Dry Grain Pulses CRSP FY 2012 Workplan and Budget

PII-UPR-1

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

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

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

Timothy Porch, USDA-ARS, U.S.
Emmanuel Prophete, CRDA, Haiti

Project Problem Statement and Justification

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

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

The research project is in the position to make significant impacts in Central America, the Caribbean, and Angola. Many small red and black bean breeding lines with enhanced disease resistance and tolerance to abiotic stress are already in an advanced stage of development. There is an established network of bean researchers in Central America with a proven capability of testing, releasing and disseminating improved bean cultivars. The Dry Grain Pulse CRSP project will complement ongoing collaborative bean research in Central America. In addition, the project includes partners from Haiti that will extend the potential impact of the collaborative research. The project will provide formal and informal training to Instituto de Investigacão Agronómica
(IIA) researchers based on the critical experiences and successes in Central America and the Caribbean. The project also plans to improve Instituto de Investigação Agronómica facilities and develop populations and bean breeding lines that will permit the Legume Program to develop improved bean cultivars for Angola.

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

Planned Project Activities for FY 2012

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

**Collaborators**

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

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

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

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

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

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

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

Recurrent selection (RS) has proven to be useful in the selection of quantitatively inherited traits such as web blight resistance and tolerance to low soil P. We plan to conduct an additional cycle of recurrent selection to develop Mesoamerican breeding lines with greater adaptation to low soil N. Preliminary screening conducted in Honduras and Puerto Rico identified disease resistant bean breeding lines that were used to form the base population for the first cycle of recurrent
selection. During FY12, the performance of F4 lines from the first cycle of RS will be evaluated in low-N plots in Honduras and Puerto Rico. Crosses to initiate the second cycle of RS will be conducted during the upcoming year. The most promising breeding lines from each cycle of recurrent selection will be included as entries in regional performance trials in Central America and the Caribbean. Black bean lines developed at the UPR with enhanced levels of root rot resistance and adaptation to low N soils were screened using molecular markers for BGYMV and BCMV resistance. These lines will be evaluated during FY12 in low-N plots in Haiti, Honduras and Puerto Rico. The Zamorano bean breeding program and Dr. Jonathan Lynch have collaborated in the development of small red and black bean breeding lines with greater tolerance to low P soils and drought. Some of these lines also have better seed yield under low N soils due to increased nodulation by resident rhizobia. Less progress has been made in the selection of Andean bean lines for adaptation to low N soils. The performance of Andean bean landrace varieties from Haiti and the Dominican Republic will be evaluated in a low N soil in Puerto Rico to attempt to identify germplasm with greater tolerance to this edaphic constraint. Zamorano and UPR scientists have experience conducting strain selection and inoculation studies. Both laboratories maintain collections of bean rhizobia and have the expertise needed to conduct the multifaceted research related to biological nitrogen fixation. Results from preliminary trials with Rhizobium tropici CIAT 899 and Rhizobium etli UMR 1597 indicated that the red mottled line PR0737-2 had the upper most nodule position with CIAT 899, while inoculation with UMR 1597 resulted in the highest nodule number. The pink bean PR0401-259 produced the greatest number of nodules among 15 lines evaluated when inoculated with CIAT 899. Results from the inoculation experiments suggest a cultivar preference for nodulation. Two field inoculation trials using the same lines and strains will study additional traits related to biological nitrogen fixation.

Knowledge of the compatibility of the Rhizobium strain with bean cultivars is needed to successfully utilize inoculant to increase biological nitrogen fixation of common beans. The strain x bean line trials will be repeated in Honduras and Puerto Rico during the upcoming year. On-farm trials using different Rhizobium strains will be conducted in Honduras. The root traits of bean lines with superior BNF capacity will be characterized at Zamorano. The project plans to conduct informal training activities to strengthen the capacity to produce Rhizobium inoculum in Central America, Haiti and Angola.

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

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

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

Resistance to charcoal rot caused by *Macrophomina phaseolina* has been reported to be associated with drought tolerance and it has been recommended that breeding for terminal
drought tolerance should include breeding for resistance to charcoal rot. The charcoal rot resistance in the breeding line BAT 477 was found to be controlled by the dominant complementary genes \( M_p^{-1} \) and \( M_p^{-2} \). A RIL population derived from the cross ‘DOR 364 x BAT 477’ was acquired from CIAT and evaluated at the Isabela Substation during two growing seasons for reaction to charcoal rot. Lines resistant and susceptible to charcoal rot were selected. These lines will be used to identify putative markers for resistance to this disease using AFLP markers and bulk segregant analysis. Greenhouse screening techniques using inoculation with Macrophomina at germination and inoculation of stems with Macrophomina using syringes are being optimized.

