PROJECT RESEARCH & TRAINING WORKPLANS

April 2008-September 2009

Dry Grain Pulses CRSP

Michigan State University

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PREFACE

Dry Grain Pulses Collaborative Research Support Program (CRSP): Workplans (April 1, 2008 – September 30, 2009) for Phase I Projects

The global pulse industry is entering a new era characterized by globalization of markets and fundamental changes in food value-chains. This presents many challenges as well as opportunities for small-holder farmers in developing countries and the United States.

Pulse crops, including such edible legumes as common bean, cowpea, pigeon pea, chickpea, lima bean, lentil, etc., represent an important group of staple food crops that contribute to addressing household food security, generate income, enhance soil quality and thus the sustainability of agricultural systems. Perhaps most importantly, pulses provide important nutrients (e.g., protein, dietary fiber, vit. B and complex carbohydrates) essential for nutritious and healthy diets.

In September 2007, the U.S. Agency for International Development (USAID) awarded a five-year (2002-2012) contract (Cooperative Agreement No. EDH-A-00-07-00005-00) to Michigan State University to serve as the Management Entity for the Dry Grain Pulses CRSP.

The global program vision of the Dry Grain Pulses CRSP is to contribute to:

- Economic growth and food and nutritional security through knowledge and technology generation,
- Sustainable growth and competitiveness of pulse valued chains utilizing socially and environmentally compatible approaches,
- Empowerment and strengthened capacity of agriculture research institutions in USAID priority countries,
- USAID's developmental objectives as defined in the *Policy Framework for Bilateral Foreign Aid* and the *Presidential Initiative to End Hunger in Africa* (IEHA), and
- Achievement of Title XII legislation objectives including the provision for dual benefits to developing country and U.S. agriculture.

The Dry Grain Pulses CRSP seeks to achieve its technical vision through support for a portfolio of integrated, multi-disciplinary research, training and outreach activities that focus on beans, cowpeas and related pulses that address four strategic themes:

1. To reduce pulse production costs and risks for enhanced profitability and competitiveness;
2. To increase the utilization of pulse grain, food products, and ingredients so as to expand market opportunities and improve community health and nutrition;
3. To improve the performance and sustainability of pulse value-chains, especially for the benefit of women; and
4. To increase the capacity, effectiveness and sustainability of agriculture research institutions which serve bean, cowpea and related pulse sectors and developing country agricultural industries.

For the initial five-year authorization of the Dry Grain Pulses CRSP, a two-phase technical program is being implemented with two project award cycles; Phase I (April 1, 2008 – September 30, 2010) and Phase II (October 1, 2010 – September 29, 2012). To this end, the Management Office issued a Request for Proposals in November 2007. Of the 27 proposals that were received and reviewed by an External Advisory Panel, eight proposals were selected that best met the evaluation criteria identified in the RFP and provided the highest likelihood of developmental outcomes. The MO subsequently issued contracts to seven "Lead" U.S. universities for the management of these Phase I collaborative projects.

The eight Phase I projects involve collaborative research, long and short term training and technology dissemination activities in ten African countries (Burkina Faso, Mali, Niger, Nigeria, Senegal, Kenya, Rwanda, Uganda, Mozambique and Angola) and three Latin American countries (Haiti, Honduras and Ecuador). A total of 22 Host Country institutions are collaborating with the Lead U.S. Universities in the Phase I projects.

The Phase I Project Workplans presented in this document are for an 18 month funding period (April 1, 2008 – September 30, 2009). These workplans were discussed and prepared in concert with the Host Country collaborators at a Dry Grain Pulses CRSP "All Researchers Meeting" held in Barcelona, Spain on February 29 – March 4, 2008. The workplans were subsequently reviewed and approved by the Management Office and the Cognizant Technical Officer for the Dry Grain Pulses CRSP, Dr. Jiryis Oweis. The following workplans were attached to all sub-agreements with both Lead U.S. universities and Fixed Price contracts with collaborating Host Country institutions.

A second set of Workplans will be developed for Phase I projects corresponding to the 12-month funding period of October 1, 2009 – September 30, 2010.

For more detailed information on the Dry Grain Pulses CRSP including the global program technical vision, project workplans, technical progress reports, project funding, and brief biosketches of Principal Investigators, visit the program's Internet web page (http://www.pulsecrsp.msu.edu/).

As the Director of the Dry Grain Pulses CRSP, I want to thank the Office of Economic Growth, Agriculture and Trade (EGAT), USAID-Washington for its financial support for this worthy program. USAID's investment in this CRSP reflects its recognition of the vital importance of pulse crops in contributing to the nutritional and food security of rural and urban poor as well as providing opportunities for resource-poor farmers and other value-chain stakeholders to generate income and escape poverty. The Host Country and U.S. scientists and institutions partnering in this endeavor are also to be thanked and commended for their commitment to generating new knowledge and technologies and to training a new generation of scientists and professionals who will provide leadership to the agricultural development of many African and Latin American countries.

Dr. Irvin E. Widders

Director
Dry Grain Pulses CRSP

Using Improved Pulse Crop Productivity to Reinvigorate Smallholder Mixed Farming Systems in Western Kenya

Principle Investigators

Julie Lauren, Cornell University, USA
John Ojiem, KARI, Kenya

Collaboratoring Scientists

Beth Medvecky, Cornell, USA
Alice Pell, Cornell, USA
John Duxbury, Cornell, USA
Peter Hobbs, Cornell, USA
Rebecca Stoltzfus, Cornell, USA
Christopher Barrett, Cornell, USA
Martins Odendo, KARI, Kenya
Samuel Mwonga, Egerton, Kenya
John Okalebo, MOI, Kenya
John Nderitu, UNairobi, Kenya
James Muthomi, UNairobi, Kenya
Robin Buruchara, CIAT, Uganda

Project Problem Statement and Justification

Many rural households in the East African highlands are no longer self-sufficient in beans, a critical source of food and income. Farmers' inability to afford fertilizer inputs, coupled with continuous cropping on ever shrinking land holdings, has led to degraded and infertile soils and a concomitant decline in crop vigor, pest and disease tolerance and overall system productivity.

Low bean and maize productivity in Western Kenya is related to both soil fertility and biological constraints. Legumes can be important options for rebuilding soil fertility but poor utilization of applied P fertilizers, conflicts between soil renewal and immediate food and income needs and low fixed nitrogen returns from many grain legumes have limited expected returns. Additional production constraints and risks for beans in Western Kenya are presented by diseases and pests. Angular leaf spot and anthracnose are major bean foliar diseases, and root rots, bean stem maggot, nematodes and root-feeding insects are particularly serious problems in intensively cultivated, degraded soils. Bean root rot can become so severe that the amount of seed harvested becomes less than the amount planted, causing farmers to abandon bean cropping altogether. We hypothesize that vigorous establishment of pulse crops leads to increased pest/disease resistance, improved N fixation, and nutrient accumulation, which ultimately reduces risk, benefits system productivity, food security and human nutrition. Practices promoting early plant vigor and growth encourage bigger and deeper root systems which can explore larger volumes of soil for limiting nutrients and compete more effectively with soil borne pathogens.

Consumption of pulses is essential for addressing iron deficiency, anemia and stunting caused by inadequate intakes of zinc. Knowledge about the mineral nutrient content of staple food products, including iron and zinc, is needed to inform selection of appropriate cultivars that will benefit consumer's health and to assist policy makers in meeting desired national health outcomes. Recent national or regional level food composition data are often unavailable forcing researchers and policy makers to rely on international databases that do not adequately represent local environmental conditions, varieties, etc. Mineral nutrient contents of major foods grown under a representative range of smallholder farmer conditions are needed to develop local food composition tables and to determine food system nutrient outputs.

Determining how to effectively increase productivity of seriously degraded soils and to maintain the fertility of still productive lands is of paramount importance to all farmers living in the East African Highlands. To achieve this outcome, farmers and scientists need to form genuine partnerships, combining farmers' highly sophisticated and nuanced understanding of local conditions with scientists' insight into underlying processes and the powerful problem-solving ability of their scientific methods. Providing opportunities for current and future scientific leaders to gain experience and expertise with participatory research and development approaches needs to be an essential part of the education process. These experiences will help students understand that adoptable and sustainable technologies are those that reduce risk and effectively address farmer constraints and resource levels.

Planned Project Activities for April 1, 2008 - September 30, 2009

Objective 1: To develop and assess farmer capacity for improving vigor and growth of pulse crops on nutrient accumulation, pest/disease resistance and system productivity across a soil degradation gradient.

Collaborators:

Beth Medvecky, Cornell University, USA
Alice Pell, Cornell University, USA
Chris Barrett, Cornell University, USA
Martins Odendo, KARI, Kenya
Crispus Njeru, KARI, Kenya
David Mbakaya, KARI, Kenya
Noel Makete, KARI, Kenya
Isabella Ememwa, KARI, Kenya
Ruben Otsyula, KARI, Kenya
Robin Buruchara, CIAT

Approaches and Methods:

1. *In Community Farmers Workshops* - KARI will organize and conduct in-community workshops for selected farmers, local extension and NGO personnel with input from the rest of the research team. Farmers invited to the workshop will be selected from an existing characterized group of farmers who had participated in a former Cornell project of the National Science Foundation Biocomplexity Initiative. These farmers' plots fall along a soil degradation gradient of steadily decreasing levels of soil C, N, P, K, Ca, Mg. Participatory approaches will be used to engage participants and facilitate the exchange of farmer and scientific knowledge as well as the rationale behind vigor-enhancing practices (root rot tolerant bean germplasm, seed priming, boma compost, combining/ concentrating organic & inorganic fertilizers, multipurpose pulse crops lablab and cowpea). Farmers will share their own knowledge and may propose additional vigor-enhancing practices to be tested by the group.

2. *On Farm Verification Trials* - Specific strategies that farmers wish to evaluate on their own farms will be facilitated and supported by the project. Given the extremely limited resources of the farmers, it will be necessary for the project to supply sufficient quantities of seed and fertilizers to plant the verification plots. KARI personnel will provide technical backstopping and follow up with the farmers. The vigor enhancing practices will be tested with beans during the long rainy season when farmers plant their main maize/bean intercrop. The drought tolerant indigenous pulses, lablab or cowpea, will be evaluated during the more erratic short rainy season.

Objective 2: To disseminate and evaluate through participatory approaches simple, low cost strategies for vigorous establishment/growth of pulse crops leading to increased system productivity and sustainability.

Collaborators:

Beth Medvecky, Cornell University, USA
Alice Pell, Cornell University, USA
Chris Barrett, Cornell University, USA
John Duxbury, Cornell University, USA
Peter Hobbs, Cornell University, USA
Rebecca Stoltzfus, Cornell University, USA
NGO and Female Farm Groups to be identified
Martins Odendo, KARI, Kenya
Crispus Njeru, KARI, Kenya
David Mbakaya, KARI, Kenya
Noel Makete, KARI, Kenya
Isabella Ememwa, KARI, Kenya
Ruben Otsyula, KARI, Kenya

Approaches and Methods:

1. *Create awareness and identify additional NGO and female farmer groups for collaboration and dissemination of vigor enhancing strategies* - Contacts will be made with NGO groups and the many informal farmer groups which exist within the target area in order to expand the impact of the project to a wider audience beyond the initial pool of selected farmers.

2. *Crop performance evaluation and in season exchange visits* - Farmers will collect crop establishment data (germination and 4 wks post-germination) and volumetric yield data (for maize, beans, and lablab or cowpea) from their verification trial plots in each cropping season. In addition, farmers will be shown how to assess and record the incidence and severity of pests and diseases (root rot, bean fly, others) with easily observed characteristic signs or symptoms. Results will be shared with the project. Each cropping season farmer-to-farmer exchange visits and visits to the replicated researcher-managed experiments will be supported to provide other opportunities for facilitating experiential learning and exchanges about successes and failures. Participant feedback after each group event will be solicited and reported.

3. *Initiate socioeconomic surveys of farmers* - A survey will be undertaken at the end of the long rains in 2009 (one full short rains-long rains cycle) to document farmer reaction to the tested strategies. Perceived benefits and constraints, changes in management approaches and labor requirements, farmer to farmer knowledge dissemination and likelihood of adoption will be assessed. Impacts on livelihood indicators also will be collected as available, such as cost-benefit analysis of the chosen strategy, status of household food self-sufficiency, as well as crop sales and disposition of cash. Input on the survey instrument will be sought from all project collaborators (KARI, Cornell, Universities, CIAT) and incorporated prior to field testing. Socioeconomic data gathered from the NSF Biocomplexity project will serve as baseline information.

Additional baseline information on bean cultivation practices not available from NSF dataset will be collected prior to the In-Community Farmer Workshops.

Objective 3: To research factors (nutrients, pest/diseases and their interactions) affecting pulse productivity across a soil degradation gradient.

Collaborators:

Beth Medvecky, Cornell University, USA
Alice Pell, Cornell University, USA
Chris Barrett, Cornell University, USA
John Duxbury, Cornell University, USA
Peter Hobbs, Cornell University, USA
Rebecca Stoltzfus, Cornell University, USA
Martins Odendo, KARI, Kenya
David Mbakaya, KARI, Kenya
Noel Makete, KARI, Kenya
Isabella Ememwa, KARI, Kenya
Ruben Otsyula, KARI, Kenya
Robin Buruchara, CIAT, Uganda
Samuel Mwonga, Egerton University, Kenya
Robert Okalebo, Moi University, Kenya
James Muthomi, University of Nairobi, Kenya
John Nderitu, University of Nairobi, Kenya

Approaches and Methods:

1. *Project Initiation Workshop* - Complex experimental designs will be used to test responses to the full complement of vigor enhancing strategies and to tease apart interactions among management practices, soils, crops and pests/diseases. All project collaborators (KARI, Cornell, Universities, CIAT) will convene to develop and detail the specific research questions, experimental design and data to be collected from the replicated trials. Research questions will likely emphasize incidence and severity of pests and diseases, characterization of soil chemical characteristics and agronomic evaluations of system productivity

2. *Implement replicated experimental trials* - KARI will establish and oversee the management of the replicated experiments on representative maize and bean fields at 4 sites across the soil degradation gradient. Farmer collaborators from each represented gradient zone will help to identify the most appropriate site within that zone and the farmer who owns the field will be fully compensated in cash and kind. These replicated experiments will be carried out over the life of the project.

3. *Data collection and evaluation* - Data from the replicated experiments as identified during the Project Initiation Workshop will be collected by KARI staff. At the end of the short rains 2008 and long rains 2009 cropping seasons, results will be collected and shared among all collaborators.

4. *In-season field visits and annual meeting review of results* - Each cropping season site visits will be made to the replicated trials by project collaborators during early crop growth to assess the effectiveness and impacts of the tested vigor enhancing strategies. Observations and comments will be reported. Project collaborators will meet after one full short rains-long rains cycle to review and synthesize results from farmer and replicated experiments. Successful and unsuccessful features of the vigor enhancing strategies and impacts will be identified. Areas needing additional attention or modification will be identified.

5. *Collection and nutrient analysis of grain and edible leaf samples* - KARI staff will gather grain sub-samples from farmer and replicated trials. Samples will be sent to Cornell Unversity for mineral nutrient analysis (Ca, Mg, P, K, S, Zn, Cu, Mn) and calculation of cropping system yields and nutrient outputs.

6. *Pursue opportunities for germplasm testing and exchange* - Phosphorus efficient bean germplasm (2-3 lines) will be obtained from the Pennsylvania State University (PSU) project and tested during the long rains season in observational plots across the soil degradation gradient. Commonly adopted root rot tolerant bean varieties from the target area will be sent to PSU for P efficiency trait testing. Likewise early and late maturity cowpea cultivars will be obtained from University of California Riverside (UCR) and tested during the short rains for biomass and grain production.

Objective 4: To facilitate and support on-farm participatory research opportunities for Kenyan agricultural scientists and graduate students.

Collaborators:

Beth Medvecky, Cornell University, USA
Alice Pell, Cornell University, USA
Chris Barrett, Cornell University, USA
John Duxbury, Cornell University, USA
Peter Hobbs, Cornell University, USA
Rebecca Stoltzfus, Cornell University, USA
Francis Muyekho, KARI, Kenya
David Mbakaya, KARI, Kenya
Samuel Mwonga, Egerton University, Kenya
Robert Okalebo, Moi University, Kenya
James Muthomi, University of Nairobi, Kenya
John Nderitu, University of Nairobi, Kenya

Approaches and Methods:

1. *Coursework in selected fields* - One student from each of the three Kenyan Universities will receive support to undertake a 2-year Masters Degree program in the areas of soil science (Egerton Univ.), plant

protection (Univ. Nairobi) or agronomy (Moi Univ.). Staff from KARI, the Ministry of Agriculture and NGOs will be actively sought as students, thereby benefiting these institutions directly when the students complete their degrees and return to work. One staff member from KARI-Kakamega has already been nominated to work with Dr. Okalebo at Moi University. Once selected the students will be enrolled and undertake Master's level coursework during the first year of the project.

