Target Outputs:
1. Four hundred 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. Two M.S. candidates will receive training in research methodology.
4. Ten undergraduates will receive field practical training.
5. Fifty potential entrepreneurs will visit the SUA exhibits displaying food products prepared from beans.

V. Engagement of USAID Field Mission(s)
Annual updates 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.

VI. Networking Activities with Stakeholders:
Networking will be a high priority and costs associated with networking were budgeted for FY12. We will target international agencies and emphasize the importance of nutrition and dry beans in the care of children and adolescents living with HIV/AIDS.

VII. 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 the time that the US PI and collaborator will spend on the project and this too is a “leveraged” resource.
Budget narrative for FY12

MSU:
1. Line a – (salary) $8,000 is for summer stipend for a Ph. D. student (Sharon Hooper) to assist in research for objective 1.
2. Line b – $15,000 total; $10,000 is requested for travel to meet with key decision makers regarding the potential for nutritional supplements to mitigate consequences of HIV and to attend scientific meetings. $5,000 is requested for Dr. Bennink and Dr. Ryan to attend the global PI meeting. (Note this $5,000 and the associated $2,600 indirect cost for Drs. Bennink and Ryan to attend the global PI meeting is in addition to the previously approved budget for year 3.)
3. Line d – $68,400 total; $56,000 for multiplex assays (800 assays @ $70/assay). $2,000 is for cost of shipping dried blood spots to US and $10,400 is for chemicals, reagents, animals, and animal per diems to perform the animal work related to objective 3.
4. Line h – Indirect cost is calculated as 52% of total direct costs.

US (MSU) for HC
1. Line d – $6,000 total; $1,000 for the purchase of spare parts for the extruder and other equipment necessary to produce the supplements. The parts will be purchased by Dr. Bennink and sent to SUA. The vitamin/mineral premix will be purchased ($5,000, line d) by Dr. Bennink and sent to SUA ($3,000 for shipping, line f).

SUA
1. Line a – $89,200 total; Salaries for technicians to run the extruder and prepare the supplements, clinical assistants to draw blood, nurses, site coordinators, technician to determine blood cell counts, out of station per diem for 2 graduate students and 2 faculty while conducting research activities related to objective 1.
2. Line b – $6,000 for travel to meet with key decision makers regarding the potential for nutritional supplements to mitigate consequences of HIV and to attend one scientific meeting.
3. Line d – $49,527 total for raw ingredients to produce the supplements and for determination of cell counts.
4. Line e – (degree) $5,600 for program fees for 2 M.S. students.
5. Line f – $43,600 is for transportation costs for delivering supplements to distribution sites.
## Dry Grain Pulses CRSP

### PERFORMANCE INDICATORS/TARGETS for FY 12

*(October 1, 2011 – September 30, 2012)*

<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree Training:</strong> Number of individuals who have received degree training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Short-term Training:</strong> Number of individuals who have received short-term training</td>
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<td></td>
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<tr>
<td>Number of women</td>
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<tr>
<td>Number of men</td>
<td>2</td>
<td></td>
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<tr>
<td><strong>Technologies and Policies</strong></td>
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<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under research</td>
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<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under field testing</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices made available for transfer</td>
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<td></td>
</tr>
<tr>
<td>Number of policy studies undertaken</td>
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<td></td>
</tr>
<tr>
<td><strong>Beneficiaries:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - <em>Female Headed households</em></td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - <em>Male Headed households</em></td>
<td>100</td>
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</tr>
<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of trade and business associations receiving technical assistance</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of community-based organizations receiving technical assistance</td>
<td>3</td>
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<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
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<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
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<td></td>
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<tr>
<td><strong>Developmental outcomes:</strong></td>
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<tr>
<td>Number of additional hectares under improved technologies or management practices</td>
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## Dry Grain Pulses CRSP: THIRD PERIOD

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

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>Institution (1)</th>
<th>Country</th>
<th>Institution (2)</th>
<th>Institution (3)</th>
<th>Institution (4)</th>
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<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>$8,000.00</td>
</tr>
<tr>
<td>Fringe Benefit</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Equipment ($5000 Plus)</td>
<td>$68,400.00</td>
</tr>
<tr>
<td>Supplies</td>
<td>$6,000.00</td>
</tr>
<tr>
<td>Training Degree</td>
<td>$5,600</td>
</tr>
<tr>
<td>Training Non-Degree</td>
<td>$3,000.00</td>
</tr>
<tr>
<td>Total Indirect Cost</td>
<td>$47,528.00</td>
</tr>
<tr>
<td>Direct Cost</td>
<td>$91,400.00</td>
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<tr>
<td>Indirect Cost</td>
<td>$13,680.00</td>
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<tr>
<td>Total</td>
<td>$138,928.00</td>
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<td>Grand Total</td>
<td>$346,535.00</td>
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### Cost Share

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<tr>
<th>Category</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
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<tbody>
<tr>
<td>In-kind</td>
<td>$25,709.00</td>
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<tr>
<td>Cash</td>
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Budgeted for U.S. institution(s): $100,000
Budgeted for H.C institution(s): $27,000
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<thead>
<tr>
<th>Percentage of effort</th>
<th>Amount corresponding to effort</th>
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</thead>
<tbody>
<tr>
<td>11.49%</td>
<td>$39,821.00</td>
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Institutional Affiliation: Maurice R. Bennink, Michigan State University
**Objective 1**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Target Achieved</th>
<th>Target Achieved</th>
<th>Target Achieved</th>
<th>Target Achieved</th>
<th>Target Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare, package, distribute food supplement</td>
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</tr>
<tr>
<td>Determine blood cell count</td>
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</tr>
<tr>
<td>Train M.S. student in research</td>
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<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Provide practical training</td>
<td>0</td>
<td>10</td>
<td>0</td>
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<td></td>
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**Objective 2**

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<tr>
<th>Objective</th>
<th>Target Achieved</th>
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<th>Target Achieved</th>
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<tbody>
<tr>
<td>Determine relative costs of nutritional supplements vs ART</td>
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<td>0</td>
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**Objective 3**

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<tr>
<td>Analyze dried blood spots</td>
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</tr>
<tr>
<td>Conduct animal study</td>
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<td>0</td>
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<td>0</td>
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**Objective 4**

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<th>Objective</th>
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<th>Target Achieved</th>
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Name of the PI reporting on benchmarks by institution

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.
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 and University:  
Mywish K. Maredia, Michigan State University

Collaborating Host Country and U.S. PIs and Institutions:  
Richard Bernsten and Eric Crawford, Michigan State University; HC and U.S. collaborators to be identified

I. 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.\(^4\) The primary focus of this project over the next three years will be on ex post impact assessment.

\(^4\) 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).
However, attention will be also devoted by the project PI to find (and fund, if budget allows) opportunities to include impact evaluation as part of CRSP projects to be implemented in Phase 2 and 3.

II. Planned Project Activities in the Workplan Period

**Objective 1:** 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 (PII-UCR-1, PII-UPR-1, PII-MSU-1)

**Approaches and Methods:**

In FY 12, the project team will focus on completing the West Africa impact assessment study on cowpea improvement research, the meta-analysis of ex post impact assessments of CRSP research and complete impact briefs based on all the documented impacts 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. The activities to be completed in FY12 include:

1a. **Benefits of genetic improvement of cowpea in Senegal and West Africa.** Due to delays in initiating the field survey in Senegal, the data analysis and a full report documenting the impacts of cowpea research in West Africa is anticipated to be completed in FY 12. 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 was initiated in early FY 11 to update and document the adoption of improved cowpea varieties in Senegal and Burkina Faso 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. The budget for data collection and field activities related to the adoption study ($32,054) is included in the FY 12 PII-UCR-1 project workplan/budget under ISRA and INERA.