Project personnel (Porch and Beaver) will collaborate with Dr. Mildred Zapata (UPR) in the evaluation of a bean population that may lead to the identification of genes and new molecular markers for resistance to common bacterial blight. The project also plans to evaluate the effectiveness of molecular markers identified by Mbogo and Myers for lectin-like genes reported to confer bruchid resistance. During the upcoming year, we expect to have segregating populations that can be screened for resistance to bruchids, BCMV, BCMNV and BGYMV.

We plan to screen Andean and Middle American bean populations to evaluate the effectiveness of the \( P_vEIF4E^2 \) marker for identifying the \( bc-3 \) gene for BCMV and BCMNV resistance. In Puerto Rico, there are plans to initiate the use of the SR21 marker for screening for the \( bgm \) resistance gene. The SR21 marker has been successfully used at Zamorano.

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

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

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

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

**Approaches and Methods:** The Lima bean (\( Phaseolus lunatus \) L.) is a heat and drought tolerant dry grain pulse crop that is produced and consumed throughout the Caribbean. Most landrace varieties are indeterminate, short day plants that produce pods during the dry season when there is often a scarcity of common beans. Because Lima beans grow well in fence rows or on walls,
the crop is well suited for urban agriculture. Lima bean landraces have been cultivated in the Caribbean during the past 500 years and may have acquired unique traits of economic value. At present, the USDA and CIAT bean germplasm collections contain very few accessions from the region. The germplasm collections currently have 2 accessions from Haiti, ≤ 3 accessions from Puerto Rico and no accessions from the Dominican Republic. We have collected and characterized morphological and agronomic traits of 55 Lima bean landrace varieties from Puerto Rico, the Dominican Republic and Haiti. Collaborators at the University of Puerto Rico (Dimuth Siritunga) has evaluated the Lima bean landraces with 24 SSR markers. Another collaborator at the University of Delaware (Emmalea Ernest) plans to evaluate the landraces for HCN concentration in the primary leaf and the seed. Passport data has been collected so that the Lima bean landraces can be included in the CIAT germplasm collection. Seed of superior Lima bean accessions will be increased for further evaluation and possible release in the country of origin.

Cowpea \( Vigna\ unguiculata\ (L.)\ Walp\) is produced on a limited scale in Central America and the Caribbean. The performance of cowpea lines from the University of California, Riverside Dry Grain Pulse CRSP project, IITA, Puerto Rico and Angola were tested in Puerto Rico during two growing seasons as part of the M.S. degree research of Angolan graduate student Antonio David. During FY12, seed of the most promising cowpea lines from these trials will be tested in Haiti, Central America and Angola. Potential areas of adoption of new cowpea lines are the semi-arid regions in northern Nicaragua and southern Honduras where the crop is used as an alternative to common beans during the ‘postrera’ season.

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

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

**Objective 5: Capacity Building**

Increase the capacity, effectiveness and sustainability of agriculture research institutions that serve the bean and cowpea sectors in Central America, Haiti and Angola.

**Collaborators**

James Beaver, University of Puerto Rico
Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez
Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras
Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti
António Chicapa Dovala and António Francisco Castame, IIA, Angola
Trainee # 1
First and Other Given Names: TBN
Last Name: TBN
Citizenship: TBN
Gender: TBN
Degree Program for training: B.S.
Program Areas or Discipline: Plant Science
Host Country Institution to Benefit from Training: TBN
University to provide training: Zamorano
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID? - No
Supervising CRSP PI: Juan Carlos Rosas
Start Date: October 2012
Projected Completion Date: December 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds: TBN
Amount Budgeted in Workplan, if providing full or partial support:
  Direct cost: $ TBN
  Indirect cost: 0
U.S. or HC Institution to receive CRSP funding for training activity: Zamorano

Trainee # 2
First and Other Given Names: TBN
Last Name: TBN
Citizenship: TBN
Gender: TBN
Degree Program for training: B.S.
Program Areas or Discipline: Plant Science
Host Country Institution to Benefit from Training: TBN
University to provide training: Zamorano
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID? - No
Supervising CRSP PI: Juan Carlos Rosas
Start Date: October 2012
Projected Completion Date: December 2012
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s) of leveraged funds: TBN
Amount Budgeted in Workplan, if providing full or partial support:
  Direct cost: $ TBN
  Indirect cost: 0
U.S. or HC Institution to receive CRSP funding for training activity: Zamorano