2. *Develop and implementation of student research projects* - Each student will prepare a student research proposal guided by the discussions during the Project Initiation Workshop and in consultation with their faculty advisor. The proposals will be shared with project collaborators for inputs and comments prior to initiation of the research. The researcher-managed and/or the farmer-managed trials will form the backbone of the students' thesis research. As needed students will establish additional satellite trials. For example, missing element experiments may be set up to assess the role of other limiting nutrients in these soils.

3. *Sharing of results in annual meetings* - Students will present results (as available) from their research projects during the project annual meeting for discussion and suggestions. Results will be incorporated into the project annual report as they become available.

Target Outputs

- Enhanced vigor strategies for pulse productivity tested by farmers and benefits documented – increased food security, livelihood and income generation opportunities for vulnerable groups (smallholder farmer and female farmers); gender equity
- Facilitating farmer-to-farmer exchanges for knowledge exchange with emphasis on females – human capacity building; gender equity
- Linking farmer learning and experimentation with the science-based research will initiate an understanding about the effects of vigor enhancing strategies on pulse and system productivity as well as interactions with soils, pests and diseases - accelerate access to research findings; increase prospects for scaling up
- Course work and initiation of Masters degree research for mid-career institutional scientists – capacity building
- Multidisciplinary development and research relationship between 2 international institutions (Cornell, CIAT) and Kenyan institutions (KARI, Egerton, Moi, Univ. Nairobi) – global partnerships, capacity building

Engagement of USAID Field Mission(s)

- Invite Agriculture Officer for Project Initiation Workshop and project site visits-May, October 2008; April 2009
- Courtesy visits to Agriculture Office –May, October 2008; April 2009

Networking Activities with Stakeholders

- Local NGO and female farmer groups will be contacted in order to create awareness, facilitate and backstop knowledge dissemination about the improved pulse productivity strategies.
- Stockists (local input suppliers) will be invited to attend the In-Community Farmer Workshops to create awareness and exchange ideas about vigor enhancing strategies, thereby stimulating opportunities for increased sales and expanded inventory in response to farmers demands.

Leveraging of CRSP Resources

Four existing projects lead by co-PIs of this project will allow us to leverage travel funds during the project period. The projects are the Biocomplexity Initiative (Sponsor: NSF, through August 2008); SANREM CRSP (Sponsor: USAID, through Sept 2009); Global Livestock CRSP (Sponsor: USAID, through Dec 2011); and Pilot Project on Building Farmer's Capacity and Marketing Skills (Sponsor: Anonymous, through April 2009).

Dry Grain Pulses CRSP Budget Summary

Using Improved Pulse Crop Productivity to Reinvigorate Smallholder Mixed Farming Systems in Western Kenya

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	Cornell	0	KARI	0	0	0
a. Personnel Cost						
Salaries	$ 34,435.68		$ 5,761.28			
Fringe Benefit	$ 16,391.38		$ -			
	$ -		$ -			
b. Travel	$ 25,203.53		$ 35,383.00			
c. Equipment ($5000 Plus)	$ -		$ -			
	$ -		$ -			
d. Supplies	$ 625.00		$ 18,623.39			
e. Training						
Degree	$ -		$ 47,830.76			
Non-Degree	$ -		$ -			
f. Other	$ 5,120.00		$ -			
g. Total Direct Cost	**$81,775.59**	**$0.00**	**$107,598.43**	**$0.00**	**$0.00**	**$0.00**
h. Indirect Cost	$ 44,112.11		$ 10,759.85			
i. Indirect Cost on Subcontracts (First $25000)	$ 13,375.00		$ -			
j. Total Indirect Cost	$ 57,487.11	$ -	$ 10,759.85	$ -	$ -	$ -
Total	**$ 139,262.70**	**$ -**	**$ 118,358.28**	**$ -**	**$ -**	**$ -**
Grand Total	**$257,621**					

	Amount	Percentage
Percentage of U.S. Budget	$ 81,775.59	**43.18%**
Percentage of Host Countries Budget	$ 107,598.43	**56.82%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ -		$ 33,510.00	$ -	$ -	$ -	$ 33,510.00
Cash	$ 42,757.00		$ 15,951.00	$ -	$ -	$ -	$ 58,708.00
Total	$ 42,757.00	$ -	$ 49,461.00	$ -	$ -	$ -	$ 92,218.00
Attribution to IEHA Objectives							
Percentage of effort							52.42%
Amount corresponding to effort	$ 83,557.62	$ -	$ 51,490.65	$ -	$ -	$ -	$135,048.27
Attribution to Capacity Building (Theme "D")							
Percentage of effort	$ 0.80	$ -	$ 1.12	$ -	$ -	$ -	47.58%
Amount corresponding to effort	$ 55,705.08	$ -	$ 66,867.64	$ -	$ -	$ -	$122,572.72

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names:	Crispus Mugambi
Last Name:	Njeru
Citizenship:	Kenyan
Gender:	Male
Degree:	M.S.
Discipline:	Soil Science
Host Country Institution to Benefit from Training:	Kenya Agricultural Research Institute Kakamega
Training Location:	Moi University
Supervising CRSP PI:	Okalebo, John
Start Date:	02/08
Project Completion Date:	02/10
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Full (Category 2a)

Student #2

First and Other Given Names:	Belinda Akinyi
Last Name:	Weya
Citizenship:	Kenyan
Gender:	Female
Degree:	M.S.
Discipline:	Soil Science
Host Country Institution to Benefit from Training:	Kenya Ministry of Agriculture Extension – Kisii
Training Location:	Egerton University
Supervising CRSP PI:	Mwonga, Samuel
Start Date:	08/08
Project Completion Date:	08/10
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Full (Category 2a)

Student #3

First and Other Given Names:	Jane Francisca
Last Name:	Lusweti
Citizenship:	Kenyan
Gender:	Female
Degree:	M.S.
Discipline:	Plant Protection
Host Country Institution to Benefit from Training:	Kenyan Ministry of Agriculture Extension
Training Location:	University of Nairobi
Supervising CRSP PI:	Muthomi, James
Start Date:	10/07
Project Completion Date:	10/09
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

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

Principle Investigators

Robert Mazur, Iowa State University, USA
Dorothy Nakimbugwe, Makerere, Uganda
Michael Ugen, NCRRI, Uganda
Henry Kizito Musoke, VEDCO, Uganda
Hilda Vasanthakaalam, KIST, Rwanda

Collaboratoring Scientists

Suzanne Hendrich, ISU, USA
Helen Jensen, ISU, USA.
Mark Westgate, ISU, USA
Barnabas Kiiza, Makerere, Uganda
Gabriel Elepu, Makerere, Uganda

Project Problem Statement and Justification

Agriculture in East Africa is characterized by women and men working in small scale, rainfed production, averaging 2 hectares per household (FAO 2006). Erratic bimodal rainfall patterns in recent years further challenge cropping results (ARB 2007). Farmers have very limited access to extension, training, inputs (quality seeds, fertilizers, etc.), improved agronomic practices, new technologies, and credit (KDA 2004; Nkonya et al. 2004). Producers 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 remains 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) using a sustainable livelihoods approach has increased food security and market readiness from 9% to 77% among 800+ farm households in the past 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% sell some in 2007. The SL approach livelihood 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 yield improving technologies result in beans (Aim 1) with better nutritive value or processing characteristics (Aim 2) is an important under-researched issue in this region. Improved linkages to emerging markets is also essential (Aim 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 (bean stem maggots, aphids, storage 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 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 April 1, 2008 - September 30, 2009

Objective 1: To Improve Harvested Bean Quality and Yields.

Collaborators:
Mark Westgate, Iowa State University, USA

Approaches and Methods:
Objective 1a: Determine and Prioritize Key Production Constraints of Six Priority Bean Varieties

Approaches and Methods

- Conduct participatory rural appraisals (PRA) to determine current local knowledge, attitudes and practices related to planting, weeding, soil fertility/nutrient management, and mitigation/control strategies for diseases and pests in four varieties of common bean in Kamuli district, Uganda, and two common bean varieties in Nyagatare district, Rwanda

- Prioritize constraints to increased production
- Prioritize constraints to improved quality

Benchmarks

Apr. – Sept. 2008

- Participatory rural appraisal guides/tools developed
- Participatory rural appraisal conducted
- Production constraints prioritized
- Quality constraints prioritized

Oct. 2008 – Mar. 2009

- Knowledge, attitudes and practices documented
- KAPs analyzed and report written

Objective 1b. Improve Quality and Yields of Beans through Evaluation of Better Production Practices

Approaches and Methods

- Evaluate yield and quality of the beans (NABE 6 [white dry bean, small seeded] and K 131 [carioca dry bean] and K 132 and NABE 4 [red mottled beans] in Kamuli and Luweero districts in Uganda, and RWR 1668 and RWR 2245 in Nyagatare district in Rwanda)
- Evaluate practical management strategies to increase and stabilize seed yield and seed quality in participatory field research
- Carry out on farm demonstrations for farmers on better agronomic practices

Benchmarks

Apr. – Sept. 2008

- Availability of certified seeds for red and mottled bean varieties established
- Locations and farmer cooperators selected for research and demonstration
- Site and location visited by US team

Oct. 2008 – Mar. 2009

- Recommended irrigation and fertigation practices for profitable yields defined
- Field sampling and laboratory procedures to quantify bean quality established
- Trials planted, managed and harvested
- Seed samples submitted for analysis
- Yields under standard production practices from first crop season quantified and analyzed
- Crop production and soil management strategies evaluated
- Harvested bean quality for each demonstration site and experimental treatment quantified

Apr. – Sept. 2009

- Yield and quality of beans harvested from second crop season quantified and analyzed
- Impacts on bean quality from improved harvest and storage techniques documented

Objective 1c: Strengthen Farmers' Collective Capabilities to Learn and Share Innovative Practices

Approaches and Methods: Promote adoption of recommended practices to increase yield of quality beans through RDE and farmer training, and facilitating access to superior varieties and priority inputs

Benchmarks

Apr. – Sept. 2008

Selected farmers mobilized to participate in training in better management and evaluation of research process and outputs

Oct. 2008 – Mar. 2009

- Farmer and extension training manuals developed for use by trainers (researchers and extension agents)
- Farmer knowledge on participatory research methodologies/designs enhanced for better trial implementation

Apr. – Sept. 2009

Recommended research results incorporated in RDE training procedures and promotion protocols

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

Collaborators:
John Muyonga, Makerere University, Uganda
Martha Nyagaya, CIAT, Uganda
Suzanne Hedrich, Iowa State University, USA

Approaches and Methods:
Objective 2a: Establish the Key Causes of Post-Harvest Losses of Beans

Approaches and Methods

- Conduct participatory rural appraisals of current knowledge, attitudes and practices (KAPs) related to pre- and post-harvest handling
- Establish the basis and magnitude of post-harvest losses associated with different stages of post-harvest handling and storage (harvesting times, threshing method, drying, storage and packaging)
- Correlate knowledge, attitudes and practices with post-harvest losses, based on both the primary information obtained during the survey and the results of laboratory analyses

Benchmarks

Apr. – Sept. 2008

- MS and PhD students admitted
- Participatory rural appraisals conducted
- Knowledge, attitudes and practices assessed

Oct. 2008 – Mar. 2009

- Post-harvest losses prioritized
- Post-harvest management innovations promoted via training

Apr. – Sept. 2009

Post-harvest management innovation adoption evaluated

Objective 2b: Evaluate Impacts of Improved Post-Harvest Practices on Post-Harvest Losses in Study Sites

Approaches and Methods

- Promote adoption of recommended pre- and post-harvest handling practices that address the identified major causes to minimize post-harvest yield and quality losses
- Assess the effect of the above practices on post-harvest losses by comparing between two groups of bean farmers: one group using the recommended practices and the other group not

Benchmarks

Oct. 2008 – Mar. 2009

Pre- and post-harvest losses reductions documented and analyzed

Apr. – Sept. 2009

Further loss reductions documented and analyzed

Objective 2c: Develop Protocols for Bean Products with Enhanced Nutritional and Organoleptic Properties

Objective 2c-1: Determine Digestibility and Utilization, Amino Acid Quality and Iron Bio-Availability

Approaches and Methods

- Determine nutritional and physico-chemical properties of bean varieties, and influences of agronomic and post-harvest handling practices on those properties
- Investigate the effect of pre-treatment of beans (malting, pre-soaking, roasting) on nutritional value of products.

Benchmarks

Apr. – Sept. 2008

Initial recipes identified and disseminated

Oct. 2008 – Mar. 2009

- Nutritional and physico-chemical analysis initiated
- Analysis of benefits for nutritionally vulnerable people initiated

Apr. – Sept. 2009

Best processing techniques to enhance protein and carbohydrate digestibility determined

Objective 2c-2: Develop Nutrient-Dense Bean Flour and Value-Added Recipes Utilizing Developed Bean Flour

Approaches and Methods

- Develop a semi-processed bean flour using the response surface methodology using preferred bean varieties from Uganda and/or Rwanda
- Develop recipes for nutritious, value-added products, using the developed bean flour
- Determine the acceptability and shelf-life of the developed products
- Promote the recipes for uptake in communities
- Demonstrate flour preparation for participating farmers to take it up as an enterprise

Benchmarks

Oct. 2008 – Mar. 2009

- Bean flour development initiated
- Protocol for semi-processed bean flour initiated

Apr. – Sept. 2009

- Acceptability data for developed products generated and analyzed
- Processing protocols for adoption by bean processors refined and promoted

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

Collaborators:
Barnabas Kiiza, Makerere University, Uganda
Gabriel Elepu, Makerere University, Uganda
Helen H. Jensen, Iowa State University, USA
VEDCO members to be determined

Approaches and Methods:
Objective 3a: Identify Solutions to Production and Marketing Constraints Faced by Producers of Beans

Approaches and Methods

- Conduct baseline surveys of producers to generate information on production and marketing constraints, and terms of trade between farm and non-farm sectors
- Analyze value chain components and linkages to identify strengths and weaknesses
- Identify barriers and challenges farmers face in accessing emerging markets
- Initiate and facilitate farmers' interaction with small, medium and large scale wholesale and retail enterprises to promote distribution and purchase of beans and value-added bean products
- Train farmers and farm groups to more successfully market beans
- Identify ways to improve packaging methods, packaging materials and storage conditions

Benchmarks

Apr. – Sept. 2008

- Local stakeholders and partners identified to address adoption constraints
- Producers' marketing constraints identified

Oct. 2008 – Mar. 2009

- Value chain analysis initiated
- Priorities for education and training activities developed

Apr. – Sept. 2009

Farmers trained and facilitated to improve their marketing of beans

Objective 3b: Characterize Consumer Demand and Preferences for Beans and Agro-Processed Products

Approaches and Methods: Participatory appraisals and baseline surveys of producers and consumers to determine knowledge, attitudes and practices regarding processing and human consumption of beans

Benchmarks

Apr. – Sept. 2008

Qualities of beans corresponding to farmers' preferences determined

Oct. 2008 – Mar. 2009

Consumer demand and preferences for beans characterized

Apr. – Sept. 2009

Consumer demand and preferences for bean products characterized

Objective 3c: Increase Consumer Awareness of Benefits of Consuming Beans and Value-Added Products and their Access to New Products

Approaches and Methods

- Train community members on the benefits of consuming beans
- Demonstrate value addition in beans and preparation of bean recipes to community members

Benchmarks

Apr. – Sept. 2008

Nutrition awareness levels of benefits of bean consumption determined

Oct. 2008 – Mar. 2009

- Product improvement strategies identified
- Strategies and practices identified to promote consumer awareness and purchase

Apr. – Sept. 2009

- Farmers trained on benefits of bean consumption
- Community members trained on value addition and preparation of various bean recipes
- Follow-up on community trainings conducted

Target Outputs

- Reports regarding recommended practices for crop production, and both pre- and post-harvest management procedures to improve quality of harvested beans and increase yields
- Training manuals (for VEDCO's Rural Development Extensionists, farm group members, etc.)
- Stronger links between farmers groups and associations to diverse types of buyers
- 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 Mission(s)

USAID agricultural initiatives in Africa seek to build economies, establish and enhance partnerships, and harness science and technology to meet the needs of the vulnerable and impoverished. This project will help USAID meet its goals for improved well-being in Uganda and Rwanda through agricultural activities

designed to promote best practices, develop and market nutritious bean-based value-added products, and successfully link farmers and producers to markets. We will meet periodically with Mission staff devoted to realization of their agriculture-related strategic objectives (SO 617-007 Economic Growth, Agriculture and Trade in Uganda) and SO 696-007 (Economic Growth, Agriculture and Trade) in Rwanda. We will also invite them to project-sponsored activities and share results of our research-development activities.