1b. **Meta-analysis study.** The project plans to conduct a meta-analysis of the documented impacts of the Bean/Cowpea and Dry Grain Pulses CRSPs in FY 12. The study will present a comprehensive summary of outputs, outcomes and impacts realized from past investments by the Pulse CRSP (and predecessor Bean/Cowpea CRSP). This summary will include global contribution of CRSP to genetic improvement of common bean and cowpea (including the U.S., LAC and SSA), contributions of CRSP investments in food science research, and documented outputs and impacts of other types of research such as IPM, grain storage technologies, nutrition and policy research.
For those research activities where documented impacts include estimation of economic benefits, the study will conduct a meta-benefit-costs analysis. Meta-benefit-cost-analysis can be defined as an aggregate benefit-cost analysis to identify generalized patterns from case observations (Maredia and Raitzer, 2006 and 2010). Just as the traditional meta-analysis approach, this method attempts to assemble as broad a pool of cases as possible from which to draw inferences and derive generalizable results. However, unlike the more common approach to meta-analysis, which typically uses statistical analysis techniques (e.g., regression) of pooled data, the meta-B-C-analysis is a simple aggregation of benefits and costs derived from case studies (i.e., published or completed ex post impact assessments of CRSP research) and applying the general framework of benefit-cost analysis to estimate the rates of return across a portfolio. Such an approach is warranted due to the fact that each of the impact studies measures a separate but partial aspect of the response of a dependent variable (economic benefits) to a shared exogenous variable (total investment). The proposed meta-B-C-study will help ‘tell the impact story’ of the bean/cowpea and the Dry Grain Pulses CRSP in a comprehensive manner and will help identify areas of research that have had greatest impact and those that have had modest impacts or turned out to be ‘dry holes.’ This will be an analysis of the global program and should provide valuable information for the Final Technical Report of the Dry Grain Pulses CRSP and preliminary results may be useful to USAID as it decides on a five-year extension of the program through 2017.

Objective 2: Investigate opportunities to integrate baseline data collection and impact evaluation strategies as part of the CRSP project design

Collaborators:
This activity will be conducted in collaboration with graduate students, a post doc to be hired and Phase II and Phase III CRSP project PIs as noted for each study

Approaches and Methods:
In FY 12, the impact assessment project team will collaborate with the following CRSP project teams to conduct baseline assessment, design impact evaluations as part of CRSP projects implemented on a pilot scale, or conduct in-depth case studies to better understand sustainable models of dissemination of agricultural technologies (which is a critical element in the impact pathway to achieve developmental impacts).

2a. Baseline assessment of the economic effects of pest problems on cowpea growing areas in Burkina Faso. This will be a joint activity with the UIUC-HERA PII-UIUC-1 project team. To address the field insect pest problems like legume pod borer, bruchids, and pod sucking bugs for which conventional breeding has not been effective, the PII-UIUC-1 project is developing alternative strategies for control of these insect pests, in order to reduce the levels of pesticides used on cowpea crops. One of the strategies being explored by the project team is to implement a comprehensive bio-control program. This research is expected to generate following long-term impacts on cowpea growers in the region: 1) Health and environmental benefits from the reduction in the use (and misuse) of pesticides. 2) Economic benefits resulting from increased productivity (due to reduction in crop losses) and increased profitability (due to reduction in input costs) to cowpea growers in the region. The realization of these impacts of the bio-control research being conducted by the PI-UIUC-1 project, critically depends on the following
realities—1) the movement and spread of bio-control agents in relation to where the pest population is present; and 2) the pest control strategies practiced by farmers to control the pests in the absence of bio-control agents.

To estimate the long term benefits of this type of research requires three types of data/information: 1) a better understanding of the pest population (that are targeted by this research) in terms of its spatial distribution, 2) tracking the movement and spread of bio-control agents over time, and 3) the change in farmers’ pest control practices and/or productivity outcomes as a result of the introduction of bio-control agents in the environment. The PI-UIUC-1 project has collected (and collecting) data towards the first two types of information that will be useful to conduct an ex post impact assessment of this CRSP project in the future. For example, they have collected pre-release (i.e., baseline) and post-release data (i.e., after the introduction of biological control agents) on the abundance of insect pests in cowpea growing areas on wild legumes. They have also conducted controlled experiments to assess the efficacy of viral-based sprays (e.g., using neem oils) on M. vitrata populations and its effects on cowpea yields in test plots. They are also using the tools of genomics to characterize not only the pest populations, but also helps determine the location and migrations of endemic pest populations and those of the introduced beneficial biologicals.

As part of this project’s workplan, we plan to collect baseline data towards the third type of information that will be needed to assess the impact of bio-control research after several years of cumulative efforts by the UIUC-INERA team in Burkina Faso. In collaboration with an economist and PI-UIUC-1 project team at INERA, we plan to conduct a baseline survey of cowpea producers in two provinces of Burkina Faso which are targeted for the deployment of bio-control agents. The households to be included in the baseline survey will be selected based on a stratified random sampling method. The plan is to collect baseline data from 560 households from 56 villages across the north and central parts of Burkina Faso. A detailed survey instrument will be developed by the MSU and INERA socio-economist team with input from the PI-UIUC-1 project team members. The instrument will include questions related to household and farm characteristics, village level characteristics, cowpea production practices (including pest control strategies) and outcome indicators, detailed input cost data to estimate the farm-level budgets, and farmers’ perception on pest problems and its effects on yield and input use.

The data will be analyzed jointly by the INERA and MSU team and results will be documented in a baseline report to be submitted to the Management Office. The data and analysis of this baseline assessment will serve as the ‘before’ scenario which can be compared with an ‘after’ scenario where the same households could be re-visited after 4-5 years to conduct an ex-post impact assessment of bio-control research in Burkina Faso. The budget for data collection and field activities related to the planned survey is included in the FY12 PII-UIUC-1 project workplan/budget under INERA ($18,128).

2b. Impact evaluation to test the effectiveness and impacts of methods of extension to disseminate materials for IPM of cowpea pests

Over the past few years, the PII-UIUC-1 project team has developed several extension materials using audio, video and print media. In FY 12, the project plans to pilot deployment strategies to
disseminate these materials to several villages in each host country through several methods of extension such as farmer field schools, extension presentations, video viewing clubs, cell-phones, etc. These activities will be undertaken in partnerships with NGOs and other government organizations. This pilot scale activity offers an opportunity to design the deployment strategy to address some policy relevant impact questions such as the effectiveness of different extension models to disseminate the IPM messages developed by the CRSP project.

In collaboration with the PII-UIUC-1 project team, we plan to address some policy relevant questions by integrating impact evaluation as part of the design of the deployment strategy and collect appropriate farm-level data to capture the effects of the extension messages and methods used to deploy them on changes in farmers’ knowledge, perceptions and behavior. The plan is to explore a randomized control trial (RCT) design in one country—Burkina Faso, whereby villages that will receive the extension interventions through different methods (the ‘treatment’) will be randomly selected from a larger pool of villages that all meet certain criteria in terms of importance of cowpea, geographic locations, etc.. To achieve statistical robustness, the goal is to have a minimum of 20 villages in each treatment group.