Trainee # 3
First and Other Given Names: Abiezer
Last Name: González
Citizenship: U.S.
Gender: Male
Degree Program for training: M.S.
Program Areas or Discipline: Plant Breeding and Genetics
Host Country Institution to Benefit from Training: N/A
University to provide training: University of Puerto Rico
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID? - No
Supervising CRSP PI: James
Start Date: October 2011
Projected Completion Date: December 2011
Type of CRSP Support (full, partial or indirect): Partial
If providing Indirect Support, identify source(s)s of leveraged funds: Family support

Amount Budgeted in Workplan, if providing full or partial support:
- Direct cost: $4,000.00
- Indirect cost: 0

U.S. or HC Institution to receive CRSP funding for training activity: UPR

**Short-term Training:**

*Training activity # 1*

Type of training: Informal training for seed production and storage on small farms
- Emmanuel Prophete, Gasner Demosthene

Location: Haiti
Duration: One week
Scheduling of training activity: Winter months 2011-2012
Participants/Beneficiaries of Training Activity: Bean producers in Haiti
Anticipated numbers of Beneficiaries (male and female): 30 people

Amount Budgeted in Workplan
- Direct cost: $1,500
- Indirect cost: $0

If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:
- This training activity will be conducted in collaboration with Dry Grain Pulse CRSP Technology Transfer project in Haiti

*Training activity # 2*

Type of training: Informal training for the production, storage and use of *Rhizobium* inoculum
- Consuelo Estevez de Jensen, Emmanuel Prophete, Gasner Demosthene, Antione Wesner

Location: Haiti
Duration: One week
Scheduling of training activity: Winter months 2011-2012
Participants/Beneficiaries of Training Activity: National Seed Service personnel and National University faculty and students
Anticipated numbers of Beneficiaries (male and female): 20 people

Amount Budgeted in Workplan
- Direct cost: $1,500
- Indirect cost: $0

If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:
- This training activity will be conducted in collaboration with Dry Grain Pulse CRSP Technology Transfer project in Haiti

*Training activity # 3*

Type of training: Biological nitrogen fixation workshop for Central America and the Caribbean researchers
- Consuelo Estevez de Jensen and Juan Carlos Rosas

Location: Honduras
Duration: One week
Scheduling of training activity: November 2011
Participants/Beneficiaries of Training Activity: Bean producers in Haiti
Anticipated numbers of Beneficiaries (male and female): 30 people

Amount Budgeted in Workplan
- Direct cost: $ in funding from the MO from for strengthening HC institutions
- Indirect cost: $0

If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:
- This training activity will be conducted in collaboration with Dry Grain Pulse CRSP Technology Transfer project in Haiti
Type of training: In service training for senior students from Zamorano at the University of Puerto Rico
Consuelo Estevez de Jensen, Timothy Porch and James Beaver

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

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

If leveraged funding is to be used to Support this Training Activity, indicate the Source and Amount:

The students are expected to pay for most of their expenses for this practical training.

### Contribution of Project to Target USAID Performance Indicators

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

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

This project addresses two of the four global themes of the Dry Grain Pulse CRSP. The development and release of bean cultivars with enhanced disease resistance and greater tolerance to abiotic stress should reduce production costs and risks for bean producers in Central America, the Caribbean and Angola. Lines with resistance to bean diseases, such as rust, should also be useful germplasm for U.S. bean breeding programs. Disease and pest resistance are key components in effective crop management systems. Bean breeding lines developed by the project will be screened for tolerance to drought and low soil fertility. Bruchid resistance should improve the quality of bean seed and reduce storage loss.
Participatory plant breeding methods and multiplication of basic stocks on underutilized research stations should result in more sustainable seed production and distribution systems. The project will use informal training to strengthen the capacity of the bean research programs in Central America, the Caribbean and Angola.

**Target Outputs**

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

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

The development and release of bean germplasm better adapted to low N soils will be of potential benefit throughout the Tropics where inputs such as fertilizer are beyond the means of many small-scale bean producers. Bean producers in the U.S. would also benefit from bean cultivars that have a lower requirement for N fertilizer. At the end of the two-year extension period, we expect to develop at least one bean germplasm line with greater adaptation to low N soils and at least one Middle American bean germplasm line with enhanced BNF capacity. We also expect to identify the most effective *Rhizobium* strain(s) for bean production in Central America and Haiti.

