Dry Grain Pulses CRSP FY 2012 Workplan and Budget

PII-PSU-1
Improving Bean Production in Drought-Prone, Low Fertility Soils of Africa and Latin America – An Integrated Approach

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Project Problem Statement and Justification
This proposal is premised on four well-established facts:

1) **Drought and low soil fertility are principal constraints to bean production in Latin America and Africa.**

2) **Most bean producers in poor countries cannot afford irrigation and intensive fertilization.**

3) **Bean genotypes vary substantially for root traits that determine their tolerance to drought and low soil fertility, making it feasible to increase yields in low-input systems through genetic improvement.**

4) **To exploit the potential of this approach, we need intelligent deployment of root traits in bean breeding programs, and better understanding of the socioeconomic and agroecological factors determining the adoption and impact of stress tolerant crops and cropping systems.**

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

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

Drought is a primary yield constraint to bean production throughout Latin America and Eastern and Southern Africa. Beans vary substantially in drought tolerance, due primarily to variation in root depth and thereby access to soil water, earliness (drought escape), and secondarily to seed
filling capacity. Drought tolerance has been identified in several races of common bean, but is complex and associated with local adaptation. Utilization of specific traits in drought breeding, through direct phenotypic evaluation or genetic markers (eg QTL) would be useful.

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

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

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

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

**Planned Project Activities for FY 2012**

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

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

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

**Objective 4:** Capacity building.

**Objective 1:** Breeding

**Collaborators**
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Celestina Jochua, IIAM, Mozambique
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Juan Carlos Rosas, EAP, Honduras
**Approaches and Methods**

**Honduras:** The activities in Central America (mainly Honduras and Nicaragua) will include continuation of objective 1 as in FY11, including the testing of a set of small red inbred backcross (IB) lines (Amadeus 77 background) in farmer’s fields to validate the multiline approach and the value of specific root traits under low fertility and drought conditions. The results of field trials conducted in FY11 will be used to determine if single lines or multiline will provide better yield stability under a varying drought/low fertility conditions encountered by small farmers in Central America.

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

During FY12 new advanced lines developed from crosses between drought and low fertility tolerant parents (previously identified by the project in collaboration with CIAT and the DGPC-Up/Beaver breeding project) with disease resistant cultivars, will be distributed for testing in at least six countries members of the CA/C Bean Research Network. In addition, promising tolerant lines identified in previous years will be validated and released in Honduras and at least one additional country during FY12.

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

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

**Mozambique**
1) **Evaluation and selection of bean genotypes**

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

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

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

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

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

3) **Advance generations of populations created in 2011**

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

4) **Seed increase/multiplication**

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

**Objective 2**: Integrated Crop Management
Collaborators
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Magalhaes Miguel, IIAM, Mozambique
Soares Almeida Xerinda, IIAM, Mozambique

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

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

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

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

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

2.5 Conduct, in Sussundenga, Gurue and Lichinga, a multiple-season field experiment to determine available P release from rock P and lime effects, and incubation time effects on bean growth and yield. These experiments will use the indicative results from pot experiments from 2011 results. It is well known that the RP effects on crop growth and yield are not immediate. Therefore, research on the efficacy of RP requires multiple season trials. Although the P-efficient genotypes can grow better and attain higher grain yield under low P, some very poor soils impair the growth of beans due to limited minimal P substrate. The RP appears to be a local P source that can be an alternative for P amendment to improve yields. These experiments are expected to continue beyond 2012. The results of our work may create business opportunities for rock P mining and marketing since the fertilizers are not available in remote areas due to poor infrastructure.

2.6 Write and submit reports.
**Objective 3: Socioeconomics**

**Collaborators**
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Rachel Smith, PSU, USA  
Bayou Demeke, CIMMYT-Nairobi  
Maria da Luz Quinhentos, IIAM, Mozambique

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

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

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

IIAM staff at the sites will conduct the household survey, in collaboration with interviewers/translators, after being trained by PSU collaborators. Training will take place in Sussundenga Fall 2010. Statistical analyses of the data will be conducted and adoption/diffusion models estimated. Simulations based on the *ex ante* and *ex post* data will conducted to estimate the overall impact of the new technology on the bean-growing regions of Mozambique, under different market scenarios.
Finally, we will collaborate closely with the Michigan State CRSP team in Mozambique to assure that both teams benefit from the other’s activities. Since both teams work collaboratively with IIAM, a PSU/MSU collaboration will provide an even greater benefit to our in-country hosts.