The plan for this project team would be to help design the deployment strategy based on RCT methodology, develop survey instruments to collect data from a subset of randomly selected farmers from the treatment villages (i.e., 10 farmers per village), and analyze the data to derive policy lessons. An advantage of a randomized experiment such as this is that the observed difference in the outcome variables between the treatment and control groups can be attributed to the treatment variable (i.e., the extension method). The results of this pilot study will generate data/information on the treatment effects (i.e., what is the effect of the extension messages in terms of outcomes) and also help identify the most cost-effective methods to scale-up methods of delivering ‘knowledge-based technologies’ beyond the pilot scale. The survey instrument will also include questions to identify the ‘content’ of delivery mechanisms that farmers value and demand the most. This will be useful to researchers as they try to develop and package a diversity of messages in the most effective delivery method.

The cost of this study is estimated to be around $20,000. Half of the cost ($10,000) of doing this activity is included in the FY12 PII-UIUC-1 project workplan/budget under INERA and the other half is requested as supplemental funding in a joint proposal submitted to the Management Office.

2c. Benefit/Cost (B/C) analysis of the bean-based nutrition intervention in Tanzania

The PIII-MSU-3 project team from MSU and SUA is conducting feeding trials to determine if eating beans will improve the immune status of children that are not being treated with antiretroviral drugs. The trial includes subjects between the age of 2-15 years that are infected with HIV and are divided into two groups—those receiving a bean-maize supplement and those receiving a fish-maize supplement. The hypothesis being tested by this experiment is that the children and adolescents eating a bean-maize supplement will maintain higher CD4 % than HIV infected 2 to 15 year old children and adolescents eating a fish-maize supplement. As part of this study, the research team is collecting and analyzing blood samples for CD4, CD8, CD3 and total
lymphocyte counts. The team is also collaborating with a SUA economist to determine the relative costs of three dietary treatments compared to HAARV drug treatment.

In FY 12, we plan to collaborate with the MSU-SUA team to explore the possibility using some of the data already collected and/or to be collected to conduct a benefit-cost analysis of the alternative treatments to enhance the nutritional status of HIV infected children and adolescents. Such an analysis will help address questions that most policy makers are interested, such as: how do alternative treatment approaches rank in terms of costs and benefits to the children/adolescents infected with HIV?

As a first step, this project team will hold discussions with the PIII-MSU-3 team to explore the feasibility of doing this analysis. The main question to be addressed at this stage is whether the data collected by the study provides enough information to convert the measurements of outcomes (e.g., CD% in blood stream) into indicators of benefits or ‘well-being.’ If deemed feasible and of mutual interest, the next step for this project team will be to identify the indicators of benefits, estimating these benefits for the experimental groups receiving alternative supplements, and researching on how those indicators can be converted into a monetary value to include in a benefit/cost analysis. On the cost side, this team will work closely with the SUA economist to collect detailed data to value all the costs involved in providing different treatments to experimental subjects. HAARV drug treatment may be included as one of the alternatives in the Cost/benefit analysis, if there are similar data available on both the benefit and cost side. Looking ahead, the results of this economic benefit/cost analysis will be useful in communicating the results of this important research to policy makers on the nutritional benefits of eating beans and the cost-effectiveness of different approaches to guide them in designing programs targeted towards HIV infected children and adolescents.

2d. Case study of the bean seed multiplication and distribution system in Central America

A major theme focused by the Pulse CRSP is to reduce bean and cowpea production costs and risks for enhanced profitability and competitiveness. One of the most important outputs of research that contributes to this thematic goal is improved varieties with traits that reduce production costs (varieties resistant to biotic stresses such as pests and diseases) and risks (e.g., varieties resistant to abiotic stresses such as drought and cold). About half of the phase II and III projects currently being funded by the Pulse CRSP will be generating outputs that will be incorporated in improved genetic planting materials—i.e., seed. The impact pathway to realize the impact of this line of research (i.e., genetic improvement using either conventional methods or modern tools of molecular biology) depends critically on the system that delivers these improved materials from researchers’ experimental fields and laboratories to farmers’ fields. In the absence of an effective and well-functioning seed multiplication and distribution system that links the technology suppliers (i.e., researchers) with the demanders (i.e., farmers), investments in research will not lead to any adoption outcomes and thus will not generate the impacts envisioned for such investments.

In most cases, the prospect of earning ‘profits’ serves as a strong incentive for the private sector to fill in the gap between the supply and demand of technology. The elements on the demand side that increase the prospects of earning profits are—the size and predictability of the demand
for new seeds every year. In a developing country setting, in the case of self-pollinated crops such as beans and cowpeas (and most other pulses), these elements on the demand side (size and predictability of demand for seed) are not at the level to induce private sector investment in the seed system. This means that the sustainability of a seed multiplication and distribution system has to depend on players that are not solely motivated by profits but by a greater public good.

Many models of seed multiplication and distribution system have been tried that are based on a combination of private, NGO and public sector partners playing niche roles in filling the gap between technology supply and demand. Examples of some of the models used to fill this gap include systems based on farmer cooperatives, strengthening networks of village-based agrodealers, promoting farmer operated seed enterprises, supporting farmer associations or CIALs, providing incentives to private seed companies to expand their product lines, etc. Some of these models are also being used by the Pulse CRSP in its ‘Bean Technology Dissemination’ project currently being implemented (through an Associate Award) in four countries in Central America (i.e., Honduras, Haiti, Guatemala and Nicaragua). Among these models, the model being used in Nicaragua is the most novel and unique, which is based on the concept of community managed and operated seed banks or “bancos comunitarios de semilla.” The seed bank model operates on the principles of self-help, whereby community members come together to produce seeds to meet their own current needs, save seeds for future seed security, and sell excess seeds to generate revenues to cover production costs. The national bean research program (INTA) through its network of regional offices plays an important role in supplying the basic seed stocks of improved varieties to community seed banks and provide technical assistance to ensure that the seeds produced by the seed bank meet some minimum quality standards as planting materials. In Honduras, the model being used is based on CIALs (or farmer associations) taking up the role of seed multiplication and distribution, in Guatemala, the model is based on the public sector playing a major role throughout the seed value chain, and in Haiti, the project is trying to use a dual approach based on private sector selling the seeds through retail outlets and the public sector distributing the seeds to resource poor farmers.

This seed dissemination project implemented in four countries in Central America offers a good opportunity to do an in-depth analysis of the unique features of different models for seed multiplication and distribution so as to identify principles of sustainability present/absent from these different models and derive implications and lessons for broader applicability to other countries where Pulse CRSP is involved. As part of the bean technology dissemination project, the lead PI of this project will be assisting in setting up a performance monitoring system to track data/information on quantities of seeds produced and distributed throughout the seed value chain. To complement that effort, this project plans to undertake a research study focused on identifying “elements of sustainability of the bean seed system’ using a case study approach. In FY12, the project team will initiate an in-depth case study of the economics of the seed bank model in Nicaragua. The work will involve key informant interviews with people involved in different aspects of the seed value chain, collecting critical information throughout the seed system to be able to estimate the costs of seed multiplication and distribution, use the data on quantity of seeds produced through the BTD project to assess the size and scale of potential benefits, and conduct a few randomly selected farmer interviews to get their perceptions on the cost and benefits of the seed banks in their communities. The plan is to collect this data at least for Nicaragua in FY 12. The analysis will be completed and/or extended to other countries in
subsequent years either through CRSP support in the extension phase or through the BTD project support under the project performance monitoring plan.

**Objective 3:** 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 1 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 objective 2 will be conducted in close collaboration with the U.S. and HC PIs from existing and new 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 12 include:
   1. Byron Reyes
   2. David DeYoung
   3. Ben Megan

**III. 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.

**IV. Target Outputs:**

Specific outputs to result from this project by the end of the 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.

V. 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.

VI. 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.

VII. Leveraging of CRSP Resources:

The following opportunities will continue to be explored in FY 12: 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 2 of this project.