Molecular markers have become an important tool for bean breeders in developed countries. There is a need, however, to continue to develop molecular markers for genes of economic importance, particularly for traits that are needed for the improvement of beans for the Tropics. During the two-year extension period, the project would focus on the development of molecular
markers for the putative dominant genes for resistance to charcoal rot. These molecular markers will improve the efficiency and effectiveness of selection for resistance to this disease and should contribute to the development of breeding lines having greater levels of resistance to terminal drought. A manuscript describing the protocol to use the molecular markers will be prepared for the Annual Report of the Bean Improvement Cooperative.

At least 50 Lima bean landraces will be collected from Puerto Rico, the Dominican Republic and Haiti. Morphological, phenological and agronomic traits of the landraces will be collected at the Isabela Substation. Arrangements will be made to include the Lima bean landraces in the CIAT germplasm collection. Landraces with superior performance will be considered for release in Haiti and/or Puerto Rico.

Project personnel will collaborate with the Dry Grain Pulse CRSP cowpea breeding project in the evaluation of cowpea breeding lines in Haiti and Central America. We expect to identify at least one cowpea breeding line that has superior performance in Central America and the Caribbean.

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

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

**Networking Activities with Stakeholders**

Collaborative research has been a key element in the success of the bean breeding activities in Central America and the Caribbean. The Dry Grain Pulse CRSP project will build upon these achievements by placing greater emphasis on the improvement of black bean lines. This collaboration will enhance the impact of the Dry Grain Pulse CRSP project research in Guatemala and Haiti where the black bean is the preferred seed type. Mr. Emmanuel Prophete and the recent Bean/Cowpea CRSP trainee from Haiti, Gasner Demosthenes, speak Spanish, which facilitates communication with other bean researchers in Central America and the Caribbean. The proposed Dry Grain Pulse CRSP project will collaborate with the bean research network in Central America and the Caribbean in the evaluation of bean lines and the multiplication of basic seed stocks of recently released cultivars. Dr. Rosas coordinates regional performance trials for black and small red beans in Central America and the Caribbean. At least 20% of the funds assigned to the Escuela Agrícola Panamericana will be used to support activities of national bean research programs in Central America. James Beaver coordinates the evaluation of red mottled bean regional performance trials in the Caribbean. He has provided seed of these seed types to collaborators in Ecuador and Africa. Dr. Tim Porch will collaborate with Mr. Antonio Chicapa Dovala in the evaluation of bean lines in Angola. Ing. Emmanuel Prophete will be responsible for the evaluation and on-farm testing of black, white and red mottled bean lines in Haiti. The project will also collaborate with NGO’s and participatory plant breeding programs in Central America and the Caribbean to promote the dissemination and adoption of bean cultivars. As project personnel learn more about the bean subsector and ongoing research and extension activities in Angola, opportunities for greater collaboration will be pursued. For example, additional informal training activities with Agostinho Neto University in Huambo, Angola could be developed. Dr. Porch has communicated with CIAT bean scientists
and Dr. Rowland Chirwa to identify opportunities for collaboration with the SABRN bean research network. He has also communicated with Mr. Kennedy Mmbui of the ZARI bean research program to determine if Dry Grains Pulse CRSP activities in Angola can benefit bean research in Zambia.

**Leveraging of CRSP Resources**

The Dry Grain Pulse CRSP has access to mature bean breeding projects at the Escuela Agrícola Panamericana in Honduras and the University of Puerto Rico. Both breeding programs have alternative sources of funding that will indirectly benefit the research goals of the project. Promising bean breeding lines are already in an advanced stage of development that will enable the project to achieve significant impact in a short period. Ing. Emmanuel Prophete is the leader of the Ministry of Agriculture seed program in Haiti that provides resources for the multiplication and distribution of bean cultivars developed by the proposed Dry Grain Pulse CRSP project. The EAP is an active participant in the Central American bean research network supported by IICA/COSUDE that provides a limited amount of resources for activities that complement proposed research and training activities. Dr. Rosas is a leader of a participatory plant breeding program supported by the Norwegian Development Fund that funds bean research in Central America. Dr. Beaver and Dr. Porch are PIs for Regional Hatch Project W-1150 that shares many research objectives with the Dry Grain Pulse CRSP. Project personnel will play an active role in supporting the activities of the USAID-funded Technology Transfer project in Central America and Haiti.
## Dry Grain Pulses CRSP: FY12