Networking Activities with Stakeholders

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

- Work with farmers, groups and associations to understand local livelihoods, agronomic practices, their previous and current linkages with various types of institutions and service providers (governmental and non-governmental), private sector traders, and transporters
- Interact regularly with various types of institutions and service providers (governmental and non-governmental), private sector traders, transporters, small, medium and large scale processors and distributors etc., to gain and maintain appropriately broad perspectives on key issues in the value chain, benefit from their special expertise, and build consensus and collaborative relationships for high levels of continued success
- Hold periodic planning and review meetings to involve all partners so that challenges and constraints are discussed and strategies to deal with them developed together
- Facilitate broad involvement in research design, data collection instruments and processes, and data analysis
- Share results from various stages of the project to encourage constructive criticism and strengthen usefulness, impact and sustainability of intervention results
- Involve other developmental partners with similar interests for complementarily and dissemination of results to other areas and countries
- Project results will be shared with the research and developments communities in Uganda, Rwanda and the region through workshops and various types of publications

Leveraging of CRSP Resources

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

Dry Grain Pulses CRSP Budget Summary

Enhancing nutritional value and marketability on beans through research and strengtrhening key value chain stakeholders in Uganda and Rwanda

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	ISU	ISU	Makerere Univ.	NaCRRI	VEDCO	Kigali Inst.
a. Personnel Cost						
Salaries	$ 6,840.00	$ 23,988.00	$ 17,100.00	$ 7,200.00	$ 15,324.00	$ 11,804.00
Fringe Benefit	$ 315.00	$ 2,783.00	$ 6,450.00	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
b. Travel	$ 28,500.00	$ 11,483.00	$ 17,169.00	$ 12,292.00	$ 3,500.00	$ 6,716.00
	$ -	$ -	$ -	$ -	$ -	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ -	$ -	$ 6,500.00	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 4,000.00	$ -	$ 9,804.00	$ 7,245.00	$ 18,336.00	$ 5,800.00
e. Training						
Degree	$ -	$ 9,133.00	$ 4,500.00	$ -	$ -	$ 1,500.00
Non-Degree	$ -	$ -	$ -	$ -	$ 8,400.00	$ 750.00
	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ 1,213.00	$ -	$ 2,918.00	$ 1,756.00	$ 750.00	$ 2,102.00
g. Total Direct Cost	**$40,868.00**	**$47,387.00**	**$57,941.00**	**$28,493.00**	**$52,810.00**	**$28,672.00**
h. Indirect Cost	$ 10,625.00	$ 9,945.00	$ 5,794.00	$ 2,850.00	$ 5,281.00	$ 2,867.00
i. Indirect Cost on Subcontracts (First $25000)	$ 26,000.00	$ -	$ -	$ -	$ -	$ -
j. Total Indirect Cost	$ 36,625.00	$ 9,945.00	$ 5,794.00	$ 2,850.00	$ 5,281.00	$ 2,867.00
Total	**$ 77,493.00**	**$ 57,332.00**	**$ 63,735.00**	**$ 31,343.00**	**$ 58,091.00**	**$ 31,539.00**
Grand Total	**$319,533.00**					

	Amount	Percentage
Percentage of U.S. Budget	$40,868.00	**15.95%**
Percentage of Host Countries Budget	$215,303.00	**84.05%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 46,191.00		$ -	$ -	$ -	$ -	$ 46,191.00
Cash	$ -		$ -	$ -	$ -	$ -	$ -
Total	$ 46,191.00	$ -	$ -	$ -	$ -	$ -	$ 46,191.00
Attribution to IEHA Objectives							
Percentage of effort							80.13%
Amount corresponding to effort	$ 49,668.93	$ 40,147.48	$ 57,361.50	$ 28,208.70	$ 52,281.90	$ 28,385.10	$256,053.61
Attribution to Capacity Building (Theme "D")							
Percentage of effort							67.73%
Amount corresponding to effort	$ 40,195.47	$ 28,843.08	$ 48,322.50	$ 27,581.84	$ 43,727.86	$ 27,754.32	$216,425.07

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names:	Cyrille
Last Name:	Syanobe
Citizenship:	Rwanda
Gender:	Male
Degree:	M.S.
Discipline:	Food Science & Technology
Host Country Institution to Benefit from Training:	
Training Location:	Makerere University
Supervising CRSP PI:	Mazur, Robert
Start Date:	08/08
Project Completion Date:	08/10
Training Status: Active	
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Student #2

First and Other Given Names:	Gerald
Last Name:	Sebuwufu
Citizenship:	Uganda
Gender:	Male
Degree:	Ph.D.
Discipline:	Agronomy
Host Country Institution to Benefit from Training:	National Crop Resources Research Institute
Training Location:	Iowa State University
Supervising CRSP PI:	Westgate, Mark
Start Date:	08/08
Project Completion Date:	05/12
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Student #3

First and Other Given Names:	Geoffrey Arijole
Last Name:	Nyakuni
Citizenship:	Uganda
Gender:	Male
Degree:	Ph.D.
Discipline:	Food Science & Human Nutrition
Host Country Institution to Benefit from Training:	Makerere University, Uganda
Training Location:	Iowa State University
Supervising CRSP PI:	Hendrich, Suzanne
Start Date:	08/08
Project Completion Date:	05/12
Training Status:	Discontinued
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Student #4

First and Other Given Names:	Aisha Nakitto
Last Name:	Musaazi
Citizenship:	Uganda
Gender:	Female
Degree:	M.S.
Discipline:	Food Science & Technology
Host Country Institution to Benefit from Training:	Makerere University
Training Location:	Makerere University
Supervising CRSP PI:	Nakimbugwe, Dorothy
Start Date:	08/08
Project Completion Date:	06/09
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Student #5

First and Other Given Names:	Simon
Last Name:	Okiror
Citizenship:	Uganda
Gender:	Male
Degree:	M.S.
Discipline:	Agricultural Economics/Agribusiness
Host Country Institution to Benefit from Training:	Makerere University
Training Location:	Makerere University
Supervising CRSP PI:	Kiiza, Barnabas
Start Date:	08/08
Project Completion Date:	06/09
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Combining Conventional, Molecular and Farmer Participatory Breeding Approaches to Improve Andean Beans for Resistance to Biotic and Abiotic stresses

Principle Investigators

James D. Kelly, Michigan State University, USA
Augostine Musoni, ISAR, Rwanda
Eduardo Peralta, INIAP, Ecuador

Collaboratoring Scientists

George Abawi, Cornell University, USA
Sieglinde Snapp, MSU, USA

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 will 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 April 1, 2008 - September 30, 2009

Objective 1: Develop through traditional breeding and marker-assisted selection (MAS) 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:
Augustine Musoni, Rwanda
Eduardo Peralta, Ecuador
George Abawi, Cornell University, USA
Sieglinde Snapp, Michigan State University, USA

Approaches and Methods:
1. Review breeding research activities, past and present in Ecuador
2. Review breeding research activities, past and present in Rwanda during in March-June growing season

3. Assemble a nursery of 20 bush types that includes collection of advanced lines in March four seed types from Ecuador and include 3 recently released climbing types
4. Increase seed in Ecuador for shipping to Rwanda prior to main planting season in September planting main cropping season. Include Andean types from the U.S.
5. Select parental breeding materials for crossing in Ecuador, Rwanda and U.S.
6. Identify select group of lines from Rwandan breeding for crossing with new introduced lines from Ecuador
7. Cross Rwandan sources of resistance for Fusarium wilt and Pythium and major foliar pathogens into large seeded lines with contrasting colors
8. Utilize markers in early-generation selection for major disease resistant traits in Ecuador
9. Initiate marker-assisted selection in Rwanda
10. Yield evaluation of advanced lines in range of seed types in Ecuador, Rwanda and U.S. Exchange of most promising materials among the three breeding programs
11. Initiate seed increase of most promising lines
12. On farm trials with advanced lines in Rwanda and Ecuador
13. Release of three bean varieties in three commercial classes for production in Michigan

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, Rwanda
Eduardo Peralta, Ecuador
George Abawi, Cornell University, USA
Sieglinde Snapp, Michigan State University, USA

Approaches and Methods:
1. Four inbred backcross line (IBL) populations will be evaluated in growers field under conditions of drought in Ecuador
2. Identify specific populations for in depth study in Rwanda
3. Advance other IBL populations with specific drought and root rot resistance traits are being developed
4. Evaluate 120 drought tolerant lines in a range of seed types from CIAT in Ecuador; a sub-set of the best lines will be tested in Rwanda
5. Complete characterization of 80 new local traditional lines collected from growers in Ecuador to determine level of drought tolerance
6. Trials will be conducted for root rot resistance sources in Ecuador each season
7. In Rwanda two screening locations have been identified for drought based on lower rainfall levels – no irrigation available; identify field site for root rot evaluation
8. Characterize germplasm for individual root pathogens at Cornell

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

Collaborators:
Augustine Musoni, Rwanda
Eduardo Peralta, Ecuador
George Abawi, Cornell University, USA
Sieglinde Snapp, Michigan State University, USA

Approaches and Methods:

1. In Rwanda conduct surveys to diagnose major root diseases and collect isolates of root pathogens for characterization. Initial survey will be conducted in Northern highland production region
2. In Ecuador complete characterization of root rot isolates collected previously in both Northern and Southern production regions at Cornell and Ecuador
3. Access potential for germplasm/isolate interaction in greenhouse at Cornell
4. Collect isolates of anthracnose, angular leaf spot (ALS) in Rwanda for race typing
5. Continue race typing of rust and anthracnose isolates, and initiate characterization of ALS in Ecuador

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

Collaborators:
To Be Determined

Approaches and Methods:

1. Design and validate sustainable farming practices including integrated nutrient and pest management systems for small farmers in Rwanda
2. Compare and contrast advanced line selection practiced by breeders and farmers in different agroecological regions in Rwanda
3. Evaluation of 10 tests in 10 CIALs each growing cycle in Ecuador
4. Facilitate non conventional seed production in Ecuador
5. Release of two bean varieties using farmer participation in Ecuador
6. Organize visit of Rwandan scientists to Ecuador to participate to interchange experience between investigators, breeding population management, germplasm banks, screening, and crossing at different INIAP research stations; interchange of experience on participatory methods and seed production for local community use with small farmer members in CIALs in Choto and Mira, Ecuador- anticipated date November 2009.

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, root health 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.

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

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

Engagement of USAID Field Mission(s)

Plan to visit USAID field mission in Kigali during first visit to Rwanda to introduce program and HC PI to the Mission Director. The Mission in Quito is aware of CRSP activities in Ecuador and publications of project on variety releases and bean production practices prepared by INIAP will be provided to the Mission Director.

Networking Activities with Stakeholders

Government Extension, Farmers cooperatives and seed production agencies, NGO in Rwanda; World Vision, CARE, ADRA, CARITIUS, Catholic Relief Services. NGO in Ecuador; PRODECI, PRODER, CRUZ ROJA, Agricultural Organizations; COPCAVIC, 10 CIALs, Grupo de Evaluadores de Frijol de Bolivar, Assoc. de Productores de Frejol de INTAG. Government Organizations; MAGAP, INIAP, Univ. Tecnia del Norte, and Univ. Catolica de Ibarra.

Leveraging of CRSP Resources

Funding from Bill and Melinda Gates/Rockfeller Foundations is being pursued by HC PI in Rwanda. In Ecuador, NGO-PRODECI and Government Funding from CEREPS

Dry Grain Pulses CRSP Budget Summary

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

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	Mich. State Univ	Rwanda	Cornell Univ.	Ecuador	Rwanda	0
a. Personnel Cost						
Salaries	$ 4,560.00	$ 20,070.00	$ 18,239.00	$ 13,120.00	$ 15,000.00	$ -
Fringe Benefit	$ 2,730.00	$ 1,972.00	$ 8,986.00	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
b. Travel	$ 18,000.00	$ 1,885.00	$ 6,500.00	$ 4,240.00	$ 5,000.00	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 15,000.00	$ -	$ 4,625.00	$ 11,000.00	$ 10,000.00	$ -
e. Training						
Degree	$ -	$ 9,679.00	$ -	$ -	$ -	$ -
Non-Degree	$ -	$ -	$ -	$ 2,000.00	$ 2,000.00	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ -	$ -	$ -	$ -	$ -	$ -
g. Total Direct Cost	**$40,290.00**	**$33,606.00**	**$38,350.00**	**$30,360.00**	**$32,000.00**	**$0.00**
h. Indirect Cost	$ 20,950.80	$ 12,442.04	$ 9,588.00	$ 2,640.00	$ -	$ -
i. Indirect Cost on Subcontracts (First $25000)	$ -	$ -	$ 6,500.00	$ 6,500.00	$ 6,500.00	$ -
j. Total Indirect Cost	$ 20,950.80	$ 12,442.04	$ 16,088.00	$ 9,140.00	$ 6,500.00	$ -
Total	**$ 61,240.80**	**$ 46,048.04**	**$ 54,438.00**	**$ 39,500.00**	**$ 38,500.00**	**$ -**
Grand Total	**$239,726.84**					

	Amount	Percentage
Percentage of U.S. Budget	$ 40,290.00	**23.07%**
Percentage of Host Countries Budget	$ 134,316.00	**76.93%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 15,000.00		$ 20,625.00	$ -	$ -	$ -	$ 35,625.00
Cash	$ -		$ -	$ -	$ -	$ -	$ -
Total	$ 15,000.00	$ -	$ 20,625.00	$ -	$ -	$ -	$ 35,625.00
Attribution to IEHA Objectives							
Percentage of effort							47.47%
Amount corresponding to effort	$ 18,372.24	$ 46,048.04	$ 10,887.60	$ -	$ 38,500.00	$ -	$113,807.88
Attribution to Capacity Building (Theme "D")							
Percentage of effort							43.03%
Amount corresponding to effort	$ 23,997.00	$ 46,048.04	$ 13,609.50	$ 9,875.00	$ 9,625.00	$ -	$103,154.54

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names:	Gerardine
Last Name:	Mukeshimana
Citizenship:	Rwandan
Gender:	Female
Degree:	Ph.D.
Discipline:	Plant Breeding and Genetics
Host Country Institution to Benefit from Training:	ISAR and National University of Rwanda
Training Location:	Michigan State University
Supervising CRSP PI:	Kelly, James
Start Date:	08/08
Project Completion Date:	08/11
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Full (Category 1)

Student #2

First and Other Given Names:	Krista
Last Name:	Isaacs
Citizenship:	US
Gender:	Female
Degree:	Ph.D.
Discipline:	Ecology, agronomy, nutrition
Host Country Institution to Benefit from Training:	US and Rwanda
Training Location:	MSU
Supervising CRSP PI:	Snapp, Sieglinda
Start Date:	08/08
Project Completion Date:	08/11
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Short-term Training:

Type of Training: Participatory plant breeding

Description of training activity: Organize and conduct participatory plant breeding and root/soil health training workshop in Rwanda planned for third year in 2010 but may be offered earlier in 2009 if possible

Status of this activity:

Reason if training activity not completed as planned:

When did the activity occur?:

Location: Rubona, Rwanda

Who benefited from this activity?:

Number of Beneficiaries: 30

Male:

Female:

Total:

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

Lead U.S. Principle Investigator and Institution

Richard H. Bernsten, Michigan State University, USA
Duncan Boughton, Michigan State University, USA
Cynthia Donovan, Michigan State University, USA

Collaboratoring Host Country and U.S. PIs and Institutions

David Kiala, Universidade Agostinho Neto, Angola
Feliciano Mazuze, Instituto de Investigação Agrária Moçambique, Mozambique
Juan Carlos Rosas, Escuela Agricola Panamericana-Zamorano, Honduras

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Project Problem Statement and Justification

Markets are critical to farmer adoption of new technologies and management practices, as they offer farmers an opportunity to specialize and take advantage of comparative advantage to capture gains from trade. Market-oriented pulse production depends on many factors in addition to technology, including the level of pulse prices and price risk, quantity premia/discounts, and the cost of bringing products to market. These factors are influenced by the level of market infrastructure and public and private institutions, including enforceable contracts (to reduce risk), formal grading systems, the availability of price information, the ability of farmers to reduce transaction costs via membership in an association, and the physical proximity of markets. Pulse markets in Angola, Mozambique, and Honduras present a continuum in terms of the level of market infrastructure. Angola is characterized as having minimal price information, low yields/production, unpredictable market channels, and poor quality although improving infrastructure. Mozambique is characterized by a relatively effective market information system, low yields/production, and some farmer organizations, but minimal production for markets (market participation) due to a lack of information on quantity/demand. In contrast, Honduras is characterized by an effective market information system, strong farmer organizations, widespread adoption of improved bean varieties, market-oriented production, and a potential to produce for specialty/niche markets. The proposed action research will help to better understand how different levels of market development affect incentives for technology adoption--a ladder of learning. A key priority of the research is to expand market opportunities and accelerate the transformation from semi-subsistence to commercial farming.

Minimal research has been conducted to identify constraints and opportunities to expanding market participation in the three countries, which is the focus of this project.

Angola: Improving smallholder productivity and marketed surplus is a key element of the Government of Angola's (GOA) poverty reduction strategy. Expanding bean/cowpea production is key to the strategy's success, since they are the country's most important legume crops (370,000 ha), are grown throughout the country, and have been identified by the government as high potential crops. Currently, imports are required to meet demand, as demand exceeds domestic production. Smallholders are in the process of shifting from subsistence to more market-oriented production and the GOA is making investments in developing markets. This project contributes to these efforts.