Training/Capacity Building Workplan Format

**Degree Training:**
None

**Short-term Training:**
None

**Equipment** (costing >$5,000):
None
## Dry Grain Pulses CRSP: THIRD PERIOD

**P3-MSU-4: Impact Assessment**

### 10/01/11 - 09/29/12

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### a. Personnel Cost
- Salaries (incl. GA stipend) $33,728.13
- Fringe Benefit (for staff, excl GA) $3,810.50

### b. Travel
$13,610.00

### c. Equipment ($5000 Plus)

### d. Supplies
$1,060.00

### e. Training (degree)
- Tuition/fees $11,122.02
- Other costs (e.g. insurance) $2,457.71

### f. Other

### g. Total Direct Cost
$65,788.36

### h. Indirect Cost
$28,426.50

### i. Indirect Cost on Subcontracts (First $25000)
$28,426.50

### j. Total Indirect Cost
$28,426.50

### Total
$94,214.85

### Grand Total
$94,214.85

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### Attribution to Capacity Building

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<td>$47,107.43</td>
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### Name of PI & Institutional Affiliation: Mywish Maredia, Michigan State University

Notes: The total budget for this project in FY 12 is $154,397 and includes the following allocations to different projects to conduct collaborative research:
- PII-UCR-1 (for ISRA and INERA): $32,054
- PII-UIUC-1 (for INERA): $28,128
- PII-MSU-4 (as noted in this Table): $94,215

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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
John Shindano, University of Zambia, Zambia
Kalaluka Lwanga Munyinda, University of Zambia, Zambia
Kennedy Muimui, Zambia Agriculture Research Institute (ZARI), Zambia
Abdul Faraj, 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 for FY 2012**

**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, phenolic acid esters, dietary fiber], as well as protein content and quality. Association between these traits and seed color and seed characteristics will be determined.

*The bulk of this objective has been accomplished; most of the tests outlined here will be selective and confirmatory in nature, especially in relation to heritability of the key traits.*

*Gross phenolic composition.* Will be used to confirm heritability of composition in progeny. 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 \( \lambda_{\text{max}} \) 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 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. 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 Pretoria, Texas A&M)*

**NMR characterization.** To obtain accurate chemical structure, major unidentified compounds in the elite cowpea lines with the highest bioactivity will be purified using semi-prep HPLC (Agilent 1200) and the fractions collected, pooled and freeze-dried. Freeze-dried extracts will be dissolved in DMSO-d₆; both ¹H (at 400 MHz) and ¹³C (at 100 MHz) spectra will be recorded at room temperature using a Varian Inova 400 spectrometer. *This technique will only be necessary if important compounds cannot be fully characterized by other methods* *(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 30 - 75 min (until soft), and then drying at 45 – 50 °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 multi-enzyme (i.e. pancreatic trypsin, chymotrypsin and peptidase) method. *(University of Zambia, Egerton University, 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 2:** Establish how the phytochemical profiles of cowpeas affect bioactivity by measuring key markers/predictors of protection against chronic diseases

**Collaborators**
Donna Winham, Arizona State University Polytechnic, USA
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. It is important to note that these assays will be done on either organic extracts or enzymic digests (simulating GIT conditions) of raw and cooked cowpea samples. Preliminary results indicate that higher levels of total phenolics and corresponding antioxidant activities are obtained for enzymic digests. The F3 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. 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⁺ 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. (Egerton University, University of Zambia, Texas A&M) From these tests, representative lines will be selected and tested along with their parents 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 cooked cowpea powder will be dispersed 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, Texas A&M)

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 atherosclerosis 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, Texas A&M)

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) (**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 using human colonic myofibroblasts (CCD-18co). We will measure:
- **Biomarkers for inflammation:** nuclear factor kappa B (NFκ-B), interleukins IL-6, IL-8, tumor necrosis factor TNF-α 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 H₂O₂, the alleviating effects of cowpea will be assessed with the ApoAlert™ DNA Fragmentation Assay (BD Biosciences) according to the manufacturer’s protocol. (**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**
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.

At this stage we will complete genetic studies and establish heritability of bioactivity traits in cowpea. We expect to conduct detailed genetic analysis up to F3, including appropriate field trials in Texas, Kenya, and Zambia. Selected F2 and F3 seeds will be shared with national programs to facilitate continued breeding and seed improvement for healthy cowpea cultivars. (Texas A&M/University of Zambia/Egerton)

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 develop a training manual and/or brochures for use by stakeholder representatives to disseminate findings from this work. These will be distributed to stakeholders who were involved in training in Year 2. Each HC PIs will organize a second 1 day workshop for 15-20 in each HC for stakeholder representatives from the government ministries and research institutions, local NGOs and women organizations. The US PI will participate in the workshops. The workshops will discuss the results from the project and how to use the information to influence public policy as well as public image of cowpea. Brochures/manuals developed will be discussed and distributed to stakeholders for use in dissemination of findings. Plans for follow-up and future collaborative efforts will be discussed with stakeholders and strategies devised to seek additional resources and community involvement. The stakeholders will also provide feedback on effectiveness of Year 2 training. HC education and extension specialists will be engaged as consultants. (University of Zambia/Egerton)

Objective 5: Strengthen cowpea nutrition research in Kenya and Zambia

Collaborators
Gary J. Wingenbach, Texas A&M University, USA
**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), 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 be at advanced stages of their PhD training at University of Pretoria, South Africa. However, due to the late start date of the project, we don’t expect the HC trainees to complete their studies by September 29, 2012. We will thus likely seek a no cost extension to enable the candidates finish their studies. PhD students, A Nderitu and T Hachibamba will be doing advanced cell line and analytical research work with Dr Awika at Texas A&M for 5 months (July 2011 – November 2011). Egerton University is also training 1 MS student who is currently working on the project.

**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. Training manuals developed with input from stakeholders will be used to train stakeholder representatives on effective ways to disseminate findings on health benefits of cowpea to influence policymakers and broader population.

**Contribution of Project to Target USAID Performance Indicators**
Degree training – 4 PhD students and 1 MS (3 directly benefiting HC research capacity)
Short term training – at least 30 stakeholders trained through workshops
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 confirmed.
Ability of antioxidant rich cowpea cultivars to influence cardiovascular markers established.
Ability of elite cowpea cultivars to influence cancer initiation and growth determined.
Ability of elite cowpea lines to regulate inflammation established.
Major bioactive compounds in cowpea identified
F3 seeds obtained, field crosses performed at TAMU.
F3 seeds characterized for heritability of key bioactive traits.
Brochures and/or training manuals specific to each HC needs will be prepared and distributed to stakeholders and key policymakers.
At least 30 stakeholder representatives (15 from each HC) trained on dissemination of nutrition and health benefits of cowpea.
Research findings published in scientific journals - at least 2
Four PhD graduate student trainees are at advanced stages of their research (2 from HC at University of Pretoria and 2 at Texas A&M) and Masters research (1 from HC at Egerton University)

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 continue consulting 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.

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 involving local NGOs representatives, like Peter Mwangi of World Vision International, and Ruth Oniang’o of Rural Outreach Program.