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

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

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<th>Institution Name</th>
<th>U.S.</th>
<th>U.S. for Host Country</th>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UPR 0</td>
<td>USDA-ARS</td>
<td>EAP</td>
<td>Haiti</td>
<td>Angola</td>
<td></td>
</tr>
<tr>
<td>a. Personnel Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$3,040.00</td>
<td>$18,000.00</td>
<td>$19,950.00</td>
<td>$7,125.00</td>
<td>$5,700.00</td>
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<td>Fringe Benefit</td>
<td>$760.00</td>
<td>$3,800.00</td>
<td>$3,990.00</td>
<td>$2,375.00</td>
<td>$1,900.00</td>
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</tr>
<tr>
<td>b. Travel</td>
<td>$11,100.00</td>
<td>$0.00</td>
<td>$8,000.00</td>
<td>$5,700.00</td>
<td>$2,850.00</td>
<td>$7,125.00</td>
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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>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>d. Supplies</td>
<td>$7,600.00</td>
<td>$5,675.00</td>
<td>$7,600.00</td>
<td>$7,125.00</td>
<td>$7,125.00</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>$6,000.00</td>
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<td>$0.00</td>
<td>$3,800.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Non-Degree</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$3,800.00</td>
<td>$2,500.00</td>
<td>$2,135.00</td>
</tr>
<tr>
<td>f. Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Total Direct Cost</td>
<td>$28,500.00</td>
<td>$0.00</td>
<td>$36,675.00</td>
<td>$56,665.00</td>
<td>$21,975.00</td>
<td>$23,985.00</td>
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<tr>
<td>h. Indirect Cost</td>
<td>$7,125.00</td>
<td>$4,075.00</td>
<td>$8,500.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>i. Indirect Cost on Subcontracts (First $25000)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>j. Total Indirect Cost</td>
<td>$7,125.00</td>
<td>$4,075.00</td>
<td>$8,500.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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<tr>
<td>Total</td>
<td>$35,625.00</td>
<td>$0.00</td>
<td>$40,750.00</td>
<td>$55,165.00</td>
<td>$21,975.00</td>
<td>$23,985.00</td>
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<tr>
<td>Grand Total</td>
<td>$187,500.00</td>
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<table>
<thead>
<tr>
<th>Cost Share</th>
<th>U.S.</th>
<th>U.S. for Host Country</th>
<th>HC or U.S. Institution (1)</th>
<th>HC or U.S. Institution (2)</th>
<th>HC or U.S. Institution (3)</th>
<th>HC or U.S. Institution (4)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$24,412.00</td>
<td>$45,000.00</td>
<td>$107,400.00</td>
<td>$107,300.00</td>
<td>$107,300.00</td>
<td>$107,300.00</td>
<td>$89,412.00</td>
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<tr>
<td>In-kind</td>
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<td>$10,700.00</td>
<td>$10,700.00</td>
<td>$10,700.00</td>
<td>$10,700.00</td>
<td>$10,700.00</td>
<td>$10,700.00</td>
</tr>
<tr>
<td>Cash</td>
<td>$24,412.00</td>
<td>$35,700.00</td>
<td>$56,100.00</td>
<td>$56,100.00</td>
<td>$56,100.00</td>
<td>$56,100.00</td>
<td>$80,112.00</td>
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<tr>
<td>Total</td>
<td>$24,412.00</td>
<td>$35,700.00</td>
<td>$56,100.00</td>
<td>$56,100.00</td>
<td>$56,100.00</td>
<td>$56,100.00</td>
<td>$80,112.00</td>
</tr>
</tbody>
</table>

### Attribution to IEHA Objectives

- **Percentage of effort:** 10.00% 100.00% 20.00% 100.00% 43.38%
- **Amount corresponding to effort:** $3,562.50 $0.00 $40,750.00 $13,033.00 $0.00 $23,985.00 $81,330.50

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

- **Percentage of effort:** 20.00% 25.00% 50.00% 50.00% 33.33%
- **Amount corresponding to effort:** $38,906.25 $0.00 $10,167.50 $32,562.50 $0.00 $11,992.50 $63,668.75

Name of PI & Institutional Affiliation: James S. Beaver, Dept. of Agron. and Soils, Univ. of Puerto Rico, Mayaguez, PR 00681-0030
Budget narrative

UPR

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

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

3. Equipment (No funding)

4. Supplies ($7,600) - Materials and supplies needed to conduct field, greenhouse and laboratory experiments and for shipping seed to Haiti.