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

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

3.3 Code and clean *ex post* data.

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

**Objective 4: Capacity Building**

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

**Approaches and Methods**

*Formal M.S. degree training for two IIAM (Mozambique) scientists at Penn State*

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

**Strengthening research infrastructure at IIAM**

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

**Strengthening research and training capacity of Zamorano**

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

**Multilingual web-based delivery of research methods for root traits**

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

**Contribution of Project to Target USAID Performance Indicators**

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

**Breeding:**

**Honduras:**

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

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

In collaboration with the UPR/Beaver DGPC project, *Rhizobium* inoculation and organic fertilizer will be used by small farmers from CIALs in Honduras to improve their bean crop nutrition and seed yield.

Drought/low fertility tolerant and disease resistance IB lines from other commercial small reds (DEORHO, Cardenal) and blacks (Aifi Wuriti, Azabache 40) cultivars are developed for testing based on the results obtained from the Amadeus multilines.

At least 15 drought /low fertility tolerant advanced lines developed for the project in collaboration with the UPR/Beaver DGPC and CIAT breeding programs, other than those included in FY11, will be included in the regional VIDAC and ECAR trials and distributed to Central American and Caribbean national programs and research organizations.

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

**Mozambique:**

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

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

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

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

**Integrated Crop Management:** At least two moisture conservation technologies to reduce drought susceptibility of P-efficient (shallow rooted) genotypes will be identified. In the following growing season will be exposed to farmers, through demonstration plots conducted with our partners (farmers associations, public extension and NGO’s).
From rock P trials will be identified minimal and optimal application PR application rates. These results will be used for field trials in the subsequent growing season. The field trial results will be shared with the socioeconomic unit of IIAM to integrate feasibility studies of RP use.

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

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

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

**Networking Activities with Stakeholders**
The project will work in collaboration with at least 20 CIAL (farmer local agricultural research committees) which are currently active in Honduras. These CIALs are composed of men and women interested in the introduction and testing of technological alternatives to improve the productivity and sustainability of the cropping systems in their communities. Although most CIAL members are male, it is quite common to find CIALs led by women and others composed only of women; also, many young farmers are members of several CIALs. Zamorano is currently collaborating with CIALs in four regions of Honduras, as part of participatory plant breeding activities started in 2000, to improve local landraces of beans and maize with specific agro-ecological adaptation and consumer preferences. So far, 12 bean (including three IB lines developed by the project from crosses of landrace x improved cultivars) and four maize cultivars have been released through these partnerships for conducting participatory plant breeding (PPB) activities with CIALs of Honduras. Several other breeding lines are under validation in communities of the regions of Yorito, Vallecillo, Yojoa Lake and the Yeguare river basin, and some will be released as cultivars by 2011-12.

The project will also collaborate with the main NGOs of Honduras, especially those organizations that have been collaborating with Zamorano for more than 10 years (FIPAH, PRR, etc.), as well as with the National Bean Research programs from Honduras, Nicaragua and other Central American and Caribbean countries members of the Bean Research Network. This regional bean research network will be the mechanism to be used for the testing, validation and dissemination of novel bean lines and multilines developed by our project. The regional bean network has been coordinated by Zamorano since 1996. The bean network has facilitated the testing of breeding lines and germplasm for nearly 20 years, and its members (the national bean programs) have been involved in the release of improved bean cultivars developed by Zamorano which are currently the main cultivars used by farmers in the region.
Foundation seed of released cultivars will be produced by Zamorano to assist certified and local seed production and distribution projects supported by governmental and NGO organizations, such as the technological bonus in Honduras, which is reaching over 75,000 farmers every year with high quality seed of improved bean cultivars. Similar seed production and distribution projects have been implemented in Nicaragua and El Salvador in recent years, to assist small farmers with seed and fertilizer, as part of a policy for food security in rural areas and urban low-income sectors. These seed production and distribution projects will be assisted with foundation seed of improved cultivars developed by the project through our collaborators from the national bean programs and NGOs who are also involved in these seed projects.