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
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: Gyebi Duodu, Amanda Minnaar, Joseph Awika  
Degree Program for training: PhD  
Program Areas or Discipline: Food Science and nutrition – She is contributing to the project in terms of potential effects of phenolic compounds from cooked cowpea varieties with low and high antioxidant activities, on cardiovascular disease prevention.  
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: Potential effects of phenolic compounds from cooked cowpea varieties with low and high antioxidant activities, on cardiovascular disease prevention  
Start Date: August 2010  
Projected Completion Date: 2013*  
Training status (Active, completed, pending, discontinued or delayed): Active  
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: Gyebi Duodu, Amanda Minnaar, Joseph Awika  
Degree Program for training: PhD  
Program Areas or Discipline: Food Science and nutrition – She is contributing to the project in terms of potential effects of phenolic compounds from cooked cowpea varieties with low and high antioxidant activities, on cancer chemoprevention.  
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: Potential effects of phenolic compounds in enzyme digests from cooked cowpea varieties with low and high antioxidant activities, on cancer chemoprevention.  
Start Date: August 2010  
Projected Completion Date: 2013*  
Training status (Active, completed, pending, discontinued or delayed): Active  
Type of CRSP Support (full, partial or indirect) for training activity: Full

**PhD Student 3:**  
First and Other Given Names: Leonnard  
Last Name: Ojwang  
Citizenship: Kenya  
Gender: Male  
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: Egerton  
Thesis Title/Research Area: Antiinflammatory properties of cowpea as influenced by phenotype and phenolic composition  
Start Date: August 2009  
Projected Completion Date: Sept 2011
Training status (Active, completed, pending, discontinued or delayed): Active
Type of CRSP Support (full, partial or indirect) for training activity: Partial

PhD Student 4:
First and Other Given Names: Archana
Last Name: Gawde
Citizenship: India
Gender: Female
Training Institution: Texas A&M University
Supervising CRSP PI: Joseph Awika, BB Singh
Degree Program for training: PhD
Program Areas or Discipline: Molecular and Environmental Plant Science
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID?
Host Country Institution to Benefit from Training: ?
Thesis Title/Research Area: Genetics and heritability of health promoting bioactive traits in Vigna unguiculata
Start Date: January 2009
Projected Completion Date: Sept 2012
Training status (Active, completed, pending, discontinued or delayed): Active
Type of CRSP Support (full, partial or indirect) for training activity: Partial

MS Student 1:
First and Other Given Names: Billy
Last Name: Kiprop
Citizenship: Kenya
Gender: Male
Training Institution: Egerton University
Supervising CRSP PI: Abdul Faraj
Degree Program for training: MS
Program Areas or Discipline: Biochemistry
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID?
Host Country Institution to Benefit from Training: Egerton
Thesis Title/Research Area: Antioxidant and phenolic composition of Kenyan cowpea of different phenotypes
Start Date: January 2010
Projected Completion Date: Sept 2011
Training status (Active, completed, pending, discontinued or delayed): Active
Type of CRSP Support (full, partial or indirect) for training activity: Partial

Short-term Training:
Type of training: Workshop for stakeholders and training manual dissemination
Description of training activity: Training manuals developed with input from stakeholders will be used to train stakeholder representatives on effective ways to disseminate findings on health benefits of cowpea to influence policymakers and broader population.
Location: University of Zambia; Egerton University, Kenya
Duration: 1 day
When will it occur: April-August 2012
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: John Shindano, Abdul Faraj, Joseph Awika
List other funding sources that will be sought (if any): N/A
Training justification: Will enable stakeholder representatives to interpret research findings and accurately convey the message to a lay audience, and also use it to influence policymakers.
*Extension will likely be requested due to delayed project start date.
## Dry Grain Pulses CRSP

**PERFORMANCE INDICATORS/TARGETS for FY 12**

**(October 1, 2011 -- September 28, 2012)**

<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree Training:</strong> Number of individuals who have received degree training</td>
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<tr>
<td>Number of women</td>
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<tr>
<td>Number of men</td>
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<tr>
<td><strong>Short-term Training:</strong> Number of individuals who have received short-term training</td>
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<tr>
<td>Number of men</td>
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<tr>
<td><strong>Beneficiaries:</strong></td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
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</tr>
<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
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<tr>
<td>Number of producer organizations receiving technical assistance</td>
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<tr>
<td>Number of trade and business associations receiving technical assistance</td>
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<tr>
<td>Number of community-based organizations receiving technical assistance</td>
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<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
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<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
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**Developmental outcomes:**

| Number of additional hectares under improved technologies or management practices | 0 |
**Dry Grain Pulses CRSP : THIRD PERIOD**

Increasing utilization of cowpeas to promote health and food security in Africa

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>UNZA (Zambia)</th>
<th>Egerton (Kenya)</th>
<th>UP (S. Africa)</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
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<td><strong>c. Equipment ($5000 Plus)</strong></td>
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<td><strong>e. Training</strong></td>
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<td><strong>f. Other</strong></td>
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<td>j. Total Indirect Cost</td>
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| Total direct cost budgeted for U.S. institution(s) | $62,068.00 | 46.79% |
| Total direct cost budgeted for H.C institution(s) | $70,578.00 | 53.21% |

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<th>Cost Share</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
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<table>
<thead>
<tr>
<th>Attribution to Capacity Building</th>
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<tbody>
<tr>
<td>Percentage of effort</td>
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<tr>
<td>Amount corresponding to effort</td>
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U.S Institution PI: Joseph Awika
### Project Title:
Please enter your project title here

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<th>Objective 1</th>
<th>TAMU</th>
<th>UNZA</th>
<th>EGER</th>
<th>UP</th>
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<td>Inhibition of LDL oxidation</td>
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<td>0</td>
<td>0</td>
<td>x</td>
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<tr>
<td>Objective 3</td>
<td></td>
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<tr>
<td>Plant F3 and parents</td>
<td>x</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>Field trials</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Objective 4</td>
<td></td>
<td></td>
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<tr>
<td>Gather stakeholders input</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Summarize stakeholder input</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>0</td>
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<td>Formulate outreach strategies</td>
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<td>x</td>
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<td>0</td>
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<tr>
<td><strong>Achieved</strong></td>
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</tbody>
</table>

#### Benchmarks by Objectives

* Please provide an explanation for not achieving the benchmark indicators on a separate sheet.
PIII-KSU-1
Pulse Value Chain Initiative—Zambia (PVCI-Z)

Lead U.S. Principal Investigator and University:
Vincent Amanor-Boadu, Kansas State University

Collaborating Host Country and U.S. PIs and Institutions:
1. Gelson Tembo, University of Zambia
2. Mukwiti Mwiinga, University of Zambia
3. Prisilla Hamukwala, University of Zambia
4. Rebecca Lubinda, University of Zambia
5. Tim Dalton, Kansas State University
6. Allen Featherstone, Kansas State University
7. Kara Ross, Kansas State University

1. 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.

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5 Dr. Kara Ross has been recruited to replace Dr. Mahmud Yesuf who left K-State. Dr. Ross is an agribusiness specialist who has worked under and with Dr. Amanor-Boadu for more than six years.
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 industries. 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.

Project Website

- Populating the Project Website
  - The project website (http://valuechains.k-state.edu) was developed and launched at the end of November 2010. Populating the site with content has been slow because of challenges in getting the project under way. However, now that field work is commencing, it is expected that the content on the website for FY 2012 will reach the level that is expected.
  - Secondary industry data from CSO and a number of NGOs were used by the project’s undergraduate students for their project reports, a partial degree requirement at UNZA. These reports currently being reviewed by HC collaborators and would be made available in appropriate formats on the project website as soon as the reviews and editing are completed.
  - Dr. Vincent Amanor-Boadu maintains responsibility for the website. Content will be supplied from the work of students and faculty involved with the project.

Guiding Student Research

- The three MS and MAB students are currently pursuing their course work and should begin their research in the fall 2011 with completion expected by fall 2012 and summer 2013 respectively. Please note that withdrawals of recruited students from the UNZA MS program (see below) have necessitated changes in completion date for the MS students.