5. Training
   - Degree ($6,000) – Research assistantship for Abiezer González to help conduct research related to the DGP CRSP project
   - Non-degree (No funding)

6. Other (no funding)

7. Total direct costs ($28,500)

8. Total indirect costs ($7,125)

9. Total ($35,625)

USDA-ARS

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

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

3. Equipment (No funding)

4. Supplies ($5,875) - Materials and supplies needed to conduct field, greenhouse and molecular marker experiments.
5. Training
   Degree (No funding)
   Non-degree (No funding)
6. Other (no funding)
7. Total direct costs ($36,675)
8. Total indirect costs ($4,075)
9. Total ($40,750)

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

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

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

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

3. Equipment (No funding)

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

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

6. Other (No funding)

7. Total direct costs ($23,985)

8. Total indirect costs No funding)
9. Total ($23,985)
Dry Grain Pulses CRSP  
Report on the Achievement of “Semi-Annual Indicators of Progress”  
(For the Period: April 1, 2012 -- September 30, 2012)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2012

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

**Objective 1:** Development, release and dissemination of improved bean cultivars.

- Germplasm acquired for key abiotic and biotic stress factors of Angola
- Germplasm tested in Angola
- Breeding populations developed
- Breeding populations tested
- Advanced trials conducted
- Promising lines validated on farm
- Cultivar released

<table>
<thead>
<tr>
<th>Benchmark Indicators by Objectives</th>
<th>UPR</th>
<th>USDA</th>
<th>EAP</th>
<th>IIA</th>
<th>Haiti</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/12</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>10/12</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>10/12</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>10/12</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

(Tick mark the Yes or No column for identified benchmarks by institution)

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

- Evaluate lines from the first cycle of recurrent selection for enhanced BNF
- Study Rhizobium strain x bean line interaction
- On-farm trials to evaluate the performance of different Rhizobium strains

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

- Identify potential markers for ashy stem blight resistance

*Provide abbreviated name of institutions in columns below*

- UPR
- USDA
- EAP
- IIA
- Haiti

*(Tick mark the Yes or No column for identified benchmarks by institution)*
<table>
<thead>
<tr>
<th>Study the inheritance of common blight resistance</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test the effectiveness of new markers for BCMNV and BGYMV resistance</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

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

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

| James Beaver | Tim Porch | Juan Carlos Rosas | Antonio Chicapa | Emmanuel Prophete |

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

* Please provide an explanation for not achieving the benchmark indicators on a separate sheet.
## Dry Grain Pulses CRSP

### PERFORMANCE INDICATORS/TARGETS for FY 12

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

<table>
<thead>
<tr>
<th>Output Indicators</th>
<th>2012 Target</th>
<th>2012 Actual</th>
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</thead>
<tbody>
<tr>
<td><strong>Degree Training: Number of individuals who have received degree training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of men</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Short-term Training: Number of individuals who have received short-term training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of women</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Number of men</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td><strong>Technologies and Policies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under research</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices under field testing</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Number of technologies and management practices made available for transfer</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of policy studies undertaken</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Beneficiaries:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Female Headed households</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Number of rural households benefiting directly from CRSP interventions - Male Headed households</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Number of agriculture-related firms benefitting from CRSP supported interventions</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of producer organizations receiving technical assistance</td>
<td>4</td>
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</tr>
<tr>
<td>Number of trade and business associations receiving technical assistance</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of community-based organizations receiving technical assistance</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of women organizations receiving CRSP technical assistance</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*(Oct 1 2011-Sept 30, 2012)*

PII-UPR-1
## Dry Grain Pulses CRSP
### PERFORMANCE INDICATORS/TARGETS for FY 12
(October 1, 2011 -- September 30, 2012)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Target</th>
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<tbody>
<tr>
<td>Number of public-private partnerships formed as a result of CRSP assistance</td>
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</tr>
<tr>
<td>Number of HC partner organizations/institutions benefiting</td>
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<tr>
<td>Developmental outcomes:</td>
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</tr>
<tr>
<td>Number of additional hectares under improved technologies or management practices</td>
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</tr>
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