Mozambique: Beans/cowpeas, the most important legume crops after peanuts, have considerable production potential. The Ministry of Agriculture's (MINAG) development strategy recognizes the importance of strengthening value chains for market-led development. Bean/cowpea production flow into

different marketsheds, each with different consumer preferences. However, consumer preferences of the different markets are not well documented. To date, little work had been done to improve the market performance and the sustainability of dry pulse value chains, which are the foci of this proposal.

Honduras: Common beans, the second most important food crop (95,000 ha) after maize, are an important source of cash income for smallholders. However, typically most smallholders sell their surpluses to traders at the farmgate and receive low prices. With the recent ratification of CAFTA, bean imports are expected to increase, thereby reducing bean prices and farmers' incomes. Smallholders need new markets that will add value to their crop. This project focuses on developing a new market opportunity for smallholders--producing and exporting organic fair trade beans to the US market.

Planned Project Activities for April 1, 2008 - September 30, 2009

Objective 1: *Angola* - This project component has 4 sub-objectives: sub-objective 1.1: summarize secondary data on bean/cowpea production and marketing, including the identification of gaps to guide future research; sub-objective 1.2: identify production areas, marketing channels, and marketing margins; and sub-objective 1.3: identify constraints, opportunities, and potential pilot interventions to improve competitiveness.

Objective 1.1: Summarize secondary data on bean/cowpea production and marketing, including the identification of gaps to guide future research

> *Collaborators*: This component is coordinated by D. Kiala (Universidade Agostinho Neto), in collaboration with C. Donovan, who will make annual site visits and maintain contact by e-mail and phone/SKYPE communications. A student at the Universidade Agostinho Neto will identify key documents and datasets.
>
> *Approaches and Methods***:** Researchers will visit key informants in order to identify information and data sources. This includes public sector agents for production and areas in beans/cowpeas. Collect/analyze secondary information to document trends in production, marketing, trade, consumption, etc., and identify information gaps
>
> *Benchmarks*: Draft literature review on agricultural production and markets in Angola, focusing on beans and cowpeas

Objective 1.2: Identify production areas, marketing channels, and marketing margins.

> *Collaborators*: This component is coordinated by D. Kiala (Universidade Agostinho Neto), with participation of C. Donovan. Among those who will be contacted in this research are staff at the Ministry of Agriculture, including staff of the IIA (Agricultural Research Institute) and the Department of Food Security. Contacts with World Vision, ADRA, and CLUSA will contribute information, as well as the Ministry of Commerce.
>
> *Approaches and Methods*: Interview key subsector participants (e.g., agricultural scientists, traders, processors, importers/exporters, NGOs) to develop a value chain diagnosis, plus information needed to improve performance and identify constraints to subsector growth

Benchmarks:

- Value chain diagnostic: Thesis proposal concerning farmer marketing
- Value chain diagnostic: Thesis proposal: Public markets: Sources and sales
- Diagnostic: proposal: Formal Private sector sources and destination
- Diagnostic: UAN Thesis: Farmer marketing
- Diagnostic: UAN Thesis: Public markets: Sources and sales
- Diagnostic: Formal Private sector sources and destination
- Draft Value chain diagnostic
- MS Thesis proposal

Objective 1.3: Identify, constraints, opportunities, and potential pilot interventions to improve competitiveness

Collaborators: Coordinated by D. Kiala (Universidade Agostinho Neto), in collaboration with C. Donovan, and the University of Pretoria, where MS graduate training will occur.

Approaches and Methods: A smallholder survey will be undertaken under the World Vision Smallholder Horticultural Value Chain Development project, and it is anticipated that the student will participate, with C. Donovan as design consultant for World Vision. The survey will include information on farmer characteristics and practices, including marketing strategies, trade, and transport—thereby documenting linkages between farmers and markets.

Benchmarks:

- Participative survey with NGO in Planalto region
- Draft article on smallholder marketing
- Outreach with NGO on smallholder marketing results

Objective 2: Mozambique - This project component has 3 sub-objectives: Sub-objective 2.1: analyze spatial and temporal patterns of bean/cowpea production and marketing, using national survey data (TIA), disaggregated by gender; Sub-objective 2.2: map marketsheds for bean/cowpea production areas, document market preferences and work with breeders to test varieties with desirable market characteristics to improve competitiveness and spur adoption of improved bean/cowpea varieties; and Sub-objective 2.3: undertake econometric analysis of the determinants of market participation by producing households, including sex of household head as an explanatory variable.

Objective 2.1: Analyze spatial and temporal patterns in bean/cowpea production and marketing in Mozambique using nationally representative agricultural survey data for 2002, 2003, 2005 and 2006 disaggregated by gender.

Collaborators: Staff from the Market Information System (SIMA) of the Directorate of Economics (DE) in MINAG, and social scientists from IIAM/CESE.

Approaches and Methods: The project will implement a multidisciplinary action research approach that engages stakeholders from public and private sectors and NGOs. This research approach includes the development of a working group across sectors. Researchers will assess with partners the development of a formal Bean/Cowpea Task Force, if the stakeholders support and commit their time and efforts, but at the very least, an informal bean/cowpea task force will be brought together as a working group. The task force will have input into the design of the activities and receive regular feedback on findings. The task force will be relevant for all objectives.

Spatial and temporal analysis of existing national agricultural survey databases will be carried out and the production and marketing data will be presented tables and in the form of maps using GIS. The tables for the descriptive analysis will be specified jointly by PI from MSU and IIAM/CESE with the participation of the staff from SIMA. The PI/IIAM will be responsible in carrying out the statistical analysis. The GIS mapping will be led by the PI from MSU with on the job training of CESE staff. Report write-up will be led by the PI from MSU with participation of PI from IIAM. Production of the policy brief will be under the responsibility of the PI from IIAM

Institutional capacity building will take the form of on-job training of two staff from CESE and two from SIMA to gain skill in using statistical package STATA for descriptive analysis of survey data and in the use of GIS to present results in maps. The on-job training will be provided by MSU staff.

Benchmarks:

- Tabular results of spatial analysis from TIA
- Summary report on price analysis (SIMA data)
- Synthesis Paper on spatial and temporal analysis of production
- Policy brief on production

Objective 2.2: Map marketsheds for bean/cowpea production areas, document market preferences, and work with breeders to evaluate varieties with desirable market characteristics to improve competitiveness and spur adoption of improved bean/cowpea varieties.

Collaborators: Staff from the Market Information System (SIMA) of the Directorate of Economics (DE) in MINAG, Department of Policy of the DE in MINAG, social scientists from IIAM/CESE, biological scientists from the leguminous program of the Directorate of Agriculture and Natural Resources of IIAM (IIAM/DARN), research scientists from the Central, and Northwest Zonal Research Centers, and NGOs working in the main bean and cowpea production regions.

Approaches and Methods: This objective will be met using the previously described multidisciplinary action research approach with the task force

The objective will be achieved through focus group discussions with smallholders and field observations in the main agro-ecologies, as well as a rapid appraisal of markets during the major marketing season. Focus group discussions will also solicit detailed information about bean/cowpea production and access to input and output markets. The rapid appraisal will focus on marketing channels and margins. Through focus group discussions with producers and traders, relevant constraints and opportunities will be identified; and potential pilot interventions will be identified and prioritized to improve competitiveness of beans and cowpeas in the principal production agro-ecologies. Existing marketing channels and marketing margins will be documented.

The focus group discussion will be facilitated by staff from IIAM/CESE with backstopping from PI from MSU. The rapid appraisal of markets will be led by staff from SIMA with backstopping by the PI from MSU.

Institutional capacity building will take the form of in-service training on focus group discussion methods and rapid appraisal and will benefit staff from CESE, SIMA and IIAM Zonal Research Centers.

Benchmarks:

- Maps on production and marketing (TIA results)
- Draft rapid appraisal (Windshield Survey) bean/cowpea section for instrument
- Conduct focus group discussions on consumer preferences
- Conduct rapid appraisal with SIMA participation
- Report on focus group discussions
- Report on the rapid appraisal (Windshield Survey)
- Establishment of a bean/cowpea task force
- Presentation of the diagnostic results to stakeholders
- Joint meeting with IIAM breeders on the market results and consumer preferences to identify potential interventions with production
- Working paper (for objectives 2.1and 2.2)
- Policy brief (for objective 2.2)

Objective 2.3: Undertake econometric analysis of the determinants of market participation by producing households, including sex of household head as an explanatory variable

Collaborators: Staff from the Market Information System (SIMA) of the Directorate of Economics (DE) in MINAG, Department of Policy of the DE in MINAG, social scientists from IIAM/CESE, biological scientists from the Legumes Program of the Directorate of Agriculture and Natural Resources of IIAM (IIAM/DARN), and NGOs working in the main bean/cowpea production regions.

Approaches and Methods:

- Participant trainee will be enrolled at MSU to pursue MS degree program in Agricultural Economics. During his/her degree program s/he will acquire skills to undertake sophisticated econometric analysis using appropriate and relevant statistical packages**.**
- Participant trainee will organize existing household survey data and if needed conduct fieldwork to gather additional data to perform the econometric analysis
- One candidate from IIAM/CESE will initiate a two-year MS training in agricultural economics at MSU

Benchmarks:

- Organize unified TIA dataset
- Draft MS thesis proposal

Objective 3: This project component has 4 sub-objectives for this period. The sub-objectives in the current workplan are the following: sub-objective: 3.1) identify markets in the US for organic fair trade common beans, including the grades and standards required by these markets; 3.2) validate via field trails existing agronomic recommendations for growing organic beans; 3.3) identify interested smallholders and train the farmers to produce organic beans that meet the grades and standards required by US retailers; 3.4) establish local market linkages required for small-scale bean farmers to export organic fair trade beans to US markets.

Objective 3.1: Identify markets in the US for organic fair trade common beans, including the grades and standards required by these markets.

Collaborators: R. Bernsten will be responsible for this component, in collaboration with J.C. Rosas (EAP). The project will be implemented, in collaboration with a multidisciplinary team of private/public sector participants, including EAP faculty (Ernesto Gallo, agricultural economist

specializing in agribusiness); with technical guidance from 3rd party certifiers (e.g., staff of the Rainforest Alliance), MSU's Partnership for Food Industry Development (Luis Flores), a staff member of Kalsec Inc. (Gustavo Puente, former B/C CRSP trainee, who is in charge sourcing spice imports from Latin America), a staff member of TransFair USA (Miguel Zamora, a former B/C CRSP trainee, who implements fair trade certification in Latin America), and purchasing agents of US food retailers/natural food distributors (e.g., Whole Foods Markets, Wal-Mart, Alter-Eco, UNFI—the major wholesaler of natural food products to retail stores).

Approaches and Methods: Key informant interviews and web searches will identify agents involved in international and domestic bean markets in the US. Researchers will contact US distributors/retailers of organic/fair trade commodities (e.g., Whole Foods, Sam's Club, United Natural Foods) to identify interested buyers, determine required grades and standards, and negotiate purchase commitments. Project researchers have already established contacts with private sector agents in the US.

Benchmarks:
- List of US retailers with potential interest in purchasing organic fair trade beans
- Identification of potential certification agency and the standards that are to be met for fair trade and organic certification

Objective 3.2: Validate via field trails agronomic recommendations for growing organic beans

Collaborators: J. C. Rosas (EAP) will lead this research with other EAP researchers.

Approaches and Methods: EAP researchers will identify organic production methods that meet international standards for organic production and test these methods via on-farm trials. Such aspects as IPM and soil fertility enhancements with organic improvements will be included.

Benchmarks:
- Establish initial organic bean production field trials
- Report on results of initial organic bean production field trials
- Establish second set of organic bean production field trials
- Report on results of second set of organic bean production field trials
- List of validated production practices for growing organic beans

Objective 3.3: Train smallholder farmers to produce organic beans that meet the grades and standards required by US retailers.

Collaborators: J. C. Rosas (EAP) will lead this research, in collaboration with village-level research committees (CIALs) participation.

Approaches and Methods: EAP researchers will use identify interested farmer groups (CIALs) and collaborating NGO interested in growing organic beans and train them on organic bean production methods.

Benchmarks:
- Identify farmers/groups/NGOs interested in growing organic beans
- Train farmers on organic bean production methods
- Initiate organic bean production for the US market

Objective 3.4: Establish local market linkages required for small-scale bean farmers to export organic fair trade beans to US markets.

Collaborators: R. Bernsten will be responsible for this component, in collaboration with J.C. Rosas (EAP). A MSU PhD student (agricultural economics) will support this objective of the project. As indicated for Objective 3.1, the project will be implemented, in collaboration with a multidisciplinary team of private/public sector participants.

Approaches and Methods: In this period of the overall project, only the initial discussions with potential private sector participants will be initiated. This will be based on key informant interviews to identify agents within Honduras involved in bean markets.

Benchmarks: A list of potential private sector transporters, processors/cleaners, and exporters will be developer.

Target Outputs

Angola: Project outputs will include: 1) a UAN thesis that provides an assessment of farmer marketing of beans and cowpeas based on rapid assessments; 2) a UAN thesis that identifies the structure and conduct of public markets with respect to bean/cowpeas; 3) a research paper that details the relationships throughout the domestic value chain for beans and cowpeas; and 4) an MS thesis (University of Pretoria), a research paper, and a policy brief identifying key leverage points in value chain, value of improved market services and interventions that can ensure that when constraints are addressed, increased production will find market opportunities w/ sustained producer incentives. All of these outputs will be the subject of outreach, with developers of the market information system and farmer extension programs of NGOs. The research results will also be communicated to GOA, USAID/Angola, and other stakeholders via reports, seminars, and meetings.

Mozambique: Project outputs will include: 1) a research paper and a policy brief summarizing objectives 1 and 2 (subsector overview and constraints to increasing smallholder productivity and market participation); 2) in-service training for new CESE socio-economists in focus group interviews, market appraisal, value chain analysis and data analysis with STATA; 3) collaboration between CESE and SIMA to identify marketsheds and consumer preferences; 4) an MS thesis (MSU), a research paper, and a policy brief quantifying determinants of smallholder market participation and constraints that must be relaxed to insure broad-based participation by households with differing asset portfolios.

Honduras: Project outputs will include: 1) the identification of retail markets in the US for organic fair trade beans; 2) identification of certification requirements for organic fair trade beans, based on the identification of a certification system; 3) identification of agronomic practices for growing organic beans; 4) training of smallholders to produce organic beans; 4) the establishment of initial market linkages for marketing organic fair trade beans, to later enable the export of organic fair trade beans to US retailers; and 5) a research paper summarizing strategy for producing/marketing organic fair trade beans, including constraints.

Engagement of USAID Field Mission(s)

During the design phase, USAID Missions were contacted for input. Communication between PIs and missions in Angola, Mozambique, and Honduras will continue through email. During the annual visits of the US-PI, the HC and UP-PI will meet with USAID Mission staff to describe the project, solicit input, and explore opportunities for Mission buy-ins. Since travel to Mozambique and Angola is paired with

other, non-CRSP related activities, there will be additional opportunities to discuss the activities and progress with Mission staff. In addition, for all outreach activities, Mission staff will be notified and invited. Where applicable, the PIs will develop success story briefs for presentation to the Mission.

Networking Activities with Stakeholders

Angola: MSU and UAN will collaborate with various agencies. It is anticipated that the MSU PI will participate in monitoring and evaluation activities with World Vision on their new Gates Foundation Project on Horticultural Value Chains. This work will enable a strong collaboration between MSU, UAN and World Vision in the implementation of a smallholder baseline survey and the data from that survey may be available for research and analysis focused on beans and cowpeas. Other NGOs in Angola are also involved in activities for agricultural production and marketing, including CLUSA, SNV, and ADRA, and the HC PI will reinforce to linkages with those partners, to share research results on the value chain as well as learn from their experiences.

The Ministry of Agriculture in Angola has several units that will be involved for they are currently active in either market information system development (DSA (Food Security Department) and INCER (Cereals Institute)) or in extension activities with smallholders (IDA (Extension Service). The working relationship between IIA (Angolan Research Institute) and UAN is strong and both are based in Huambo, facilitating the linkages. There are two other Pulse CRSP activities in Angola, both based with IIA. Continued discussions with the breeding program with University of Puerto Rico will be particularly important as work on the value chain proceeds.

Private sector agents will be interviewed and later involved in outreach concerning the value chain analysis. These include Nosso Super (supermarket chain), Shoprite (supermarket chain), Jumbo, Angolan Chamber of Commerce, and UNAC (farmers association).

Mozambique: A bean/cowpea taskforce including the principal stakeholders will be created and will have the following functions: 1) review the activities to be undertaken by the project; 2) participate in the evaluation pilot production and market interventions; and 3) promote the uptake of the recommendations arising from the study

Honduras: The PI's will meet periodically with staff of various HC-institutions (e.g., Ministry of Agriculture and Animal Husbandry, EAP, NGOs, processors/packers, exporters, third-party certifiers) to present an overview of the action research project and solicit their suggestions for implementations. The project will invite a limited number of key parties to serve on a project advisory team.

Leveraging of CRSP Resources

Across the countries, we will be seeking funding to enable the sharing of experiences between the Central American research on advanced value chains and value chain development in Southern Africa.