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

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

The project will also encourage farmers to organize themselves in organizations formed by several farmers associations and work with them in plant variety testing and evaluation. Currently, in almost all village communities in Mozambique farmers are organized in associations and sometimes, a number of farmers associations in a community form a cooperative, ending up with an organization with a large number of farmers. This is being encouraged by the CLUSA in Lioma, Gurue, which enables them to empower the farmers for acquisition of more expensive farming facilities and equipment, such as animal traction, tractors, implements, warehouses, etc., and better market access for their produce. We will be working with CLUSA to ensure that innovative technologies generated by the project can reach a large number of farmers capable of selling their increased production.

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

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

**Leveraging of CRSP Resources**

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

- a project funded by the McKnight Foundation Collaborative Crop Research Program entitled *Increasing Bean Productivity and Household Food Security in Stressful Environments in Mozambique Through the Use of Phosphorus-efficient Seeds by Farm Households* for $435,175 for 4 years to IIAM, PSU, and EAP

- a project funded by the Generation Challenge Program entitled *Basal Root Architecture and Drought Tolerance in Common Bean* for $900,000 for 4 years to PSU and CIAT

- a project funded by the Howard G Buffett Foundation entitled *Roots of the second green revolution* for $1,426,000 plus ca. $500,000 in capital investments for 5 years to PSU, with support from IIAM and CIAT

- a project funded by the International Atomic Energy Agency entitled *Characterization of root traits contributing to enhanced phosphorus acquisition from low fertility soil* for $40,000 for 4 years to PSU

- a project funded by the Norwegian Development Fund entitled *Participatory Plant Breeding for Mesoamerica: Promoting the management, conservation and development of Agrobiodiversity* for $250,000 for 5 years to EAP

- a project funded by the International Science and Education Program of the U.S Department of Agriculture entitled *Ag 2 Africa: Development of an International-US Learning Laboratory* for $149,993 for 4 years to PSU.

- a project entitled *Investigating the Social Influences Underlying Agricultural and Malaria Practices in Mozambique in Order to Diffuse Innovations in Beans and Malaria Vector-control* funded by the Clinical and Translational Sciences Institute (CTSI) for one year for $50,000.

- a pilot project funded by the Social Science Research Institute (SSRI) to explore the potential for developing cell phone technologies for widespread dissemination of information on improved bean seed, legume pests, and new seed access to illiterate farmers in Mozambique and East Africa. Total pilot project funding is one year for $20,000.
### Dry Grain Pulses CRSP

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

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>U.S. Institution</th>
<th>U.S. for Host Country</th>
<th>EAP</th>
<th>IIAM</th>
<th>HC or U.S. Institution (b)</th>
<th>HC or U.S. Institution (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Personnel Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$13,725.00</td>
<td>$0.00</td>
<td>$8,000.00</td>
<td>$0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fringe Benefits</td>
<td>$2,807.78</td>
<td>$0.00</td>
<td>$2,000.00</td>
<td>$0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Travel</td>
<td>$6,000.00</td>
<td>$6,440.00</td>
<td>$5,000.00</td>
<td>$12,000.00</td>
<td></td>
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<tr>
<td>c. Equipment ($5000 Plus)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Supplies</td>
<td>$10,000.00</td>
<td>$17,000.00</td>
<td>$6,000.00</td>
<td>$14,300.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td>$40,159.78</td>
<td>$2,000.00</td>
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<tr>
<td>Non-Degree</td>
<td>$0.00</td>
<td>$3,000.00</td>
<td></td>
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<tr>
<td>f. Other</td>
<td></td>
<td>$1,200.00</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>g. Total Direct Cost</td>
<td>$32,532.78</td>
<td>$63,599.78</td>
<td>$26,000.00</td>
<td>$27,500.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Indirect Cost</td>
<td>$15,615.73</td>
<td>$23,211.27</td>
<td>$4,000.00</td>
<td>$0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Indirect Cost on Subcontracts (First $25000)</td>
<td>$15,615.73</td>
<td>$23,211.27</td>
<td>$4,000.00</td>
<td>$0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Total Indirect Cost</td>
<td>$15,615.73</td>
<td>$23,211.27</td>
<td>$4,000.00</td>
<td>$0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$48,148.51</td>
<td>$86,811.05</td>
<td>$30,000.00</td>
<td>$27,500.00</td>
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<tr>
<td>Grand Total</td>
<td>$192,459.56</td>
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<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$48,148.51</td>
<td>25.02%</td>
</tr>
<tr>
<td>$144,311.05</td>
<td>74.98%</td>
</tr>
</tbody>
</table>