- Graduate students are being guided and in their research by Dr. Vincent Amanor-Boadu, Dr. Allen Featherstone, Dr. Timothy Dalton and Dr. Gelson Tembo.

Category I Objectives

- Field work: Data collection at the producer level will continue for the first quarter of FY 2012. This has been necessitated by the slow start up of the project, exemplified by difficulty opening a U.S. dollar account for the project in HC and delays in transfer of funds from KSU to UNZA. These challenges have finally been worked out and the research team and HC collaborators have designed a strategy to accelerate the data collection and analyses by engaging the project undergraduate students through the first quarter of FY 2012. Additionally, Dr. Vincent Amanor-Boadu and Dr. Timothy Dalton will increase the amount of time they devote to analyses once the field data start coming in.

- The research team will also conduct the downstream chain and partner (processors, distributors, retailers, hotels, institutions and restaurants, government agencies, NGOs and other governmental organizations) interviews simultaneously instead of the sequential process that was initially proposed in order to speed up the data collection process. U.S. PIs Amanor-Boadu and Dalton plan to spend significant time in the first quarter of FY 2012 in HC to beef up and accelerate interviews of downstream value chain participants. Graduate students will be active participants in this activity. Expected completion February/March 2012.
• Data analyses
  o Preliminary analyses of primary data and comparison with secondary data commences October/November 2011 and continues through summer 2012
  o The specific Category I objectives to be addressed with statistical and econometric analyses will commence with data analyses beginning in the first quarter of FY 2012. Included in these are:
    ▪ Identify supply chains used by different players in the Zambian pulse industry and the determining factors of these choices
    ▪ Determine and measure pecuniary and non-pecuniary value embedded in the Zambian pulse value chain
    ▪ Estimate cross-border flows of pulse products, chain stage where flows occur and the factors influencing such flows and any differences across beans and cowpeas and regions
  o In addition to the above, hypotheses of interest described in the Technical Report and the Addenda (Responses to Reviewer and Responses to Daguma) will be tested and the results presented in the reports.
• Report writing
  o Manuscript development begins with report writing with the objective of achieving target publications by September 2012.

Category II Objectives
• Conversations with downstream players in the Zambian pulse industry suggest a strong interest in piloting governance mechanisms to determine how chain participants respond to them and use these responses to improve chain relationship management, reduce transaction costs and improve net total value across the chain. This work was originally scheduled to commence in last quarter of FY 2011. However, due to startup challenges already discussed, we have moved this to commence in the second quarter of FY 2012 and continue to the end of the project.
• Data will be collected continuously and analyzed, using the results to educate and improve participants’ decision-making and relationship management skills and capabilities. As the TMAC advised and we agreed (TMAC-KSU Responses 1), we intend to proceed carefully in the implementation of this phase of the project. Keeping an “open mind” demands significant flexibility in research design and a willingness to improvise. The proposal is bold and innovative and we will tread gently, consulting with TMAC members for advice as we need them. We will also work closely with HC institutions and partner organizations to ensure the pilot project design process – selection of producers, traders and other downstream organizations -- does not bias or skew outcomes, lessons learned and outreach programs developed.

Collaborators
These activities will be led by Dr. Amanor-Boadu and the K-State team in collaboration with the HC team. Additionally, human capital resources from networking organizations – MACO, Southern Africa Bean Research Network and the World Food Program Zambian office – will be leveraged to expedite the foregoing activities. Team members will continue email, Skype and telephone conversations to facilitate project management.
3. Target Outputs:

Being the final phase of the project, the target outputs in FY 2012 encompass the stated broad outputs of this research project:

- Technical reports describing the major findings of the research based on the stated research objectives, including but not limited to:
  - Regional and gender effects on chain choice and performance
  - Trans-border flows of pulse products and influencing factors
  - Perceptions about policy and intervention tools aimed at influencing the pulse industry
  - Policy options to improve the contributions of pulses to hunger and poverty alleviation and income and nutrition improvement

- Parts of these technical reports will be organized into journal articles for publication in leading and relevant professional journals (AJAE, AJAR, Agribusiness, IFAMR, etc.). It is anticipated that the 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 2012

- Outreach curricula and programs focused on enhancing the value chain management skills and competences for all chain participants that would be organized for delivery by HC collaborators and partners

- Case studies elucidating the factors influencing the types and performance of value chain relationships in the Zambian pulse industry. These case studies will be organized for both research and teaching purposes.

- Student theses and research papers on various aspects of the research questions and project objectives defined herein will be disseminated through multiple outlets, including the project website and K-State Libraries
  - Three MS student theses
  - Three MAB student theses
  - Six undergraduate student research reports

- Develop a system dynamic model that allows for simulation of alternative policy recommendations to assess their impact on producer and other stakeholder accrued value, including incomes, using iThink® (http://iseesystems.com). Its principal advantage is its graphical user interface architecture which facilitates intuitive appreciation of process and decision flows, impacts and effects, allowing participation by a broad spectrum of players in conversations and simulations. The system dynamic model will be developed using decision and behavioral data from the pilot project on governance as well as perception data from producers and other chain participants about policies and intervention instruments. The hands on exercise using computer simulations that allows policy makers to evaluate the effects and outcomes of alternative policies and intervention instruments on the pulse industry should enhance the development of more effective policies and intervention instruments to address the industry’s challenges and facilitate seizure of emerging opportunities to achieve desired goals.
o The simulation exercise 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 2012.

4. Engagement of USAID Mission(s)

We have maintained relationship with USAID mission personnel during FY 2011. The Mission staff was extremely helpful in securing visas for MAB students coming to the U.S. and facilitating the VCS system.

We have plans to continue this engagement through FY 2012. Dr. Amanor-Boadu will visit Mr. Michael McCord and his staff when he gets to Zambia and coordinate with his office in consultation with HC PIs to present a seminar on the results as soon as analyses are complete. HC PIs have also been encouraged to maintain their contact with the Mission staff through FY 2012.

5. Networking Activities with Stakeholders

The HC PIs will continue engaging the following organizations throughout FY 2012:
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
6. World Food Program
7. Southern Africa Bean Research Network

6. Leveraging CRSP Resources

As noted in the FY 2011 Work Plan, the project's vision is to contribute to food and nutrition security through research, education and engagement through a contribution to understanding the role economics plays in the participation on value chain participation and performance is critical to this vision. We are collaborating with Southern Africa Bean Research Network (SABREN) on their value chain initiative in the collection of data and coordination of analyses of data.

Additionally, World Food Program has requested we include the Eastern Province in our sampling frame and they are going to augment our HC budget to accomplish this. The budget for the WFP/UNZA/PVCI-Z relationship is being worked on and should lead to the signing of a memorandum of understanding between WFP, UNZA and PVCI-Z to formalize the collaboration.

We will continue to pursue opportunities to collaborate with organizations with whom we share the vision of enhancing food and nutrition security, including the Bill and Melinda Gates’ Foundation Africa Initiative and World Vision. Our objective is to use the results from ongoing work to solicit collaboration in entrenching the capacity development of smallholder producers as well as downstream supply chain partners in their efforts to enhance incomes, increase food
and nutrition security and reduce poverty. HC partners are working on building these relationships.