Angola: The project will leverage Angolan government resources from the University of Agostinho Neto, Faculty of Agricultural Sciences. Production training and research at UAN is funded publicly, and the salaries and facilities of staff will provide a basis for the project operations. The Bean Program at IIA is also publicly funded and their participation will be sought in this training/research. MINADER has indicated strong interest in establishing market information services using public sector funding, and the project will be able to link with that work, as both the project and MINADER will use the rapid market appraisal methodology and results. Given the investments in smallholder market development by private sector agents, including Chevron, the project seeks to tie in with those efforts in specific areas of operations.

Mozambique: Public sector funding through the common-fund mechanism PROAGRI contributes substantially to the development of this research and training program. That funding provides the salaries and facilities for the CESE staff members, including the HC-PI in Mozambique. In addition, MINAG funds through PROAGRI funds the Bean Program of IIAM. That National Directorate of Economics and the provincial MINAG offices support both the national household surveys (TIA) and the market data collection of the Agricultural Market Information System (SIMA), through public sector funding. Rockefeller Foundation is supporting the local MIS in one of the high bean potential areas, a leverage point for innovation market information efforts.

Honduras: EAP, a private university will support the project by salary support for the HC-PI's participation in the project. In addition, the PIs will contact several organizations to solicit additional leveraged funds, including 1) EAP (e.g., units/projects interested in participating organic agriculture training), 2) the Millennium Development Corporations/Honduras (a former B/C CRSP trainee now work for the MCC), 3) the Department of Agriculture and Animal Husbandry (agribusiness section), 4) Red SICTA (a ICTA related Central American organization, which is has a mandate for technology transfer and is now focusing on strengthening agribusiness/food chains for smallholders), and 5) Honduran-based NGOs involved in agricultural initiatives.

Dry Grain Pulses CRSP Budget Summary

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

	Budget Summary 04/01/08 - 09/30/09						
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)
Institution Name	**MSU**	**MSU**	**Brazil**	**Angola**	**Mozambique**	**Honduras**	**S. Africa**
a. Personnel Cost							
Salaries	$ 27,202.00	$ -	$ -	$ 1,082.00	$ 11,527.00	$ 8,244.00	$ 8,515.00
Fringe Benefit	$ 6,399.00	$ -	$ -	$ -	$ 4,810.00	$ 3,380.00	$ 775.00
	$ -	$ -	$ -	$ -	$ -	$ -	$ -
b. Travel	$ 24,250.00	$ 3,500.00	$ -	$ 3,627.00	$ 7,400.00	$ 19,163.00	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 5,944.00	$ 10,400.00	$ -	$ 3,209.00	$ 3,209.00	$ 6,388.00	$ -
e. Training							
Degree	$ -	$ -	$ 15,773.00	$ -	$ 1,414.00	$ -	$ 3,484.00
Non-Degree	$ -	$ -	$ -	$ 4,243.57	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ -	$ -	$ -	$ -	$ -	$ -	$ -
g. Total Direct Cost	**$63,795.00**	**$13,900.00**	**$15,773.00**	**$12,161.57**	**$28,360.00**	**$37,175.00**	**$12,774.00**
h. Indirect Cost	$ 33,173.40	$ 7,228.00	$ -	$ -	$ -	$ -	$ -
i. Indirect Cost on Subcontracts (First $25000)	$ -	$ -	$ 4,100.98	$ 3,162.01	$ 6,500.00	$ 6,500.00	$ 3,321.24
j. Total Indirect Cost	$ 33,173.40	$ 7,228.00	$ 4,100.98	$ 3,162.01	$ 6,500.00	$ 6,500.00	$ 3,321.24
Total	**$ 96,968.40**	**$ 21,128.00**	**$ 19,873.98**	**$ 15,323.58**	**$ 34,860.00**	**$ 43,675.00**	**$ 16,095.24**
Grand Total	**$247,924**						

	Amount	Percentage
Percentage of U.S. Budget	$ 63,795.00	**34.68%**
Percentage of Host Countries Budget	$ 120,143.57	**65.32%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 24,242.25		$ -	$ -	$ -	$ -	$ 24,242.25
Cash	$ -		$ -	$ -	$ -	$ -	$ -
Total	$ 24,242.25	$ -	$ -	$ -	$ -	$ -	$ 24,242.25
Attribution to IEHA Objectives							
Percentage of effort							38.23%
Amount corresponding to effort	$ 38,787.36	$ 21,128.00	$ -	$ 34,860.00	$ -	$ -	$94,775.36
Attribution to Capacity Building (Theme "D")							
Percentage of effort							35.26%
Amount corresponding to effort	$ -	$ 21,128.00	$ 15,323.58	$ 34,860.00	$ -	$ 16,095.24	$87,406.82

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names:	Maria da Luz
Last Name:	Quinhentos
Citizenship:	Mozambican
Gender:	Female
Degree:	M.S.
Discipline:	Agricultural Economics
Host Country Institution to Benefit from Training:	IIAM
Training Location:	Michigan State University
Supervising CRSP PI:	Boughton, Duncan
Start Date:	08/08
Project Completion Date:	08/10
Training Status:	
Type of CRSP Support (full, partial or indirect):	Full (Category 1)

Student #2

First and Other Given Names:	Ana Lidia
Last Name:	Gungulo
Citizenship:	Mozambiquan
Gender:	Female
Degree:	M.S.
Discipline:	Agricultural Economics
Host Country Institution to Benefit from Training:	IIAM
Training Location:	University of Pretoria, South Africa
Supervising CRSP PI:	Boughton, Duncan
Start Date:	2/09
Project Completion Date:	10/10
Training Status:	Delayed
Type of CRSP Support (full, partial or indirect):	Full (Category 1)

Student #3

First and Other Given Names: Estaveo
Last Name: Chaves
Citizenship: Angolan
Gender: Male
Degree: M.S.
Discipline: Agricultural Economics
Host Country Institution to Benefit from Training: UAN
Training Location: University Federal Vicosa, Brazil
Supervising CRSP PI: Donovan, Cynthia
Start Date: 2009
Project Completion Date: 2011
Training Status: Pending
Type of CRSP Support (full, partial or indirect): Full (Category 1)

Short-term Training:

Type of Training: In-service training
Description of training activity: Provision of skills to the trainees on using value chain concepts to evaluate bean and cowpea supply and demand systems nationally and regionally
Status of this activity: Postponed
Reason if training activity not completed as planned: Due to scheduling conflicts, this activity has been postponed until early 2009. Training materials are in development.
When did the activity occur?:
Location: UAM, Huambo
Who benefited from this activity?:
Number of Beneficiaries: 20
Male:
Female:
Total:

Type of Training: In-service Training
Description of training activity: Provision of skills to the trainees on data entry and processing and econometric analysis of bean and cowpea production and marketing data
Status of this activity: Postponed
Reason if training activity not completed as planned: Due to scheduling conflicts, this activity has been postponed until 2009.

When did the activity occur?:

Location: UAM, Huambo

Who benefited from this activity?:

Number of Beneficiaries: 10

Male:

Female:

Total:

Type of Training: In-service Training

Description of training activity: Provision of skills to the trainees on participatory focus groups discussions to gather insights on beans and cowpeas based farming systems, major constraints and opportunities for bean/cowpea sub-sector development and new strategies for development of bean/cowpea markets towards increased bean and cowpea production and productivity

Status of this activity: Postponed

Reason if training activity not completed as planned: Due to scheduling conflicts, this activity has been postponed until 2009.

When did the activity occur?:

Location: IIAM, Maputo

Who benefited from this activity?:

Number of Beneficiaries: 6

Male:

Female:

Total:

Type of Training: In-service Training

Description of training activity: Provision of skills to the trainees on participatory rapid rural appraisals to elicit key informants to provide insights on beans and cowpeas based farming systems, production constrains and potential demand for beans and cowpeas nationally and regionally

Status of this activity: Postponed

Reason if training activity not completed as planned: Due to scheduling conflicts, the training has been postponed until 2009

When did the activity occur?:

Location: Zonal Center of IIAM

Who benefited from this activity?:

Number of Beneficiaries: 6

Male:

Female:

Total:

Type of Training: In-service Training

Description of training activity: Provision of skills to the trainees on using value chain concepts to evaluate bean and cowpea supply and demand systems nationally and regionally

Status of this activity: Postponed

Reason if training activity not completed as planned: Due to scheduling and time conflicts, the training has been postponed until early 2009

When did the activity occur?:

Location: IIAM, Maputo

Who benefited from this activity?:

Number of Beneficiaries: 4

Male:

Female:

Total:

Type of Training: Practical Training

Description of training activity: Practical training for farmers who will grow organic beans and EAP staff interested in learning about organic bean production methods.

Status of this activity: Completed as planned

Reason if training activity not completed as planned:

When did the activity occur?: September 2008

Location: Honduras

Who benefited from this activity?: Farmer groups participating in organic bean production, and NGO technicians/EAP staff interested in learning how to grow organic beans

Number of Beneficiaries:

Male: 13

Female: 2

Total: 15

<u>Equipment</u> (costing > $5000):

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

Principle Investigators

Jonathan Lynch, Pennsylvania State University, USA
Juan Carlos Rosas, EAP, Honduras
Magalhaes Miguel, IIAM, Mozambique

Collaboratoring Scientists

Celestina Jochua, IIAM, Mozambique
Soares Xerinda, IIAM, Mozambique
Jill Findeis, Penn State, USA
Kathleen Brown, Penn State, USA Jonathan Lynch, Penn State, USA

Project Problem Statement and Justification

This project is premised on four well-established facts:

1. Drought and low soil fertility are principal, pervasive constraints to bean production in Latin America and Africa.
2. The vast majority of 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 crop production throughout the developing world, and this is especially true of common bean, which in poor countries is typically a smallholder crop grown in marginal environments with few inputs. Phosphorus limitation is the most important nutrient constraint to bean production, followed by the acid soil complex of excess Al, excess Mn, and low base supply. The importance of nutritional stress in bean production systems of Latin America and Africa cannot be overstated. Fertilizer use is negligible in many developing countries, especially in sub-Saharan Africa, which generally have the poorest soils. 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 growth and yield in low fertility soil.

We have shown substantial variation in bean P efficiency that is stable across soil environments in Latin America. Analysis of the CIAT germplasm collection identified several sources with outstanding P efficiency - from 100 to 200% better than existent checks such as Carioca. Studies with these genotypes identified a number of distinct root traits that contribute to P acquisition through topsoil foraging, including root hair length and density, adventitious rooting, basal root shallowness, and traits that reduce the metabolic costs of soil exploration such as root etiolation and root cortical aerenchyma. Genetic variation for these traits is associated with from 30 – 250% 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.

Genotypes that are more responsive to inputs may promote the use of locally available inputs in improved Integrated Crop Management (ICM) systems. Several African countries have reserves of sparingly soluble rock P whose effectiveness may be improved by the use of nutrient-efficient bean genotypes. Beans are superior to maize in their ability to solubilize P in their rhizosphere. The introduction of bean genotypes with superior root systems may enhance the utilization of rock P, thereby improving P availability and N availability (through symbiotic N fixation) in maize/bean systems. Similarly, bean genotypes with deeper root systems may be synergistic with soil management techniques to conserve residual moisture. Our project will test these hypotheses.

We also 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. Factors such as family structure may play a 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 April 1, 2008 - September 30, 2009

Objective 1: Develop bean genotypes with improved tolerance to drought and low P

Collaborators:
In Latin America: INTA (Nicaragua), Nicaraguan farmers group, CIALs from Honduras, members of the Central American and Caribbean bean network, and NGOs.
In Africa: Manuel Amane (IIAM), Carvalho Ecole, IIAM, Centro Zonal Noroeste, IIAM, Public extension services, Patricio Augustin (World Vision International), farmers associations (APLA), Rowland Chirwa (CIAT- Malawi, SABRN), CIAT, Rose Mongi, Uyole Agricultural Research Institute, Tanzania.

Approaches and Methods:
Drought and poor soil fertility are primary constraints to pulse production in developing countries. Several specific root traits that enhance bean productivity under drought and low fertility stress have been identified. The overall goal of under objective 1 is to improve bean production in Africa and Latin America through genetic improvement.

The activities under this objective include collection of germplasm, phenotyping root traits, screening root traits for low P/drought tolerance, introgression of root traits into elite lines in Africa and Latin America, and evaluation and development of low P/drought tolerant varieties for farmers using PBV and PVS.

Bean germplasm will be collected from various breeding programs in Africa and Latin America: CIAT, SABRN, BILFA and BIC, regional landraces, improved cultivars, advanced lines. Bean germplasm will be systematically screened for key root traits including root hair length, root hair density, basal root whorl number (BRWN), basal root growth angle (BRGA), and adventitious rooting. Phenotypic screens will be conducted under controlled conditions and also as field root crown evaluations. The Latin America germplasm to be screened will also include landraces and improved lines from the Mesoamerican and Andean gene pools of *Phaseolus vulgaris* useful for Central American and the Caribbean, and Interspecific lines from *P. vulgaris* x *P. coccineus* crosses developed by the LAC project during the previous Bean/Cowpea CRSP.

Introgression of root traits conferring greater drought tolerance and P efficiency will be carried out by developing inbred backcross (IB) populations. These IB populations will be composed of breeding lines which combine key root traits with multiple disease resistance and preferred seed types in the target regions. The initial cross will be made between the recurrent parent (selected elite cultivars and/or advanced lines for CA/C and African target countries) and the donor parents (selected germplasm with the higher expression of key root traits), followed by two backcrosses to the recurrent parent and three generations of selfing by single seed descent to develop IB populations.

Field selection will be based on the average performance of advanced IB lines in replicated drought and low P trials, complemented with field and greenhouse evaluations of root traits. Selected lines will be tested individually or in multiline combinations. The identified locations for testing include Lichinga, Gurue, Angonia, Sussundenga and Chokwe in Mozambique, and Zamorano, Yojoa Lake, Yorito and El Paraíso in Honduras. Selection for some disease resistance will be conducted in the field. In addition, advanced lines will be evaluated in Malawi, Nicaragua and Haiti.

Participatory plant breeding (PPB) and PVS approaches will be used in the field trials for evaluation of the performance of the IB lines under drought/low P, agronomic adaptation and commercial seed types. Participants in the value chain of common beans (production, processing, commercialization and export) in the target countries will be invited to participate in these evaluations.

Objective 2: Develop integrated crop management systems for stress tolerant bean genotypes.

Collaborators:
Carvalho Ecole, IPM, IIAM, Mozambique
Momade Ibraimo, CZNd, Pedology, IIAM, Mozambique
Patricio Augustin WVI, Gurue, Mozambique
Domingos Dias, Agronomy, CZC, IIAM, Mozambique
Manuel I. V. Amane, Plant Nutrition, IIAM-HQ, Mozambique

Approaches and Methods:
A) Evaluation of the effect of P efficient bean genotypes on soil erosion:

To conduct this study we will install erosion lysimeters at IIAM station in Lichinga in Mozambique. Using methods we have developed and used successfully in Costa Rica and Ecuador, these 2 by 1.6 m plots allow the measurement of soil and P lost from erosion from specific genotypes.

B) Evaluation of the utility of local rock P with P efficient bean genotypes:

In this activity we will first obtain ground local rock phosphates from Monapo and Montepuez districts and evaluate the their efficacy for bean genotypes with contrasting root traits in greenhouse and field conditions at Sussundenga and Lichinga. Results will test the hypotheses that more P efficient bean

genotypes will have better utilization of local rock P than traditional genotypes, and that local rock phosphate can be a useful source of both P and Ca in red acid soils of Central and Northern Mozambique.

C) Evaluation of synergy of water conserving soil management with drought tolerant genotypes:

Various methods of soil management such as mulching, crop residue management, crop rotations, microcachement systems, and minimum tillage may conserve residual moisture during the dry season and periodic drought. Root traits may have synergy with these methods by for example permitting better exploitation of water deep in the soil profile. These issues have never been investigated.

In this activity we will establish soil moisture plots to compare traditional and drought-tolerant genotypes under traditional versus moisture-conserving soil management to text the hypothesis that combined packages of novel genotypes and integrated soil management have greater potential impact than either approach in isolation. Plant materials to be evaluated will include those developed for drought tolerance by CIAT-Malawi.

D) Evaluation of the effect of root traits in maize/bean intercrops:

The effects of BRGA, BRWN, and root hair length on root competition in maize intercrops will be the MS thesis research of one of the IIAM students at Penn State. Closely related bean genotypes contrasting for root traits (RILs of L-88) will be grown in sole crop or intercropped with maize, with and without irrigation and at high and low P fertility, in field studies at the Rock Springs research station at Penn State. Root phenotypes will be confirmed through destructive sampling of root crowns as well as nondestructive root imaging with minirhizotrons. Soil cores at R5-R7 will permit analysis of root length by depth. Plant P acquisition and water status will be assessed over time. Results will test the hypothesis that root traits that benefit bean growth under drought and low P may or may not affect yields of maize intercrops depending on spatial niche segregation. Parallel studies with more genotypes and less intensive physiological sampling will be conducted at the IIAM Sussundenga research station in Mozambique.