### Cost Share

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

### Attribution to Capacity Building

<table>
<thead>
<tr>
<th>Percentage of effort</th>
<th>80.00%</th>
<th>100.00%</th>
<th>50.00%</th>
<th>50.00%</th>
<th>50.00%</th>
<th>80.06%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount corresponding to effort</td>
<td>$38,518.81</td>
<td>$86,811.05</td>
<td>$15,000.00</td>
<td>$13,750.00</td>
<td>$0.00</td>
<td>$154,079.86</td>
</tr>
</tbody>
</table>

**U.S. Institution PI**: Jonathan P. Lynch

**Authorized Institutional Approval**: 

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## Objective 1: Breeding

### Honduras
- Testing IB lines - Drought/low P
- Testing lines/cultivars - BNF
- Tolerant lines in regional trials
- Develop new improved lines
- Conduct on-farm trials
- Lines sent to IIAM

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

## Objective 2: Integrated Crop Management

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

## Objective 3: Socioeconomics

- Conduct PVS
- Farm household surveys
- Code and clean ex post data
- Analyze data

## Objective 4: Capacity Building

- MS degree training S Camilo
- Nondegree training of Venancio Salagua
- Training in PVS and MAS at EAP
- Strengthen research infrastructure at IIAM
- Strengthen research and training capacity at EAP
- Multilingual web delivery of root research methods

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

| J.C. Rosas | M Miguel | JP Lynch |

### Signature/Initials:

| JCR | JPL |

### Date:

---

**Improving bean production in drought-prone, low fertility soils of Africa and Latin America - An integrated approach.**
## Output Indicators

<table>
<thead>
<tr>
<th>Degree Training: Number of individuals who have received degree training</th>
<th>2012 Target</th>
<th>2012 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of women</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of men</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Short-term Training: Number of individuals who have received short-term training</th>
<th>2012 Target</th>
<th>2012 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of women</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Number of men</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

### Technologies and Policies

| Number of technologies and management practices under research | 21 |
| Number of technologies and management practices under field testing | 9  |
| Number of technologies and management practices made available for transfer | 21 |
| Number of policy studies undertaken                                | 0  |

### Beneficiaries:

| Number of rural households benefiting directly from CRSP interventions - Female Headed households | 150 |
| Number of rural households benefiting directly from CRSP interventions - Male Headed households | 850 |
| Number of agriculture-related firms benefitting from CRSP supported interventions              | 7   |
| Number of producer organizations receiving technical assistance                                  | 65  |
| Number of trade and business associations receiving technical assistance                         | 5   |
| Number of community-based organizations receiving technical assistance                           | 5   |
| Number of women organizations receiving CRSP technical assistance                               | 8   |
Dry Grain Pulses CRSP  
PERFORMANCE INDICATORS/TARGETS for FY 12  
(October 1, 2011 -- September 30, 2012)

| **Number of public-private partnerships formed as a result of CRSP assistance** | 1 |
| Number of HC partner organizations/institutions benefiting | 6 |
| **Developmental outcomes:** |
| Number of additional hectares under improved technologies or management practices | 5125 |