7. Training/Capacity Building Work Plan Format

Degree Training:

<table>
<thead>
<tr>
<th>First</th>
<th>Last</th>
<th>Citizenship</th>
<th>Gender</th>
<th>Program</th>
<th>Institution</th>
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</thead>
<tbody>
<tr>
<td>Esther</td>
<td>Tatenda</td>
<td>Zulu</td>
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<td>5th - Year UG</td>
<td>UNZA</td>
</tr>
<tr>
<td>Agness</td>
<td>Myece</td>
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<td>UNZA</td>
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<tr>
<td>Natasha</td>
<td>Chilundika</td>
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<td>5th - Year UG</td>
<td>UNZA</td>
</tr>
<tr>
<td>Chimuka</td>
<td>Samboko</td>
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<td>5th - Year UG</td>
<td>UNZA</td>
</tr>
<tr>
<td>Edna</td>
<td>Ngoma</td>
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<td>Female</td>
<td>5th - Year UG</td>
<td>UNZA</td>
</tr>
<tr>
<td>Chalwe</td>
<td>Sunga</td>
<td>Zambian</td>
<td>Female</td>
<td>5th - Year UG</td>
<td>UNZA</td>
</tr>
<tr>
<td>Susan</td>
<td>Chiona</td>
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<td>UNZA</td>
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<tr>
<td>Stephen</td>
<td>Kabwe*</td>
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<tr>
<td>Maxwell</td>
<td>Choombe*</td>
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<tr>
<td>Conrad</td>
<td>Chilala**</td>
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<tr>
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<td>Daka**</td>
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<tr>
<td>Martin</td>
<td>Mwansa</td>
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<td>Male</td>
<td>MAB</td>
<td>KSU</td>
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<tr>
<td>Sosthenes</td>
<td>Mwansa</td>
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<td>Male</td>
<td>MAB</td>
<td>KSU</td>
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<tr>
<td>Lydia</td>
<td>Mtsocha</td>
<td>Zambian</td>
<td>Female</td>
<td>MAB</td>
<td>KSU</td>
</tr>
</tbody>
</table>

* These students withdrew from the graduate program at the Department of Agricultural Economics, UNZA.

** These students were recruited from the Department of Economics, UNZA to replace the two who withdrew.

Supervising PI for the 5th-Year Undergraduates: Ms. Mukwiti Mwiinga and Dr. Gelson Tembo
Supervising 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. Allen Featherstone with Dr. Gelson Tembo

All the undergraduate degrees and one MS degree are in agricultural economics and agribusiness. The other two MS students are enrolled in the Department of Economics.

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.

Projected Completion Date:

- All undergraduates recruited for the project have completed their program of study and are awaiting placement in the Zambian agri-food sector. Two of them – Esther Zulu and Agness Myece – graduated with distinction while the other four graduated with Merit.
• MS students: Fall 2012 – adjusted because of the withdrawals and the orientation of the new recruits to conduct pulse research within the framework of the PVCI-Z project
• MAB students: Summer 2013 – on track as projected

Training status (Active, completed, pending, discontinued or delayed): Active for MS and MAB students; Completed for the undergraduate students

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
For FY 2012 work plan period, the following short-term training programs are planned:

Training Topic: System Dynamics in Management Research
Description: This is an introductory seminar for collaborators and other interested parties in the use of system dynamics in simulations of alternative strategies to achieve desired outcomes.
Location: University of Zambia, Lusaka
Time and Duration: October 2011 for 2 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. Special invitation will go to the USAID Mission.
PI/Collaborator with Responsibility for Training: 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 on 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 30—Zambian government policymakers, USAID Mission staff, UNZA students and faculty.
Time and Duration: Summer/Fall 2012; 2-hour seminar
PI/Collaborator with Responsibility for Training: Dr. Gelson Tembo/Ms. Rebecca Lubinda/Dr. Vincent Amanor-Boadu
Workshop on 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
**Dry Grain Pulses CRSP**  
*Research, Training and Outreach Workplans*  
*(October 1, 2011 -- September 28, 2012)*

**FY 2012 PERFORMANCE INDICATORS**  
for Feed the Future

**Project Title:** Pulse Value Chain Initiative - Zambia  
**Lead U.S. PI and University:** Vincent Amanor-Boadu, Kansas State University  
**Host Country(s):** Zambia

<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
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<tbody>
<tr>
<td>Degree Training: Number of individuals enrolled in long-term degree training</td>
<td></td>
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<tr>
<td>Number of women</td>
<td>1</td>
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</tr>
<tr>
<td>Number of men</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Short-term Training: Number of individuals who received short-term training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>50</td>
<td></td>
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<tr>
<td>Technologies and Policies</td>
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<tr>
<td>Number of technologies and management practices under research</td>
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<tr>
<td>Number of technologies and management practices under field testing</td>
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<td>Number of technologies and management practices made available for transfer</td>
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<td>Number of policy studies undertaken</td>
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<tr>
<td>Beneficiaries:</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
<td>200</td>
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<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
<td>500</td>
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<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
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<td></td>
</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Number of trade and business associations receiving technical assistance</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of community-based organizations receiving technical assistance</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
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<td></td>
</tr>
<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
<td>2</td>
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</tr>
<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Developmental outcomes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of additional hectares under improved technologies or management practices as a result of CRSP technical assistance</td>
<td>4186.75</td>
<td></td>
</tr>
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</table>
These notes run alongside the above “FY2012 Performance Indicators” chart, beginning at “Number of women” under “Short-term Training: Number of individuals who received short-term training.”

<table>
<thead>
<tr>
<th>Students, collaborators, partner organizations’ staff members, stakeholders in the value chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Governance Systems (Contract farming, Outgrower schemes and Strategic alliances)</td>
</tr>
<tr>
<td>Alternative Governance Systems (Contract farming, Outgrower schemes and Strategic alliances)</td>
</tr>
<tr>
<td>Undergraduate and postgraduate studies</td>
</tr>
<tr>
<td>The estimated sample size is 700 and there are more male headed households</td>
</tr>
<tr>
<td>Freshpkt, SM's Catering, (</td>
</tr>
<tr>
<td>Central Growers Association &amp; Zambia National Farmers Union</td>
</tr>
<tr>
<td>Food Suppliers Association (Traders), Zambia Chambers of Small and Medium Business Association (ZCSMBA)</td>
</tr>
<tr>
<td>Peasant farmers association and district farmers association under ZNFU</td>
</tr>
<tr>
<td>Zambia Women In Agriculture</td>
</tr>
<tr>
<td>Freshpkt &amp; UNZA; Bean network,</td>
</tr>
<tr>
<td>MOA, UNZA, CSO, CGA, WFP, ZARI &amp; ZNFU</td>
</tr>
<tr>
<td>5% increase of the 2009/10 cropping season area under bean cultivation of 83,735 ha measured over two years from FY 2012</td>
</tr>
<tr>
<td>Institution Name</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>a. Personnel Cost</td>
</tr>
<tr>
<td>Salaries</td>
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<tr>
<td>Fringe Benefit</td>
</tr>
<tr>
<td>b. Travel</td>
</tr>
<tr>
<td>c. Equipment ($5000 Plus)</td>
</tr>
<tr>
<td>d. Supplies</td>
</tr>
<tr>
<td>e. Training</td>
</tr>
<tr>
<td>Degree</td>
</tr>
<tr>
<td>Non-Degree</td>
</tr>
<tr>
<td>f. Other</td>
</tr>
<tr>
<td>g. Total Direct Cost</td>
</tr>
<tr>
<td>h. Indirect Cost</td>
</tr>
<tr>
<td>i. Indirect Cost on Subcontracts (First $25000)</td>
</tr>
<tr>
<td>j. Total Indirect Cost</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Grand Total</td>
</tr>
</tbody>
</table>

**Cost Share**

<table>
<thead>
<tr>
<th>Cost Share</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-kind</td>
<td>$13,498</td>
<td>$3,000.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$16,498.00</td>
</tr>
<tr>
<td>Cash</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$16,498.00</td>
</tr>
<tr>
<td>Total</td>
<td>$13,498</td>
<td>$3,000.00</td>
<td>$3,000.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$16,498.00</td>
</tr>
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**Attribution to Capacity Building**

<table>
<thead>
<tr>
<th>Percentage of effort</th>
<th>25.00%</th>
<th>100.00%</th>
<th>55.00%</th>
<th>65.60%</th>
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</thead>
<tbody>
<tr>
<td>Amount corresponding to effort</td>
<td>$12,624.00</td>
<td>$75,114.00</td>
<td>$27,679.00</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

**Grand Total**

- Total direct cost budgeted for U.S. institution(s): $57,894.64 (31.58%)
- Total direct cost budgeted for H.C institution(s): $125,439.00 (68.42%)

**Name of PI & Institutional Affiliation:** Vincent Amanor-Boadu, Kansas State University
| Objective 1 | Complete producer survey instrument | X | X |
| Complete downstream interview guide | X | X |
| Complete producer survey 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 |
| Describe the non-pecuniary value associated with beans and cowpeas at each stage in the different value chains | X | X |
| Estimate the total pecuniary and non-pecuniary value associated with beans and cowpeas at each stage in the different value chains and compare across value chains | X | X |
| Analyze the relative value captured at the different stages across value chains | X | X |

| Objective 4 | Complete interview guide for government officials | X | X |
| Classify institutional and policy issues identified by industry stakeholders | X | X |
| Analyze institutional and policy issues | X | X |
| Conduct policy interviews with government officials using survey and interview results as inputs | X |
| Develop report from interviews and analysis | X |

Name of the PI responsible for reporting on benchmarks: Amanor-Boadu, Gelson Tembo

Signature/Initials: VA B GT

Date: 5-Jul-11
FY 2012 Budget Narrative
Pulse Value Chain Initiative – Zambia

U.S. Lead PI: Vincent Amanor-Boadu, Kansas State University

Framework

The Pulse Value Chain Initiative-Zambia (PVCI-Z) received its award late and experienced significant hurdles establishing the project in the host country of Zambia. For example, June 1, 2010 to September 30, 2010 was spent principally getting contracts completed between KSU and the MO and arranging organizational issues in Zambia and the first quarter of FY 2011 was spent by the HC PI working through UNZA’s account establishment protocols because we had requested that PVCI-Z be given a separate U.S. dollar account that the HC PI had direct control over. Thus, the timing of planned activities has been put off by about three to six months (one quarter to two quarters). Despite these challenges, the PIs believe they can make up lost time through innovative organization of the project, especially with respect to primary data collection. We note this only because we do not what other challenges may come our way as we work the last FY of the project because of the institutional learning that is occurring on both sides of the partnership. We are confident that once the administrative personnel learn about the Pulse CRSP process and work things effectively into skills and competences, future progress will be swift.

FY 2012 begins October 1, 2011 and ends September 28, 2012. Within this period, we anticipate completing the project and achieving all the specified objectives. The principal activities of this period is conducting the pilot governance experiment described in the technical proposal, collecting the relevant data from the alternative governance systems and analyzing them for solutions and the development of education and training programs. We maintain cognizance of the TMAC’s advice to maintain an open mind. The last year working in Zambia has entrenched the need for not only an open mind but acute flexibility.

Budget Discussion

The budget is divided into six principal categories: (a) Personnel Cost, covering both salaries and fringe benefits; (b) Travel; (c) Equipment (only if above $5000); (d) Supplies, covering the consumables that support the research activities; (e) Training, covering both formal and informal and short-term and long-term training to enhance human capacity for HC; (f) Other costs, defined to capture costs associated directly with data collection, computers, printers and internet service. There was no change in any of these items from the original presentation of the budget with the exception of travel under U.S. institution.

The original allocation for travel in FY 2012 was $10,364 for the U.S. institution. This covered trips by PIs to Zambia to conduct project business. The MO informed in an April 2011 memo to include travel for the Global PI Meeting of the Dry Grain and Pulses CRSP, planned for somewhere in Eastern or Southern Africa in second quarter of FY 2012. While the MO will cover all domestic expenses associated with the meeting (local travel, accommodation and meals), U.S. PIs were instructed to include their air fare in the FY 2012 budgets. Table 1 shows the changes in the original budget when the travel budget was adjusted to include air fare for two U.S. PIs of the PVCI-Z to attend the Global PI Meeting. The $5,000 increase in travel budget plus $2,400 in indirect cost resulted in $7,400 increase in total budget relative to the original budget presented.

Table 1: Change in Total Budget (Original v. Revised)
Dr. Vincent Amanor-Boadu, lead U.S. PI for the PVCI-Z project and Dr. Timothy Dalton, Co-PI for the PVCI-Z project are scheduled to attend the Global PI meeting in Africa during the second quarter of FY 2012. The original total cost for FY 2012 was budgeted at $175,934, of which 71.3 percent was allocated to the HC directly. With the inclusion of the Global PI meeting (and with the MO paying for HC PIs directly), the total budget of $183,334 has about 68.42 percent allocated directly to the HC.

The distribution of the total revised budget is presented in Figure 1. It shows that personnel costs for U.S. and HC PIs and students account for about 28 percent as does total travel costs. The latter includes two trips to the U.S. by the three MAB students. Training cost cover tuition costs for the graduate students both at UNZA and K-State, and that accounted for about 24 percent. Indirect costs at 48 percent of total direct costs accounted for about 20 percent of total budgeted costs for FY 2012. The difference is a result of the fact that K-State does not charge indirect on tuition and subcontracted component of the budget. The significant allocation of the budget to training even in the FY 2012 budget indicates our commitment to human capacity improvement in this project.

It is noteworthy that while we had a total 13 students in formal training in the program and seven were female, enrolment in the graduate programs of agricultural economics and economics at UNZA was such that we could only recruit one female into the MS program and one female into the MAB program. This challenge suggests the need for programs that specifically identifies female graduates from the UNZA undergraduate program (five of whom were in our project and two of whom graduated with distinction) for sponsorship into graduate studies to enhance the gender balance in post graduate education in Zambia. While not a new discovery by any means, one thing this project has highlighted thus far is the latent potential female students have and the need for special efforts to be made to tap that potential for economic and social development.

Total in-kind contribution amounted to $16,498 for the two participating institutions. Of this

<table>
<thead>
<tr>
<th>Activity</th>
<th>K-State (Original)</th>
<th>K-State Revised</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Personnel Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$16,163</td>
<td>$16,163</td>
<td>$0</td>
</tr>
<tr>
<td>Fringe Benefit</td>
<td>$5,091</td>
<td>$5,091</td>
<td>$0</td>
</tr>
<tr>
<td>b. Travel</td>
<td>$10,364</td>
<td>$15,364</td>
<td>$5,000</td>
</tr>
<tr>
<td>f. Other</td>
<td>$2,500</td>
<td>$2,500</td>
<td>$0</td>
</tr>
<tr>
<td>g. Total Direct Cost</td>
<td>$34,118</td>
<td>$39,118</td>
<td>$5,000</td>
</tr>
<tr>
<td>h. Indirect Cost</td>
<td>$16,377</td>
<td>$18,777</td>
<td>$2,400</td>
</tr>
<tr>
<td>Total</td>
<td>$50,495</td>
<td>$57,895</td>
<td>$7,400</td>
</tr>
</tbody>
</table>
amount, 82 percent or $13,498 was contributed by K-State from salary contributions from Dr. Allen Featherstone. However, as noted in the original budget narrative, K-State’s in-kind contribution exceeds this amount because not all Dr. Tim Dalton’s time allocated to this project was counted and supplies used by project staff at K-State were also not counted. All other aspects of the budget remain as discussed in the original budget narrative.