Objective 3: Understand constraints to adoption of new bean technologies, income and nutrition potential, and intra-household effects and impacts.

Collaborators:
Bayou Demeke, Agricultural Economics, Penn State
Feliciano Mazuze, CESE, IIAM, Mozambique
Venancio Salegua, CESE, IIAM, Mozambique
Ana Lidia Gunguro, CESE, IIAM, Mozambique

Approaches and Methods:
Farm households in the four study areas in Mozambique will participate in identification of a) barriers to widespread adoption, b) constraints to achieving potential income and nutrition impacts, and c) intra-household impacts of introduction of new bean technologies. Questions related to the implications of human disease for production, marketing and health status will be included. To achieve Objective 3, a quantitative survey of farm households will be conducted in villages proximate to the four project study areas (Sussundenga, Lichinga, Gurue, and Angonia).

The Mozambique Vulnerable Soil Vulnerable Household (VSVH) Survey will be conducted in a face-to-face format. Male and female surveys will be conducted, with one adult male (primary decision-maker) and one adult female (a spouse of primary decision-maker) surveyed in each household. It is recognized that not all households will include both spouses; in these cases, two adult decision-makers will be

interviewed or only one adult will be interviewed, if two are not available. The location of each surveyed household will be geo-identified using GPS.

The survey instrument will be developed, translated and cleared through the Human Subjects approval process at Pennsylvania State University in the first 6 months of the project. The face-to-face survey will then be pretested at the Sussundenga site; the face-to-face surveys will be conducted at the four Mozambique sites in the period October 1, 2008-September 30, 2009 period.

Target Outputs

This is clearly identified in the benchmarks document, and target outputs are presented below.

Objective 1: breeding

- Aggregate germplasm;
- Phenotyping root traits;
- Screen for drought/low P tolerance;
- Field evaluation/trials of identified genotypes; and
- Introgress root traits for drought/low P tolerance

Objective 2: agroecology

- install erosion lysimeters Lichinga;
- conduct erosion studies Lichinga;
- analyze erosion results Lichinga;
- obtain ground local rock phosphate (RP);
- conduct greenhouse studies with RP;
- establish soil moisture plots; and
- intercropping study conducted.

Objective 3: socioeconomics

- develop survey instrument;
- human subjects approval of survey;
- interviewer training completed;
- survey instrument pre-tested; and
- quantitative survey conducted.

Objective 4: capacity building

- IIAM MS students recruited;
- MS student practicum;
- MS student coursework;
- MS student research begun;
- INTA training at Penn State;
- internet access at Chokwe established;
- analytical capacity at Sussundenga established;
- web resource root methods available; and
- root phenotyping methods available.

Engagement of USAID Field Mission(s)

In Mozambique, we will be reporting to the USAID Mission the progress made during the implementation of the activities as we achieve the expected benchmarks during each period of project implementation. In addition, we will be inviting USAID Mission staff members to perform field visits as a means to verify the benchmarks reported in each period, as well as to encourage the participation of USAID Mission staff members in field days with farmers.

The USAID Mission in Honduras has been very supportive of Bean/Cowpea CRSP research activities conducted by Zamorano over the last 18 years. They are aware of the impact of the cultivars released by the program in bean production in Honduras. EAP will be reporting to the USAID mission in Honduras about the progress made during the implementation of the project. In addition, when US PIs and MO staff visits project activities in Honduras, EAP will encourage them to perform a courtesy visit to the Mission, when it is possible.

Networking Activities with Stakeholders

The PIs participate in a range of research networks including Central American and African bean research networks.

Leveraging of CRSP Resources

This project is highly leveraged against synergistic activities under the supervision of the project participants, including an $800,000 grant from the McKnight Foundation to JL and MM and a colleague in China, two other Pulse CRSP grants to JCR, FAO/IAEA projects to JL and MM, and over $1.5M in related root biology projects in the Lynch lab at Penn State.

Dry Grain Pulses CRSP Budget Summary

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

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	PSU	PSU	Mozambique	Honduras (EAP)	0	0
a. Personnel Cost						
Salaries	$ 6,247.00	$ 49,756.00	$ 3,150.00	$ 9,750.00	$ -	$ -
Fringe Benefit	$ 512.00	$ 7,079.00	$ -	$ 1,950.00	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
b. Travel	$ 9,000.00	$ -	$ 40,072.12	$ 2,600.00	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ 13,350.00	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 16,000.00	$ 8,000.00	$ 5,925.00	$ 4,000.00	$ -	$ -
e. Training						
Degree	$ -	$ 32,258.00	$ -	$ -	$ -	$ -
Non-Degree	$ -	$ -	$ -	$ 2,000.00	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ -	$ -	$ 2,747.00	$ 8,450.00	$ -	$ -
g. Total Direct Cost	**$31,759.00**	**$97,093.00**	**$65,244.12**	**$28,750.00**	**$0.00**	**$0.00**
h. Indirect Cost	$ 15,054.00	$ 30,731.00	$ -	$ -	$ -	$ -
i. Indirect Cost on Subcontracts (First $25000)	$ -	$ -	$ 11,850.00	$ 11,850.00	$ -	$ -
j. Total Indirect Cost	$ 15,054.00	$ 30,731.00	$ 11,850.00	$ 11,850.00	$ -	$ -
Total	**$ 46,813.00**	**$ 127,824.00**	**$ 77,094.12**	**$ 40,600.00**	**$ -**	**$ -**
Grand Total	**$292,331.12**					

	Amount	Percentage
Percentage of U.S. Budget	$31,759.00	**14.25%**
Percentage of Host Countries Budget	$191,087.12	**85.75%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 60,366.00		$ -	$ -	$ -	$ -	$ 60,366.00
Cash	$ -		$ -	$ -	$ -	$ -	$ -
Total	$ 60,366.00	$ -	$ -	$ -	$ -	$ -	$ 60,366.00
Attribution to IEHA Objectives							
Percentage of effort							46.14%
Amount corresponding to effort	$ 42,131.70	$ -	$ 77,094.12	$ 15,668.20	$ -	$ -	$134,894.02
Attribution to Capacity Building (Theme "D")							
Percentage of effort							54.67%
Amount corresponding to effort	$ 42,131.70	$ -	$ 77,094.12	$ 40,600.00	$ -	$ -	$159,825.82

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names: IIAM Scientist 1
Last Name: TBD
Citizenship: Mozambique
Gender: Male
Degree: M.S.
Discipline: Agronomy
Host Country Institution to Benefit from Training:
Training Location: Penn State
Supervising CRSP PI: Lynch, Jonathan
Start Date: 10/08
Project Completion Date: 10/10
Training Status:
Type of CRSP Support (full, partial or indirect): Full (Category 1)

Student #2

First and Other Given Names: IIAM Scientist 2
Last Name: TBD
Citizenship: Mozambique
Gender: Male
Degree: M.S.
Discipline: Plant Nutrition
Host Country Institution to Benefit from Training: IIAM
Training Location: Penn State
Supervising CRSP PI: Lynch, Jonathan
Start Date: 10/08
Project Completion Date: 10/10
Training Status:
Type of CRSP Support (full, partial or indirect): Full (Category 1)

Short-term Training:

Type of Training: In service

Description of training activity: in service training of INTA agronomists in root biology

Status of this activity:

Reason if training activity not completed as planned:

When did the activity occur?:

Location: Penn State

Who benefited from this activity?: INTA agronomists

Number of Beneficiaries: 2

Male:

Female:

Total:

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

Principle Investigators

Philip A. Roberts, University of California-Riverside, USA
Ndiaga Cisse, ISRA, Senegal
Issa Drabo, INERA, Burkina Faso
António Chicapa Dovala, IIA, Angola

Collaboratoring Scientists

Jeff Ehlers, University of California-Riverside, USA

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 Marketing with Improved Varieties: New cowpea varieties must have features desired by consumers as well as farmers, including rain 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 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 urban centers in Nigeria, but the standard rough-brown 'Ife Brown' is 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. 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 reflects insufficient quantities of Breeder and Foundation Seed. We propose to help support increased production of Breeder Seed and work with producers of Foundation Seed to strengthen their production and marketing. Strengthening seed production and delivery at the early breeder-involved stages will promote availability of high quality planting seed.

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

Planned Project Activities for April 1, 2008 - September 30, 2009

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, ISRA, Senegal.
Tignegre Jean-Baptiste, INERA, Burkina Faso
Clementine Dabire, INERA, Burkina Faso.
Abdoussalam Sawadogo, INERA, Burkina Faso
Jose Pedro, IIA, Angola.
David Kiala, Universidade Agostinho Neto, Angola.
Antonio Castame Francisco, IIA, 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 lines developed under the previous Bean/Cowpea CRSP of other germplasm in the development 'pipeline', and initiate new short- and long-term breeding strategies to develop high-yielding improved varieties.

Final Testing and Release of Varieties

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

Table 1. Varietal candidate lines

Candidate Line	Developing Institution	Releasing Institution	Type	Steps Needed in Workplan Period
03Sh-50	UCR	UCR	Blackeye	Completion of Release, PVP Documentation
07-11-572	UCR	UCR	All-white	Experiment station tests. Breeder and Foundation seed increase
03-11-747	UCR	UCR	'Dry Green'	Experiment station tests. Breeder and Foundation seed increase
IT98K-205-8	IITA	INERA	White	Seed production and on-farm evaluations
Melakh	ISRA	INERA	White	Seed production and on-farm evaluations
KVx421-2J	INERA	INERA	White	Seed production and on-farm evaluations
ISRA2065	ISRA	ISRA	White	Final on-farm evaluation, Breeder and Foundation seed increase

In Burkina Faso and Senegal, final on-farm evaluations of four lines (Table 1) will be conducted, and the lines released by the end of workplan period. In Senegal, candidate ISRA 2065 will be compared to 'Melakh' in on-farm trials grown at five sites in the 'Peanut Basin' area of the country. Each on-farm trial will consist of plots ¼ ha in size. Also, 60 advanced lines will be evaluated in on-station trials at 3 locations (Bambey, Nioro, Louga). The trials will have 4 replications with each plots being four rows and 5 m length.

In Burkina Faso, the 3 varietal candidate lines will be grown in on-farm trials by 5 farmer groups at Pisela Village and at 10 other sites in Central and Northern Burkina Faso. Sites will be considered as replications and each plot will be 300 m^2. In addition, six other new candidate varieties that have been developed at INERA will be evaluated in on-farm trials at the same 10 sites in Central and Northern Burkina Faso.

At UCR, breeder and foundation seed of 03Sh-50 was produced in 2007 in anticipation that this variety would be released in 2008. We will continue to work with at least two farmers and one cleaning warehouse (Cal Bean and Grain, Pixley, CA) by monitoring these fields from planting through sales of the product. The farmers will grow two 15-ha production-scale fields of 03Sh-50 and the standard cultivar CB46. The grain produced will be cleaned at Cal Bean and Grain and this warehouse will supply commercial 'clean-out' information. During the first six months, we will collate existing information from on-station and on-farm trials conducted between 2003 and 2007 with this variety, request formation of a UCR Variety Release Committee, and file for Plant Variety Protection and Variety Registration through the Crop Science Society of America. For 07-11-572 and 03-11-747 (or a related 'sister line'), a 'fast-track' release protocol will be followed to accommodate the needs of potential licensees for these varieties to be made available as quickly as possible. We will be able to do this because these varieties

represent new grain types that do not have existing standard varieties with which they can be compared. In anticipation of release of these lines, Breeder and Foundation Seed of these lines will be produced by the end of the workplan period.

A set of five advanced blackeye lines have already been identified as potential blackeye cowpea varieties for the US. These will be included in advanced trials that will be conducted in trials conducted at two locations (Shafter and Kearney) during the workplan period. Each trial will have at least four replications with plots consisting of 4 rows, with rows 8m long. One or more of these varieties may be advanced to candidacy for release by the end of the workplan period.

We will initiate a new two-tiered breeding strategy to meet the immediate and longer term needs of farmers. The **Short-Term Strategy** will use improved and local varieties having both grain quality and agronomic features appreciated by farmers such as appearance, taste, cooking qualities, yield stability, appropriate plant type and maturity. Obvious defects in local and improved varieties will be improved by breeding in resistance to diseases and pests plus other traits, using a rapid recurrent backcrossing approach that will improve productivity and be accepted by farmers. During the first six months, selected varieties to be improved by this approach are given in Table 2.

Table 2. Lines to be improved by introgression of specific traits using backcrossing.

Recurrent Parent Line	**Institution**	**Trait being introgressed**	**Trait donor (non-recurrent) parent**
Yacine	ISRA	Macrophomena	IT93K-503-1
Yacine	ISRA	Flower thrips resistance	58-77
Yacine	ISRA	Striga	SuVita 2
Mouride	ISRA	Large grain	Montiero derived line
Melakh	ISRA	Striga resistance	IT97K-499-39
Melakh	ISRA	Green grain	UCR 03-11-747
KVx396-4-5-2D	INERA	Striga resistance, Large grain	IT81D-994
KVx396-4-5-2D	INERA	Green grain	UCR 03-11-747
IT98K-205-8	INERA	Large seed	Montiero derived line
CB5	UCR	Fusarium wilt	CB27
CB46	UCR	Green grain	UCR 03-11-747
CB46	UCR	Root-knot nematodes	IT84S-2049

During the workplan period crosses between the recurrent and non-recurrent parents will be made, plus the first and second backcrosses, followed by inbreeding the second backcross progenies to develop BC_2F_2 families. Early in the second workplan period, these progenies will be evaluated for trait expression, and a third backcross made onto selected individuals. Molecular markers for some of the target resistance traits emanating 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 for another round of backcrossing.

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 will use a 'two-stream' recurrent selection approach. One stream will include the six possible biparental crosses between highly drought tolerant lines SuVita 2, 58-

57, TN88-63, IT93K-503-1. The F_1's will be made at UCR, then advanced to the F_2 generation and subjected to seedling screening for drought tolerance. A set of 100 drought-tolerant F_2 individuals will be identified and advanced to the F_3 for each population. By the end of the workplan period, the 100 F_3 lines of each population will be developed. They would then be selected again for drought tolerance at the seedling stage, and 50 F_4 lines selected at UCR. Two of the six populations of 50 F_4 lines would be distributed to each program (UCR, ISRA, and INERA) for drought tolerance phenotyping. A smaller subset of 10 lines would be selected from this evaluation, and reevaluated for drought tolerance at the F_5 generation. Individuals from the most drought tolerant lines will be used for crossing to the improved lines developed under the backcrossing program described earlier and in Table 2. Also in the workplan period, breeders in Senegal and Burkina Faso will choose a set of popular local cowpea varieties for targeted genetic improvement through MAS or MARS. These will be hybridized to sources of known thrips resistance and heat/drought tolerance. Using greenhouse and off-season nurseries, the F_1 and F_2 generations will be advanced as quickly as possible. Individuals selected with markers will be evaluated for trait expression to validate the usefulness of the markers in different genetic backgrounds.

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

Collaborators:
Samba Thiaw, ISRA, Senegal.
Tignegre Jean-Baptiste, INERA, Burkina Faso
Jose Pedro, Centro Nacional de Recursos Fitogenetico, Angola.
David Kiala, Universidade Agostinho Neto, Angola.
Antonio Castame Francisco, IIA, Angola.

Approaches and Methods: Cowpea seed production and delivery systems in Burkina Faso and Senegal will be strengthened to ensure delivery of improved varieties. Adoption of improved varieties is constrained by inadequate supply of Breeder and Foundation Seed, which in turn limits the Certified Seed that can be produced. Insufficient resources limit growing, harvesting and storing Breeder Seed increases, in turn limiting Foundation Seed and Certified Seed for farmers is due to the lack of Foundation seed coupled with the relatively low interest in cowpea by public and governmental organizations and private seed companies.

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

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

In Burkina Faso, Breeder Seed will be produced in the off-season for five varieties (IT98K-205-8, Melakh, KVX421-2J, KVX414-22-2, Gorom Local) on 200 m^2 per variety. The seed will be produced at Bazega 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 4 tonnes of Foundation Seed on 5 ha planting. This will address the estimated 20 % shortage of Foundation seed, kick-starting an expansion of the self-sustaining system seed production system. Training of farmers as Certified Seed producers will be done in three locations (ZandomaProvince and SenmatengaProvince in the north, and NayalaProvince in the center). At each location, 25 seed producers, a mix of women and men, will be trained. Foundation Seed will be provided and farmers will be trained in seed production, harvest and post-harvest handling, recognizing that this process differs from the production of cowpea for consumption.

In Senegal, availability of Foundation Seed has been identified as a bottleneck for adequate supply of seed to farmers. Foundation seed is used to produce the Certified Seed that is distributed to farmers for production planting. To overcome this, N. Cisse will produce ½ ha of Melakh and ½ ha of Yacine 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 3 locations (Thilmakha region, Merina district, Mekhe). 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.

In Angola, we will conduct an initial assessment of the infrastructure available upon which to develop a viable seed production and distribution system, recognizing that no system exists currently. We will link with government and NGO institutions, including World Vision, Africare, CRS and ADRA-Angolana, to determine opportunities for initiating the cowpea seed system. We will provide guidelines and descriptions for Angolan nationals in multiplication of high quality seed of selected varieties for farmers. In parallel to this effort, the cowpea field evaluations will be conducted under Objective 1, with the aim of identifying candidate varieties among local landraces, and Bean/Cowpea CRSP (in Ghana, Senegal and/or Burkina Faso) and IITA varieties. One or more of these candidates will become the first varieties to be formally produced for farmers under the new seed system. We will plan to use the data from the primary season trials, planned for completion in March 2009, to make the variety selection and produce the first generation (G1) of Breeder seed by the end of the workplan period.

Target Outputs

- Develop six elite x elite drought tolerant F_5 breeding populations.
- Release of new cowpea varieties in Burkina Faso (X varieties), Senegal (X varieties) and California (X varieties).
- Two California blackeye varieties improved with four traits
- Two Burkina Faso cowpea varieties improved with three traits
- Three Senegal cowpea varieties improved with five traits
- Cowpea breeding manual in hard copy and web-based format.
- Foundation and Certified Seed production strengthened in Burkina Faso and Senegal.
- One MS student from Angola trained in plant breeding with research on cowpea.
- One Host Country PhD student enrolled in graduate program at UCR.
- HC cowpea breeders trained in application of new molecular markers for key traits.

Engagement of USAID Field Mission(s)

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

Networking Activities with Stakeholders

We will work closely with national and international cowpea breeders, including Drs. Ousmane Boukar and Christian Fatokun, Senior Scientists and Cowpea Breeders at IITA, Dr. Mohammed Ishiyaku of the IAR in Nigeria, and Dr. Francis Padi of University of Ghana, Legon in Ghana. 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 NGO xyz in Burkina Faso, NGO xyz in Senegal, and NGO xyz in Angola. This will be especially important in the Objective 2 activities on advancing and developing seed production and delivery systems.

Leveraging of CRSP Resources

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

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

The CGIAR Generation Challenge Program (GCP) Tropical Legumes I Project funded for 3 years (May 2007-April 2010) with expectation for extension of funded research. 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), Cameroon (PI O. Boukar) and Senegal (PI N. Cisse), and IITA (PI, C. Fatokun). This project funded at nearly $1.9M is developing cowpea genomic resources, including cDNAs, BACs, ESTs and SNP genotyping for genetic and physical mapping and for development of easy-to-use markers for major traits. Traits targeted are insect resistance, especially flower Thrips, nematode and disease resistance, and drought and heat tolerance. The more upstream genomics and marker work funded under this project provides an excellent leveraging for CRSP activities described here to be used for more application (downstream) breeding.

A second GCP project funded to UC Riverside (Ehlers, Roberts, and Close) for $450,000 starting January 2008 to December 2010, focuses on development of phenotyping protocols for cowpea drought tolerance, with work in the West Africa partner countries, California and Texas. This provides direct leveraging opportunities for the drought tolerance efforts.

USDA Germplasm Committee grant to UC Riverside for phenotyping cowpea USDA core collection for nematode and aphid resistance (2007-2008 at $16,000).

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.

Dry Grain Pulses CRSP Budget Summary

Modern Cowpea Breeding to overcome critical production constraints in Africa and the U.S.

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	UCR	0	Burkina Faso	Senegal	Angola	0
a. Personnel Cost						
Salaries	$ 34,985.00	$ -	$ 17,000.00	$ 17,000.00	$ 17,000.00	$ -
Fringe Benefit	$ 10,063.00	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
b. Travel	$ 9,000.00	$ -	$ 3,000.00	$ 3,000.00	$ 3,000.00	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 4,120.33	$ -	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ -
e. Training						
Degree	$ -	$ 71,568.00	$ -	$ -	$ -	$ -
Non-Degree	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ -	$ -	$ -	$ -	$ -	$ -
g. Total Direct Cost	**$58,168.33**	**$71,568.00**	**$30,000.00**	**$30,000.00**	**$30,000.00**	**$0.00**
h. Indirect Cost	$ 29,084.17	$ -	$ -	$ -	$ -	$ -
i. Indirect Cost on Subcontracts (First $25000)	$ -	$ -	$ 6,500.00	$ 6,500.00	$ 6,500.00	$ -
j. Total Indirect Cost	$ 29,084.17	$ -	$ 6,500.00	$ 6,500.00	$ 6,500.00	$ -
Total	**$ 87,252.50**	**$ 71,568.00**	**$ 36,500.00**	**$ 36,500.00**	**$ 36,500.00**	**$ -**
Grand Total	**$268,320.50**					

	Amount	Percentage
Percentage of U.S. Budget	$58,168.33	**26.47%**
Percentage of Host Countries Budget	$161,568.00	**73.53%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 36,615.75		$ 650.00	$ 45,650.00	$ 650.00	$ -	$ 83,565.75
Cash	$ -		$ -	$ 10,700.00	$ -	$ -	$ 10,700.00
Total	$ 36,615.75	$ -	$ 650.00	$ 56,350.00	$ 650.00	$ -	$ 94,265.75
Attribution to IEHA Objectives							
Percentage of effort							40.52%
Amount corresponding to effort	$ 40,455.00	$ 11,250.00	$ 33,350.00	$ 14,230.00	$ 9,450.00	$ -	$108,735.00
Attribution to Capacity Building (Theme "D")							
Percentage of effort							23.52%
Amount corresponding to effort	$ 26,694.63	$ 5,250.00	$ 10,385.00	$ 16,360.00	$ 4,410.00	$ -	$63,099.63

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names: Manuel
Last Name: Costa
Citizenship: Angola
Gender: Male
Degree: M.S.
Discipline: Plant Breeding/Genetics/Plant Pathology
Host Country Institution to Benefit from Training: Angola
Training Location: University of Puerto Rico
Supervising CRSP PI: Roberts, Phillip
Start Date: 10/08
Project Completion Date: 09/10
Training Status:
Type of CRSP Support (full, partial or indirect): Full (Category 1)

Student #2

First and Other Given Names: TBD
Last Name: TBD
Citizenship: African
Gender: Female
Degree: Ph.D.
Discipline: Plant Breeding/Genetics/Plant Pathology
Host Country Institution to Benefit from Training:
Training Location: University of Ghana, Legon and UCR
Supervising CRSP PI: Roberts, Phillip
Start Date: 10/08
Project Completion Date: 10/12
Training Status:
Type of CRSP Support (full, partial or indirect): Partial (Category 2b)

Student #3

First and Other Given Names:	Antonio
Last Name:	David
Citizenship:	Angola
Gender:	Male
Degree:	M.S.
Discipline:	Plant Breeding
Host Country Institution to Benefit from Training:	Angola
Training Location:	UPR
Supervising CRSP PI:	Roberts, Phillip
Start Date:	04/09
Project Completion Date:	06/11
Training Status:	Delayed
Type of CRSP Support (full, partial or indirect):	Full (Category 1)

Biological Foundations for Management of Field Insect Pests of Cowpea in Africa

Principle Investigators

Barry Pittendrigh, University of Illinois at Urbana-Champaign, USA
Ibrahim Baoua, INRAN, Niger
Clémentine Dabiré, INERA, Burkina Faso
Mohammad Ishiyaku, IAR, Nigeria

Collaboratoring Scientists

Jeremy McNiel, UWO, Canada
David Onstad, UIUC, USA
Niang Malick Ba, INERA, Burkina Faso
Larry Murdock, Purdue, USA
William Muir, Purdue, USA
Joseph Huesing, Monsanto, USA

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, but 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 use (and misuse) of neurotoxic pesticides to control cowpea insect pests with, in some unfortunate cases, dire consequences to their health, the health of their families, and the end users of those who purchase the cowpeas*. Thus, there is a need to develop alternative strategies for control of insect pests of cowpea, in order to reduce the levels of pesticides used on cowpea crops.

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

The major pests of cowpea in the field in northern Nigeria, Niger, and Burkina Faso include: (i) the legume pod borer, *Maruca vitrata* Fabricius; (ii-iii) the coreid pod-bugs, *Clavigralla tomentosicollis* Stal and *Anoplocnemis curvipes* (F.); (iv) the groundnut aphid, *Aphis craccivora* Koch; and, (v-vi) thrips, *Megalurothrips sjostedti* Trybom and *Sericothrips occipitalis* Hood. A limited amount of work has been done to understand these insect pests in the areas we propose to work. Also, there are few alternatives to pesticide sprays for many of these pest species. Two notable exceptions to this situation exist. The first is *M. vitrata,* where a potential biotechnology-based pest control solution exists. Transgenic cowpea expressing the *Bt*-protein Cry1Ab, effective against *M. vitrata* already exists, however, these plants are unlikely to be available for use by African farmers during the current CRSP funding cycle. However, before transgenic *Bt*-cowpea can be released there will be a need for an insect resistance management (IRM) plan. Although not the primary focus of the current project, our studies will ultimately provide the necessary data for the eventual

development of an IRM plan for *Bt*-cowpea. The second pest of cowpea, where a potentially new strategy for insect control exists, are thrip-resistant cultivars that have been developed by Drs. Phillip Roberts and Jeff Ehlers of University of California at Riverside (UC-R) in conjunction with Drs. Drabo and Dabire of INERA (*e.g.*, variety 58-77). We will work with the aforementioned investigators, to investigate the interactions between thrip-resistant cowpeas and trips in field experiments in Northern Nigeria, Niger, and Burkina Faso.

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

Planned Project Activities for April 1, 2008 - September 30, 2009

Objective 1: *Light Trapping of Maruca and Microsatellite Markers*
This activity will build both (i) institutional infrastructures to monitor *Maruca* (ii) as well as a better understanding of the problems of this pest within the host counties. Although our efforts are not specifically focused on *Bt* cowpea, this work will lay the basis for the development of an IRM plan for *Bt* cowpea, as well as potentially providing the basis for other IPM-based pest control strategies.

Collaborators:
David Onstad, UIUC, USA
Larry L. Murdock, Purdue University, USA
Jeremy McNeil, University of Western Ontario, Canada
Phillip Roberts, University of California at Riverside, USA
Jeff Ehlers, University of California at Riverside, USA
Issa Drabo, INERA, Burkina Faso

Approaches and Methods: Light trapping will occur throughout the 18 months at the existing locations: (i) in Niger the current locations is Maradi; (ii) in Nigeria the existing location is Zaria; and, (iii) in Burkina Faso the existing locations are Farako-ba, Kamboinsé, and Fada N'Gourma. The site at Pobe in Burkina Faso will not be used due to high fuel costs associated with the generator. Instead we will build a new light trap at Dori, where the light trap can be plugged into a main electricity source. In Niger we will also added a location at Kornaka and move the light trap at Niamey to Gaya. In Nigeria additional traps will be stationed at Kadawa and Minjbir. Adults will be monitored and collected from the light traps on a daily basis. Adults will be sent to UIUC through a courier service for microsatellite analysis. The aforementioned work will be the responsibility of the host country P.I.'s.

The microsatellite analysis will be performed by Dr. Weilin Sun, in Dr. Pittendrigh's laboratory, over the last 1 year of the 18-month budget period (and for one more year of the 2.5 year grant based on the availability of funds).

Objective 2: This activity will provide the basis for a better understanding of the problems of pest insects of cowpeas within the host countries. It will also allow for cross training in pest insect biology across the three host countries. Although our efforts are not specifically focused on *Bt* cowpea, this work will lay the basis for the development of an IRM plan for *Bt* cowpea, as well as potentially providing the basis for other IPM-based pest control strategies for both *Maruca* and other pest insects of cowpea.

Collaborators:
Dr. Larry L. Murdock, Purdue University, USA
Dr. Jeremy McNeil, University of Western Ontario, Canada
Dr. William Muir, Purdue University, USA

Approaches and Methods:
The data sharing from our preliminary work and the experimental design for the field studies on the insect pests of cultivated cowpeas will be completed in the first six month budget period. Based on these experimental plans we will study the presence and detailed life-history of the five major pests of cowpea (in the field and where necessary in the laboratory). This will be achieved through the use of randomized complete block design experiments using multiple lines of cowpea and alternative host plants. In Burkina Faso, Dr. Dabire will have one graduate student in working on the pests of cultivated cowpea. All experimental designs will be checked with our statistician (Dr. William Muir of Purdue University) to ensure proper experimental design and analysis of the datasets. Planting for these experiments will occur in the summer of 2008. Data collection will occur upwards of into November/December of 2008. The data will be tabulated, shared with the group, and analyzed. Another round of planting will occur in the summer of 2009, however, the experiments will be completed beyond the 18-month budget period.

Objective 3: This activity will provide the basis for a better understanding of the problems of pest insects of cowpeas within the host counties both during the growing season and when cowpea is not in season. Although our efforts are not specifically focused on *Bt* cowpea, this work will lay the basis for the development of a refuge system for *Bt* cowpea, as well as potentially providing the basis for other IPM-based pest control strategies for both *Maruca* and other pest insects of cowpea.

Collaborators:
Dr. Larry L. Murdock, Purdue University, USA
Dr. Jeremy McNeil, University of Western Ontario, Canada
Dr. William Muir, Purdue University, USA
Dr. Joe Huesing, Monsanto Company, USA

Approaches and Methods: A standardized scouting plan will be established within the first six months of the project. Scouting of pests of cowpea on alternative host plants will occur both during and outside of the cowpea-growing season. The frequency and distances of the scouting trips will be dependent on the costs of transportation (*e.g.,* fuel prices). However, no fewer than one scouting trip will occur per country per six-month budget period. Every effort will be made to maximize the amount of scouting data in relationship to the resources available.

Surveys of wild alternative hosts around and near cowpea fields will be designed in the first six months of the project. The experiments will be performed in each country during the cowpea-growing season. Briefly, farmers' fields will be surveyed for the numbers of insects on cowpeas in relationship to any nearby wild alternative hosts (or the lack of alternative hosts will be documented). In the case of *Maruca*, this will provide the basis for the estimated wild refuge potential for an IRM plan for *Bt* cowpea.

Target Outputs

Better understanding of pest biology -- where/when they are a concern
Networks for the development of IPM programs for pests of cowpea
FFS will lay the foundation for the deployment of IPM programs
Important information for the development of an IRM program for *Bt* cowpea
Capacity building

Engagement of USAID Field Mission(s)

We will work with the Management Entity at MSU to determine opportunities to engage USAID field missions. Where possible the host country collaborators and Dr. Pittendrigh will visit the field missions in order to determine the possibility of common interests and possible synergistic activities.

Networking Activities with Stakeholders

Our primary focus will be to work with farmer field schools. However, we will explore the possibility of interacting with other NGO organizations in the development and deployment of pest control strategies.

Leveraging of CRSP Resources

- Dr. Pittendrigh will leverage funds from (i) his endowed chair position, (ii) general university funds provided to him, (iii) or both, at UIUC, to support a graduate student.
- Part of Dr. Pittendrigh's time at UIUC will be cost-shared.
- Dr. Joe Huesing's (Monsanto Company) time will be donated to the project.
- Where possible, Drs. Dabire, Baoua, and Ishiyaku will hold farmer field schools in conjunction with other NGOs in order to increase the impact of the current resources.

Dry Grain Pulses CRSP Budget Summary

Biological Foundations for Management of Field Insect Pests of Cowpea in West Africa

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	UIUC	0	INERA	INRAN	IAR	0
a. Personnel Cost						
Salaries	$ 30,000.00	$ -	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ -
Fringe Benefit	$ 10,683.00	$ -	$ 3,000.00	$ 3,000.00	$ 3,000.00	$ -
b. Travel	$ 23,791.00	$ -	$ 3,000.00	$ 3,000.00	$ 3,000.00	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 11,280.00	$ -	$ 4,246.00	$ 4,246.00	$ 4,246.00	$ -
e. Training						
Degree	$ -	$ -	$ 3,000.00	$ -	$ -	$ -
Non-Degree	$ -	$ -	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ -	$ -	$ 400.00	$ 400.00	$ 400.00	$ -
g. Total Direct Cost	**$75,754.00**	**$0.00**	**$27,646.00**	**$24,646.00**	**$24,646.00**	**$0.00**
h. Indirect Cost	$ 41,664.70	$ -	$ 4,146.90	$ 3,660.00	$ 2,464.60	$ -
i. Indirect Cost on Subcontracts (First $25000)	$ -	$ -	$ 13,750.00	$ 13,750.00	$ 13,750.00	$ -
j. Total Indirect Cost	$ 41,664.70	$ -	$ 17,896.90	$ 17,410.00	$ 16,214.60	$ -
Total	**$ 117,418.70**	**$ -**	**$ 45,542.90**	**$ 42,056.00**	**$ 40,860.60**	**$ -**
Grand Total	**$245,878**					

	Amount	Percentage
Percentage of U.S. Budget	$ 75,754.00	**49.61%**
Percentage of Host Countries Budget	$ 76,938.00	**50.39%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 70,064.00		$ -	$ -	$ -	$ -	$ 70,064.00
Cash	$ -		$ -	$ -	$ -	$ -	$ -
Total	$ 70,064.00	$ -	$ -	$ -	$ -	$ -	$ 70,064.00
Attribution to IEHA Objectives							
Percentage of effort							33.68%
Amount corresponding to effort	$ 40,271.33	$ -	$ 15,422.20	$ 13,707.35	$ 13,400.59	$ -	$82,801.46
Attribution to Capacity Building (Theme "D")							
Percentage of effort							33.68%
Amount corresponding to effort	$ 40,271.33	$ -	$ 15,422.20	$ 13,707.35	$ 13,400.59	$ -	$82,801.46

Capacity Building Activities

Degree Training:

Student #1

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

Short-term Training:

Type of Training: 1) Dr. Ba will visit Dr. Pittendrigh's lab. 2) Farmer field schools

Description of training activity: Microsatellite and computational modeling (UIUC)

Status of this activity:

Reason if training activity not completed as planned:

When did the activity occur?:

Location: UIUC

Who benefited from this activity?: INERA and our overall network of African researchers

Number of Beneficiaries: 61

Male:

Female:

Total:

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

Principle Investigators

James Beaver, University of Puerto Rico, Puerto Rico
Juan Carlos Rosas, EAP, Honduras
Timothy Porch, USDA-ARS, U.S.
António Chicapa Dovala, IIA, Angola
Emmanuel Prophete, CRDA, Haiti

Project Problem Statement and Justification

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

Planned Project Activities for April 1, 2008 - September 30, 2009

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

Collaborators:
James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, EAP, Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala, IIA, Angola
António Francisco Castame, IIA, Angola

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

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

The project will initiate collaborative research with Mr.Antonio Chicapa Dovala, Head of the Legume Program of the Instituto de Investigacão Agronómica in Angola. Promising bean breeding lines from Central America, the Caribbean and the U.S., primarily of medium-sized market classes, will be provided to the Angolan bean research program for evaluation for local adaptation and consumer acceptance.

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

Collaborators:
James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, EAP, Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala, IIA, Angola
António Francisco Castame, IIA, Angola

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

Recurrent selection (RS) has proven to be useful in the selection of quantitatively inherited traits such as web blight resistance and tolerance to low soil P. We propose to conduct one cycle of recurrent selection to develop Mesoamerican and Andean breeding lines with greater adaptation to low soil N. A second cycle of RS would be conducted if the project is extended beyond the initial 30 months of funding. Preliminary screening conducted in Honduras and Puerto Rico has identified disease resistant bean breeding lines that could be used to form the base population for recurrent selection. A few elite small red bean breeding lines from Zamorano were found to have good biological nitrogen fixation when evaluated in field trials in Minnesota (Peter Graham, personal communication). The root rot resistant black bean line PR0443-151 from Puerto Rico and CIAT bean breeding lines A 774 and VAX 3 have performed well in a low N soil in Puerto Rico. During the past five years, the Zamorano bean breeding program and Dr. Jonathan Lynch have collaborated in the development of small red and black bean breeding lines with greater tolerance to low P soils and drought. Some of these lines also have better yield under low N soils due to increased nodulation by resident rhizobia. Zamorano has experience conducting strain selection and inoculation studies, maintains a collection of bean rhizobia and has the expertise needed to conduct the multifaceted research related to biological nitrogen fixation. Black bean lines developed at the University of Puerto Rico with enhanced levels of root rot resistance, will serve as a source of root rot resistance. In the proposed project, breeding lines will be evaluated in the F_3 and F_4 generations in replicated field trials. The field trials will receive low levels (20 kg/ha) of N fertilizer. The bean lines will be inoculated with recommended bean *Rhizobium* strains to create conditions favorable for biological nitrogen fixation. Dr. Tim Porch will evaluate the F_4 generation for root rot resistance in a field maintained specifically for root rot screening and selection. The most promising F_5 lines will be screened using molecular markers for disease resistance and traits associated with tolerance to low P soils. The most promising lines from each cycle of recurrent selection will be included as entries in regional performance trials in Central America and the Caribbean.

Objective 3: Develop molecular markers for disease resistance genes.

Collaborators:
James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, 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 two dominant complementary genes. The RAPD $B386_{900}$ has been reported to be linked in coupling with one of the resistance genes (*Mp-1*) whereas $B459_{1600}$ was reported to be linked in repulsion with the other resistance gene (*Mp-2*). The utility of these markers has not been confirmed because the presence of the markers has not been surveyed in susceptible lines and in other sources of resistance to charcoal rot. The Dry Grain Pulse CRSP project will evaluate the usefulness of the putative molecular markers. If proven to be useful, Dr. Tim Porch will convert these RAPD markers to SCAR markers. If the putative RAPD markers are proven to be ineffective, recombinant inbred lines will be developed from crosses between BAT 477 and susceptible bean lines to attempt to identify new molecular markers for the charcoal rot resistance genes using bulk segregant analysis (BSA).

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.

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 Investigacao Agronomica (IIA), Angola

Approaches and Methods: The Lima bean (*Phaseolus lunatus* L.) is a heat and drought tolerant dry grain pulse crop that is produced and consumed throughout the Caribbean. Most landrace varieties are indeterminate, short day plants that produce pods during the dry season when there is often a scarcity of common beans. Because Lima beans grow well in fence rows or on walls, the crop is well suited for urban agriculture. Lima bean landraces have been cultivated in the Caribbean during the past 500 years and may have acquired unique traits of economic value. At present, the USDA and CIAT bean germplasm collections contain very few accessions from the region. The germplasm collections currently have 2 accessions from Haiti, ≤ 3 accessions from Puerto Rico and no accessions from the Dominican Republic. We plan to collect and characterize the agronomic traits of at least 30 Lima bean landrace varieties from Puerto Rico and Haiti. Passport data will be collected so that the germplasm can be included in the CIAT and USDA germplasm collections. Seed of superior Lima bean accessions will be increased for further evaluation and possible release in the country of origin.

Cowpeas [*Vigna unguiculata* (L.) Walp] are produced on a limited scale in the Caribbean. Ing. Emmanuel Prophete has expressed interest in evaluating promising cowpea breeding lines from the University of California, Riverside and IITA. The Dry Grain Pulse CRSP project will serve as a facilitator in obtaining cowpea breeding lines for testing in Haiti. The project will also attempt to identify research programs in Central America that might be interested in evaluating cowpea breeding lines. Zamorano will conduct preliminary evaluations of cowpea lines and will provide seed of the best adapted lines to other programs and organizations interested in this crop. Potential areas of adoption of new cowpea lines are the semi-arid regions in northern Nicaragua and southern Honduras where the crop is used as an alternative to common beans during the 'postrera' season. We also plan to collaborate with the University of California, Riverside Dry Grain Pulse CRSP in Angola in the evaluation of beans, cowpeas and other grain legumes, such as Lima beans or pigeonpeas.

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 80,000 farmers in Central America plant small red bean cultivars developed by the Bean/Cowpea CRSP project. We propose to use a similar approach to develop and release improved black bean varieties. Because promising black and red mottled bean lines are already in an advanced stage of development, it is likely that the project will demonstrate significant impact in Central America and the Caribbean during the first 30 months of funding from the Dry Grain Pulse CRSP through the release of improved bean breeding lines. We expect to test and release at least one improved black bean in Central America. In Haiti, we expect to test and release one 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 light red kidney and white bean cultivars. At the end of the first 30 months of funding, 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. It should be possible, however, to identify potential sources of resistance to the principal biotic and abiotic constraints and to initiate the development of bean breeding populations. The project plans to conduct informal training activities that would strengthen bean research capabilities in Angola. At the end of the 30 month period of funding, bean research personnel in Angola should have sufficient experience and skills to continue to develop, test and release improved bean lines.

The development and release of bean germplasm better adapted to low N soils would 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 30 month period of funding, at least one bean germplasm line with greater adaptation to low N soils is expected to be released.

Molecular markers have become an important tool for bean breeders in developed countries. There is a need, however, to continue to develop molecular markers for genes of economic importance, particularly for traits that are needed for the improvement of beans for the Tropics. During the first 30 months of funding, 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 30 Lima bean landraces will be collected from Puerto Rico and Haiti. Morphological, phenological and agronomic traits of the landraces will be collected at the Isabela Substation. Arrangements will be made to include the Lima bean landraces in the USDA and CIAT germplasm collections. Landraces with superior performance will be considered for release in Haiti and/or Puerto Rico.

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

Engagement of USAID Field Mission(s)

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

Networking Activities with Stakeholders

Collaborative research has been a key element in the success of the small red bean breeding activities in Central America. The Dry Grain Pulse CRSP project will build upon these achievements by placing greater emphasis on the improvement of black bean lines. This collaboration will enhance the impact of the Dry Grain Pulse CRSP project research in Guatemala and Haiti where the black bean is the preferred seed type. Mr. Emmanuel Prophete and the recent Bean/Cowpea CRSP trainees from Haiti, Gasner Demosthenes and Ronald Dorcinvil, speak Spanish, which will facilitate communication with other bean researchers in Central America and the Caribbean. The proposed Dry Grain Pulse CRSP project will collaborate with the bean research network in Central America and the Caribbean in the evaluation of bean lines and the multiplication of basic seed stocks of recently released cultivars. Dr. Rosas will coordinate regional performance trials for black and small red beans in Central America and the Caribbean. At least 25% of the funds assigned to the Escuela Agrícola Panamericana will be used to support activities of national bean research programs in Central America. James Beaver will coordinate the evaluation of red mottled and light red kidney bean regional performance trials in the Caribbean and will provide seed of these seed types to collaborators in Ecuador and Africa. Dr. Tim Porch will collaborate with Mr. Antonio Chicapa Dovala in the evaluation of bean lines in Angola. Ing. Emmanuel Prophete will be responsible for the evaluation and on-farm testing of black, white and red mottled bean lines in Haiti. The project will also collaborate with NGO's and participatory plant breeding programs in Central America and the Caribbean to promote the dissemination and adoption of bean cultivars. As project personnel learn more about the bean subsector and ongoing research and extension activities in Angola, opportunities for greater collaboration will be pursued. For example, formal or informal training activities with Augostinho 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 Muimui of the ZARI bean research program to determine if Dry Grains Pulse CRSP activities in Angola can benefit bean research in Zambia.

Leveraging of CRSP Resources

The Dry Grain Pulse CRSP has access to mature bean breeding projects at the Escuela Agrícola Panamericana in Honduras and the University of Puerto Rico. Both breeding programs have alternative sources of funding that will indirectly benefit the research goals of the project. Promising bean breeding lines are already in an advanced stage of development that will enable the project to achieve significant impact in a short period. Ing. Emmanuel Prophete is the leader of the Ministry of Agriculture seed

program in Haiti that will provide resources for the multiplication and distribution of bean cultivars developed by the proposed Dry Grain Pulse CRSP project. The EAP is an active participant in the Central American bean research network supported by IICA/COSUDE that provides a limited amount of resources for activities that complement proposed research and training activities. Dr. Rosas is a leader of a participatory plant breeding program supported by the Norwegian Development Fund that funds bean research in Central America. Dr. Beaver plans to prepare a proposal to the USDA *Phaseolus* Crop Germplasm Committee to support the collection and evaluation of *P. lunatus* landraces from the Caribbean. Project personnel will attempt to obtain additional support for research and training activities from USAID Missions. For example, Dr. Rosas recently provided seed of a promising black bean cultivar to USAID personnel in Haiti for seed multiplication and on-farm evaluation trials. The project will also seek opportunities for support or collaboration with NGO's and private companies.

Dry Grain Pulses CRSP Budget Summary

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

	Budget Summary 04/01/08 - 09/30/09					
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)
Institution Name	UPR	0	USDA-ARS	EAP	Haiti	Angola
a. Personnel Cost						
Salaries	$ 18,000.00	$ -	$ 25,500.00	$ 23,000.00	$ 8,500.00	$ 3,000.00
Fringe Benefit	$ 6,000.00	$ -	$ 5,100.00	$ 4,600.00	$ 2,500.00	$ 1,000.00
	$ -	$ -	$ -	$ -	$ -	$ -
b. Travel	$ 3,750.00	$ -	$ 11,000.00	$ 11,000.00	$ 3,246.00	$ 6,000.00
	$ -	$ -	$ -	$ -	$ -	$ -
c. Equipment ($5000 Plus)	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -
d. Supplies	$ 10,750.00	$ -	$ 8,399.00	$ 13,535.00	$ 5,500.00	$ 7,436.00
e. Training						
Degree	$ -	$ 20,000.00	$ -	$ 6,000.00	$ -	$ -
Non-Degree	$ -	$ -	$ -	$ 5,358.00	$ 420.00	$ 1,905.00
	$ -	$ -	$ -	$ -	$ -	$ -
f. Other	$ -	$ -	$ -	$ 14,400.00	$ -	$ 500.00
g. Total Direct Cost	**$38,500.00**	**$20,000.00**	**$49,999.00**	**$77,893.00**	**$20,166.00**	**$19,841.00**
h. Indirect Cost	$ 9,000.00	$ -	$ 5,001.00	$ 14,357.00	$ -	$ -
i. Indirect Cost on Subcontracts (First $25000)	$ -	$ -	$ -	$ 6,500.00	$ 5,334.00	$ 5,159.00
j. Total Indirect Cost	$ 9,000.00	$ -	$ 5,001.00	$ 20,857.00	$ 5,334.00	$ 5,159.00
Total	**$ 47,500.00**	**$ 20,000.00**	**$ 55,000.00**	**$ 98,750.00**	**$ 25,500.00**	**$ 25,000.00**
Grand Total	**$271,750.00**					

	Amount	Percentage
Percentage of U.S. Budget	$38,500.00	**17.01%**
Percentage of Host Countries Budget	$187,899.00	**82.99%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	Total
In-kind	$ 36,618.00		$ -	$ 67,000.00	$ -	$ -	$ 103,618.00
Cash	$ -		$ -	$ 17,100.00	$ -	$ -	$ 17,100.00
Total	$ 36,618.00	$ -	$ -	$ 84,100.00	$ -	$ -	$ 120,718.00
Attribution to IEHA Objectives							
Percentage of effort							38.45%
Amount corresponding to effort	$ 4,750.00	$ -	$ 55,000.00	$ 19,750.00	$ -	$ 25,000.00	$104,500.00
Attribution to Capacity Building (Theme "D")							
Percentage of effort							32.20%
Amount corresponding to effort	$ 11,875.00	$ -	$ 13,750.00	$ 49,375.00	$ -	$ 12,500.00	$87,500.00

Capacity Building Activities

Degree Training:

Student #1

First and Other Given Names:	Ronald
Last Name:	Dorcinvil
Citizenship:	Haiti
Gender:	Male
Degree:	M.S.
Discipline:	Soil Sciences
Host Country Institution to Benefit from Training:	Haiti
Training Location:	University of Puerto Rico
Supervising CRSP PI:	Beaver, James
Start Date:	08/06
Project Completion Date:	05/09
Training Status:	Active
Type of CRSP Support (full, partial or indirect):	Partial (Category 2b)

Student #2

First and Other Given Names:	Monica
Last Name:	Mbui
Citizenship:	Angolan
Gender:	Female
Degree:	M.S.
Discipline:	Plant breeding
Host Country Institution to Benefit from Training:	IIA, Angola
Training Location:	University of Puerto Rico
Supervising CRSP PI:	Beaver, James
Start Date:	08/09
Project Completion Date:	08/11
Training Status:	Pending
Type of CRSP Support (full, partial or indirect):	Full (Category 1)

Short-term Training:

Type of Training: Informal training of bean research personnel in Angola

Description of training activity: Tim Porch, Juan Carlos Rosas and James Beaver will travel to Angola to provide short-term training to bean research personnel in Angola on research techniques used to screen bean lines for resistance to biotic and abiotic constraints. Dr. Rosas will share his experience using participatory plant breeding techniques in Central America to promote the adoption of bean cultivars.

Status of this activity:

Reason if training activity not completed as planned:

When did the activity occur?:

Location: Huambo, Angola

Who benefited from this activity?: Pulse crop researchers and staff

Number of Beneficiaries: 15

Male:

Female:

Total:

Type of Training: Informal training of Salvadoran researcher

Description of training activity: Aldemaro Clara and Aura Morales de Borja, technicians from the bean research program in El Salvador ,received short-term training at Zamorano dealing with bean research techniques. The goal of the training is to increase the research capacity of the bean program in El Salvador

Status of this activity: Completed as planned

Reason if training activity not completed as planned:

When did the activity occur?: August 2008

Location: Zamorano

Who benefited from this activity?: The CENTA bean research program in El Salvador

Number of Beneficiaries: 2

Male:

Female: 2

Total: 2

Type of Training: Bean breeding workshop for Central American and Caribbean bean researchers.

Description of training activity: The workshop will discuss recent advances in bean breeding and review standard techniques used to screen beans for resistance to biotic and abiotic stresses. The testing and validation bean lines will be discussed.

Status of this activity:

Reason if training activity not completed as planned:

When did the activity occur?:

Location: Zamorano

Who benefited from this activity?: Not specified

Number of Beneficiaries: 15

Male:

Female:

Total: