Dry Grain Pulses CRSP Proposal

COVER PAGE (must print on one page)

Title of Proposal: Development, testing and dissemination of genetically improved bean cultivars for Central America, the Caribbean and Angola
Name(s), institutional affiliation and contact information of Lead U.S. Principal Investigator(s) submitting this proposal: **James Beaver, Dept. of Agronomy and Soils, Univ. of Puerto Rico, Mayaguez, PR** **Timothy Porch, USDA-ARS Tropical Agriculture Research Station, Mayaguez, PR**
Name(s) and institutional affiliation of all Host Country (HC) and U.S. Co-PIs **Juan Carlos Rosas, Escuela Agrícola Panamericana** **Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti** **António Chicapa Dovala, Instituto de Investigacao Agronomica, Angola**

Proposed Project Period: (30 months maximum, between April 1, 2008 – September 30, 2010)	**Total federal funds requested**	**Total non-federal cost share commitment by U.S. institution(s)**
April 1, 2008 to September 30, 2010	**$450,000**	

Proposed HCs where project activities will be implemented:	**Proposed HC institutions to be sub-contracted (abbreviated name):**	**Proposed budget for a sub-contract to a HC institution**	**Are you requesting the ME (MSU) to manage the Fixed-Price sub-contract for this HC Institution? (Yes/No)**
Honduras	**Escuela Agrícola Panamericana**	**$152,500**	**Yes**
Haiti	**Ministry of Agriculture, Haiti**	**$42,500**	**Yes**
Angola	**Inst. Inv. Agronómica, Angola**	**$80,000**	**Yes**

Authorized lead U.S. institutional representative
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Signature:_____ Date:_____

Dry Grain Pulses CRSP Proposal
SUMMARY PAGE (must print on one page)

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

Name and Institutional Affiliation of the U.S. Principal Investigator:

James S. Beaver, Department of Agronomy and Soils, University of Puerto Rico, P.O. Box 9030, Mayaguez, PR 00681

Abstract (Limit: 1800 characters including spaces—about 200-250 words):

The proposed Dry Grain Pulse (DGP) CRSP project will focus on the development, testing and dissemination of genetically-improved common bean lines for Central America, the Caribbean and Angola that have enhanced levels of disease resistance and tolerance to abiotic stress. Research in Central America and the Caribbean will emphasize the improvement of black bean lines. Many promising black bean breeding lines are already in an advanced stage of development. The proposed DGP CRSP project would collaborate closely with the Central American bean research network in the testing and multiplication of seed of black and small red bean lines and recently-released cultivars. Populations will be developed to identify reliable and versatile molecular markers for specific bean disease resistance genes to facilitate marker-assisted selection. Institutional capacity building activities will include PhD training in plant breeding, informal training dealing with bean research techniques using short-term training and the Internet and the purchase of materials needed to sustain and enhance field and laboratory research in Central America, the Caribbean and Angola. The project proposes to collaborate with other DGP CRSP projects in studying virulence patterns of bean pathogens, screening beans for tolerance to drought and low soil fertility and the evaluation of cowpeas in Central America and the Caribbean.

Pulse Crop of Focus ***(select at least one between beans and cowpeas)***

Beans ☒ **Cowpeas** ☐ **Other (specify):** ☐

Topical Areas to be Addressed By this Project

Select one or more under Global Themes A-C:

A. To reduce bean and cowpea production costs and risks for enhanced profitability and competitiveness.

- ☒ 1. Genetic Improvement
- ☒ 2. Integrated Crop Management
- ☒ 3. Mitigating Effects of Low Soil Fertility/Drought
- ☐ 4. Grain Quality
- ☒ 5. Sustainable Seed Systems

B. To increase the utilization of bean and cowpea grain, food products and ingredients so as to expand market opportunities and improve community health and nutrition.

- ☐ 1. Health and Nutritional Attributes
- ☐ 2. Consumer Attitudes and Preferences
- ☐ 3. Influencing Decision Makers
- ☐ 4. Urban Consumer Access to Value-added Pulse Foods

C. To improve the performance and sustainability of bean and cowpea value-chains, especially for the benefit of women.

- ☐ 1. Understanding constraints to smallholder pulse farmer participation in markets and trade
- ☐ 2. Identifying "weak links"/constraints in the functionality of dry grain pulse value-chains
- ☐ 3. Identifying strategic public sector interventions to alleviate constraints or market failures.

Select at least one from Global Theme D; If none selected from A-C, then select at least two:

D. To increase the capacity, effectiveness and sustainability of agriculture research institutions

- ☒ 1. Building and promoting partnerships with key stakeholders
- ☒ 2. Strengthening regional dry grain pulse commodity research networks
- ☒ 3. Training young scientists in the use of modern tools for research, management and outreach

Summary Checklist ***(select as many as appropriate)***

- ☒ Project addresses IEHA objectives (give anticipated level of effort as % of total budget requested): 42.9 %
- ☒ Project devotes at least 30% of project funds on HC capacity building activities (Global Theme D) (give total % budgeted): 34.2%
- ☒ Project involves research on biotechnology as defined in the RFP (give % effort on biotechnology) 15%
- ☐ Project involves the use or generation of genetically modified organisms (GMOs)
- ☐ Project involves human subject approval
- ☐ Project involves animal use approval
- ☒ Project involves M.S. or Ph.D. degree training of HC personnel (how many?) 1

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4. Technical Approach

- Problem Statement and Justification (8 page limit)

Common bean (*Phaseolus vulgaris* L.) is an important source of protein for low income families in Central America, the Caribbean and Angola. Increased or more stable bean yield can improve the diet and provide a reliable source of income for small-scale farm families in these countries. An increased supply of beans should also benefit the urban consumer of beans. Almost 50% of the population in Guatemala, Honduras and Nicaragua continue to live in poverty, over 70% live below the poverty line in Angola, and in Haiti, more than half of the population experiences abject poverty (CIA Factbook, 2007).

Beans continue to be an important crop for farmers in Central America, the Caribbean and Angola. Proyecto Red SICTA (2007) estimated that there are almost 700,000 farm families in Central America that produce beans on approximately 600,000 ha. Agriculture is the principal source of income for almost two-thirds of the Haitian population (CIA Factbook, 2007). A large portion of the rural population in Haiti survives on small-scale subsistence farms where beans constitute an important component of the diet. In Angola, 90% of farmers operate small subsistence farms (≤ 1 ha) and 85% of the national labor force works in the agricultural sector (CIA Factbook, 2007).

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. Bean/Cowpea CRSP plant breeders and plant pathologists, in collaboration with the International Center for Tropical Agriculture (CIAT) and national bean research programs, made considerable progress in Central America and the Caribbean in the development and release of disease resistant bean cultivars and germplasm (Smith et al. 2007; Blair et al. 2006; Beaver et al. 2005; Rosas et al. 2004a; Rosas 2003; Beaver et al. 2003). These cultivars have been widely adopted throughout the region resulting in greater and more stable bean yields (Hernández-Fonseca and Elizondo-Porras, 2006; Mather et al., 2003; Rosas et al., 2004b). The bean breeding program at Zamorano currently has under development small red bean lines that combine enhanced levels of disease resistance with tolerance to abiotic stress such as drought and low soil fertility. During the past 10 years, 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. 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. However, 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 had already initiated the development of black bean breeding lines and a sizeable number of breeding lines have already been distributed to bean network members in Guatemala and Haiti. Black bean lines developed by the project that combine resistance to Bean Golden Yellow Mosaic (BGYM) and Bean Common Necrotic Mosaic (BCNM) are currently being tested

in Central America in regional performance trials. 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 proposed research project would place a greater emphasis on field testing of breeding lines in Central American and Caribbean countries that produce black beans. Andean (red mottled and light red kidney) bean lines with resistance to BGYM, BCNM and rust have been developed at the University of Puerto Rico. The proposed research project would complete the development, release and dissemination of these lines in the Caribbean.

The proposed 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. In a recent meeting in Guatemala, sponsored by Sistema de Integración Centroamericana de Tecnología Agrícola (SICTA), the national bean research programs in Central America concluded that the continued development, testing and release of improved bean cultivars should be a high priority activity of a regional research network. The proposed research for the Dry Grain Pulse CRSP would complement ongoing collaborative bean research in Central America. In addition, it would bring in partners from the Caribbean (Haiti and the Dominican Republic) that would extend the potential impact of the collaborative research. The proposed research would also train researchers in Angola based on the critical experiences and successes in Central America and the Caribbean.

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. The small red bean is the second most important seed type in Eastern Africa (Dr. Steve Beebe, personal communication). 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 (Wortman et al., 1998). There is also increased interest in Africa in bean production at lower altitudes (Kimani, 2006). Central American bean breeding lines with resistance to common bacterial blight and web blight may be of particular value to northeastern Angola where small red beans are produced in hot and humid conditions (Kimani, 2006). Although black beans are estimated to account for < 5% of bean production in Africa, Wortman et al. (1998) reported that black beans are often a component of mixtures grown in low fertility soils. The lowland bean breeding team has also developed Andean (red mottled and light red kidney) bean breeding lines with resistance to BCNM (*bc3*) and rust (*Ur-11*) that may be useful in Eastern Africa. Angola, a major importer of pinto beans, may benefit from testing the BelMiDak bean breeding lines that have resistance to BCNM (*bc3*) and rust (*Ur-11, Ur-6*, *Ur-4*). We propose to collaborate with Dry Grain Pulse CRSP projects and bean research networks in Africa to evaluate improved bean breeding cultivars and breeding lines from the U.S., Central America and the Caribbean.

Each team member makes a unique contribution to the proposed research project. Dr. Rosas, bean breeder at the Escuela Agrícola Panamericana, will serve as the coordinator of the small red and black bean regional performance trials in Central America and the Caribbean. He also will be responsible for the development of improved small red and black bean breeding lines. Honduras provides an ideal environment for screening bean breeding lines for resistance to rust and angular leaf spot and for tolerance to low soil fertility and drought. Laboratory facilities at the Escuela Agricola Panamericana also permit the breeding program to use marker-assisted selection. Ing. Emmanuel Prophete, Director of the Ministry of Agriculture Seed Program, will be responsible for the evaluation of black and red mottled bean lines in Haiti. He will also manage the on-farm testing, release and seed multiplication of improved bean cultivars. Mr. Antonio Chicapa Dovala, Head of the Legume Program of the Instituto de Investigacão Agronómica in Angola will assist the project in the evaluation of breeding lines on experiment stations and in on-farm trials. Dr. James Beaver, bean breeder at the University of Puerto Rico, will be responsible for coordinating the testing and release of Andean bean breeding lines in the Caribbean. The more humid environment in Puerto Rico is favorable for screening bean breeding lines for resistance to common bacterial blight and web blight. University of Puerto Rico researchers can also conduct greenhouse screening of bean lines for resistance to BCNM. Puerto Rico has sites that permit the screening of bean lines for adaptation to low soil fertility or acid soils. Field screening for resistance to leafhoppers can also be conducted in Puerto Rico. Laboratory facilities are also available at the University of Puerto Rico to conduct marker-assisted selection and screening for the presence of Arcelin using SDS-PAGE. Dr. Tim Porch, USDA/ARS Research Geneticist at the Tropical Agriculture Research Station, currently collaborates with the University of Puerto Rico bean research program in field and laboratory research related to common bacterial blight, ashy stem blight and root rot. Dr. Porch has a well-equipped molecular biology laboratory capable of marker-assisted selection and the tagging and mapping genes of economic importance. Dr. Porch will be responsible for identifying germplasm in the medium-size seed classes with abiotic and biotic stress tolerance traits important for production in Angola, coordinating the evaluation of bean breeding lines in Angola, and identifying opportunities to strengthen bean research capabilities in Angola.

The proposed research would collaborate with other research teams who plan to submit proposals to the Dry Grain Pulse CRSP. We would collaborate with Dr. James Steadman, plant pathologist at the University of Nebraska, in the characterization of the virulence patterns of rust isolates from Central America, the Caribbean and Angola, and in the development of strategies for the effective deployment of disease resistance genes. We plan to collaborate with Dr. Graciela Godoy-Lutz, IDIAF plant pathologist in the Dominican Republic, in the characterization of virulence patterns of web blight isolates from Central America, the Caribbean and Angola and in the evaluation of breeding lines at the Arroyo Loro Experiment Station. We would send promising Andean bean breeding lines to Dr. James Kelly and Ing. Eduardo Peralta for evaluation in Ecuador and Rwanda. We also plan to collaborate with Dr. Rick Bernsten in a rapid appraisal of the bean sector in Angola. Results from the rapid appraisal will help to direct bean research priorities in that country toward areas of greatest potential benefit. Researchers in the proposed Dry

Grain Pulse CRSP project would meet frequently to evaluate bean lines in nurseries and to exchange information at scientific meetings. This will facilitate communication among team members. Central American and Caribbean bean researchers will meet each year at the PCCMCA to discuss research results and to plan research and training activities for the upcoming year.

- Objectives

1. Development, release and dissemination of improved bean cultivars for Central America, the Caribbean and Angola.
2. Selection of beans for adaptation to low N soils.
3. Develop molecular markers for disease resistance genes.
4. Evaluation of other dry pulse crops for Central America and the Caribbean.

- Approaches and Methods

Objective 1: Plant breeders will focus on the combination of disease (BGYMV, BCMNV, rust, web blight, common bacterial blight, anthracnose and angular leaf spot) resistance with enhanced resistance to pests (bruchid, leafhopper) and greater tolerance to abiotic stress (drought, low soil fertility, high temperature). Elite bean breeding lines with multiple disease resistance have already been crossed with sources of resistance to pests or tolerance to abiotic stress. Bean lines will be screened for the selected traits each generation in environments that are most likely to provide the desired abiotic or biotic stress. This can be most easily achieved through collaboration among Dry Grain Pulse CRSP scientists and the regional bean research network in Central America and the Caribbean. Regional performance trials for black, small red, red mottled and light red kidney bean lines will be conducted in collaboration with national bean research programs in Latin America and the Caribbean. Our team is the only group of scientists in the bean research community who have focused on the development of bean lines with combined resistance to BCMNV, rust, common bacterial blight and web blight. Therefore, the bean breeding lines developed by this research program possess unique combinations of traits. Basic seed stocks of bean varieties developed and released by the project will be multiplied and small lots of seed will be distributed to farmers in Latin America and the Caribbean for testing in on-farm trials. Performance of the varieties in the on-farm trials also provides bean breeders with valuable feedback concerning the direction of their research. The project will also produce basic seed stocks of the most promising bean breeding lines and make seed available to the national bean research programs and NGO's involved in the multiplication and dissemination of improved seed. The project will initiate collaborative research with Mr. Antonio Chicapa Dovala, Head of the Legume Program of the Instituto de Investigacão Agronómica in Angola. Promising bean breeding lines from Central America, the Caribbean and the U.S., primarily of medium-sized market classes, will be provided to the Angolan bean research program for evaluation for local adaptation and consumer acceptance.

Objective 2: Inadequate soil nitrogen is a frequent yield constraint for common beans in the tropics (Graham and Vance, 2003). The use of nitrogen fertilizers increase production costs and, in some intensive bean production systems, can contribute to groundwater contamination (Lynch, 2007). Biological nitrogen fixation only provides a portion of the nitrogen needed by the bean plant (Franco et al., 2001). Lynch (2007) pointed out the need for the use of integrated soil nutrient management that would combine 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 has proven to be useful in the selection of quantitatively inherited traits such as web blight resistance and tolerance to low soil P. We propose to conduct one cycle of recurrent selection to develop small red and black bean breeding lines with greater adaptation to low soil N. A second cycle of RS would be conducted if the project is extended beyond the initial 30 months of funding. Preliminary screening conducted in Honduras and Puerto Rico has identified disease resistant bean breeding lines that could be used to form the base population for recurrent selection. A few elite small red bean breeding lines from Zamorano were found to have good biological nitrogen fixation when evaluated in field trials in Minnesota (Peter Graham, personal communication). The root rot resistant black bean line PR0443-151 from Puerto Rico and CIAT bean breeding lines A 774 and VAX 3 also performed well in a low N soil in Puerto Rico. During the past five years, the Zamorano bean breeding program and Dr. Jonathan Lynch have collaborated in the development of small red and black bean breeding lines with greater tolerance to low P soils and drought. Some of these lines also have better yield under low N soils due to increased nodulation by resident rhizobia. Zamorano has experience conducting strain selection and inoculation studies, maintains a collection of bean rhizobia and has the expertise needed to conduct the multifaceted research related to biological nitrogen fixation. Black bean lines developed at the University of Puerto Rico with enhanced levels of root rot resistance, will serve as a source of root rot resistance. In the proposed project, breeding lines will be evaluated in the F_3 and F_4 generations in replicated field trials. The field trials will receive low levels (20 kg/ha) of N fertilizer. The bean lines will be inoculated with recommended bean *Rhizobium* strains to create conditions favorable for biological nitrogen fixation. Dr. Tim Porch will evaluate the F_4 generation for root rot resistance in a field maintained specifically for root rot screening and selection. The most promising F_5 lines will be screened using molecular markers for disease resistance and traits associated with tolerance to low P soils. The most promising lines from each cycle of recurrent selection will be included as entries in regional performance trials in Central America and the Caribbean.

Objective 3: Marker-assisted selection has proven to be a very useful tool for bean breeders (Miklas et al., 2006; Kelly et al., 2003). 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 (Mayek et al., 2004). Fram et al. (2005) concluded that breeding for terminal drought tolerance should include breeding for resistance to charcoal rot. Olaya et al. (1996) reported that the charcoal rot resistance in the breeding line BAT 477 was controlled by two dominant complementary genes. The symbols *Mp-1* and *Mp-2* were proposed for these resistance genes. Mayek-Pérez et al. (2001) also reported that the charcoal rot resistance of BAT 477 was conferred by two dominant complementary genes. Olaya et al. (1996) reported that the RAPD $B386_{900}$ was linked in coupling with one of the resistance genes (*Mp-1*) whereas $B459_{1600}$ was linked in repulsion with the other resistance gene (*Mp-2*). Kelly and Miklas (2003) note that the utility of these markers has not been confirmed because the presence of the markers has not been surveyed in susceptible lines and in other sources of resistance to charcoal rot. The proposed Dry Grain Pulse CRSP project would evaluate the usefulness of the putative molecular markers. If proven to be useful, Dr. Tim Porch will convert these RAPD markers to SCAR markers. If the putative RAPD markers are proven to be ineffective, recombinant inbred lines will be developed from crosses between BAT 477 and susceptible bean lines to attempt to identify new molecular markers for the charcoal rot resistance genes using bulk segregant analysis (BSA).

Most of the small red and black bean cultivars currently in use in Central America have an unprotected *I* gene for resistance to BCM. Consequently, lowland (< 1000 m) bean producers in the region are vulnerable to the arrival of the seed-borne BCNM. This virus has already begun to cause significant yield loss to black beans planted in Haiti and the Dominican Republic. The presence of BCMN in Africa and the Caribbean requires the deployment of recessive resistance genes such as *bc-3*. Kelly and Miklas (2003) note that the availability of a reliable SCAR for *bc-3* would accelerate the development of lines with BCNM resistance by eliminating the need for progeny tests. RAPD markers linked to *bc-3* require progeny testing or have proven to be unreliable (Miklas et al., 2006). Mukeshimana et al. (2005) identified the codominant AFLP marker E*AC AMCGG* 169/172 which was tightly linked (3.5 cM) to the *bc-3* gene. They also reported that the *bc-3* gene was flanked by the RAPD marker OG6.595. Unfortunately, most of bean breeding laboratories in the tropics are not equipped to work with AFLP markers. Because AFLP markers are more costly and require more technical expertise than RAPD or SCAR markers, the utility of these markers for routine screening by bean breeding programs in developing countries would be limited. Dr. Tim Porch will collaborate with Dr. James Kelly to convert the AFLP and flanking RAPD marker for the *bc-3* gene to STS or SCAR markers, respectively. A similar approach was used to convert an AFLP marker for a carrot gene to a PCR-based marker (Bradeen and Simon, 1998).

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.

Objective 4 : 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. For example, the Lima bean accession L-136 from Puerto Rico was used by plant breeders at the University of California, Davis as a source of root knot nematode resistance in the development of the cultivar 'Cariblanco N' (Helms et al., 2004). Unfortunately, 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 propose to collect and characterize the agronomic traits of at least 50 Lima bean landrace varieties from Puerto Rico, the Dominican Republic and Haiti. Passport data will be collected so that the germplasm can be included in the CIAT and USDA germplasm collections. Seed of superior Lima bean accessions will be increased for further evaluation and possible release in the country of origin.

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

- Collaboration with Host Country Institutions

Collaborative research among National Bean Programs was a key element in the success of the Bean/Cowpea CRSP project in Central America. The proposed Dry Grain Pulse CRSP project will build upon this success by placing greater emphasis on the improvement of black bean lines. This should enhance the impact of the Dry Grain Pulse CRSP project research in Guatemala and Haiti where the black bean is the preferred seed type. Mr. Emmanuel Prophete and the recent Bean/Cowpea CRSP trainees from Haiti, Gasner Demosthene and Ronald Dorcinvil, speak Spanish, which will facilitate communication with other bean researchers in Central America and the Caribbean. The proposed Dry Grain Pulse CRSP project will collaborate with the bean research network in Central America and the Caribbean in the evaluation of bean lines and the multiplication of basic seed stocks of recently released cultivars. Dr. Rosas will coordinate regional performance trials for black and small red beans in Central America and the Caribbean. At least 25% of the funds assigned to the Escuela Agrícola Panamericana will be used to support activities of national bean research programs in

Central America. James Beaver will coordinate the evaluation of red mottled and light red kidney bean regional performance trials in the Caribbean and will provide seed of these seed types to collaborators in Ecuador and Africa. Dr. Tim Porch will collaborate with Mr. Antonio Chicapa Dovala in the evaluation of bean lines in Angola. Ing. Emmanuel Prophete will be responsible for the evaluation and on-farm testing of black, white and red mottled bean lines in Haiti. The project will also collaborate with NGO's and participatory plant breeding programs in Central America and the Caribbean to promote the dissemination and adoption of bean cultivars. As project personnel learn more about the bean subsector and ongoing research and extension activities in Angola, opportunities for greater collaboration will be pursued. For example, formal or informal training activities with Augostinho Neto University in Huambo, Angola could be developed. Dr. Porch has communicated with CIAT bean scientists and Dr. Rowland Chewra to identify opportunities for collaboration with the SABRN bean research network. He has also communicated with Mr. Kennedy Moimoi of the ZARI bean research program to determine if Dry Grains Pulse CRSP activities in Angola can benefit bean research in Zambia.

- Benchmarks

The most important output of the proposed Dry Grain Pulse CRSP project is the release and dissemination of bean cultivars having enhanced levels of resistance to disease, pests and abiotic stress. The research team has a proven record of success. At present, more than 80,000 farmers in Central America plant small red bean cultivars developed by the Bean/Cowpea CRSP project. We propose to use a similar approach to develop and release improved black bean varieties. Because promising black and red mottled bean lines are already in an advanced stage of development, it is likely that the project will demonstrate significant impact in Central America and the Caribbean during the first 30 months of funding from the Dry Grain Pulse CRSP through the release of germplasm. Research achievements in Angola would be more modest. It should be possible, however, to identify potential sources of resistance to the principal biotic and abiotic constraints and to initiate the development of bean breeding populations. The project plans to conduct informal training activities that would strengthen bean research capabilities in Angola.

The development and release of bean germplasm better adapted to low N soils would be of potential benefit throughout the tropics where inputs such as fertilizer are beyond the means of many small-scale bean producers. Bean producers in the U.S. would also benefit from bean cultivars that have a lower requirement for N fertilizer.

Molecular markers have become an important tool for bean breeders in developed countries. There is a need, however, to continue to develop molecular markers for genes of economic importance; particularly for traits that are needed for the improvement of beans for the tropics. During the first 30 months of funding, the project would focus on the development of molecular markers for the putative dominant genes for resistance to charcoal rot. These molecular markers would improve the efficiency and effectiveness of selection for resistance to this disease and should also contribute to the development of breeding lines having greater levels of resistance to terminal drought.

5. HC Institutional Capacity Building (two pages)

Institutional capacity building will be focused on Haiti and Angola and will be conducted with a gender inclusive approach. During the upcoming year, Mr. Gasner Demosthene plans to complete a M.S. degree in plant breeding and genetics and Mr. Ronald Dorcinvil plans to complete a M.S. degree in soil science from the University of Puerto Rico, Mayaguez Campus. Upon completion of their degrees they plan to return to Haiti to work for the bean research program of the Ministry of Agriculture in Haiti. The Dry Grain Pulse CRSP will provide critical support to help these young scientists initiate bean research activities in Haiti. It will be necessary to purchase some materials and supplies for their laboratories. The Dry Grain Pulse CRSP project will provide opportunities for these scientists to return to the University of Puerto Rico to conduct specific short-term research activities such as screening promising bean breeding lines with molecular markers for disease resistance genes. In Angola, Dry Grain Pulse CRSP project personnel will meet with the members of the bean research program of the Instituto de Investigação Agronómica and representatives of the Agostinho Neto University to identify formal and informal training needs. During the first year of the proposed project, Dr. Juan Carlos Rosas will travel to Angola to provide informal training in participatory plant breeding and seed multiplication techniques. He will share his experiences conducting research in Central America and will attempt to determine how participatory techniques might be adapted to Angola. Dr. Tim Porch and Dr. James Beaver will also travel to Angola during the first year of the project to provide informal training dealing with strategies and techniques used to breed bean for resistance to biotic and abiotic stress. During the second year of the project, informal training in plant breeding and plant pathology research techniques will be provided at Zamorano to a field technician from Angola. The project will attempt to identify alternative sources of funding to support formal training activities. M.S. degree training at the University of Puerto Rico could be offered to students from Angola with limited skills in English. In addition, the cost of graduate degree training at the University of Puerto Rico is significantly lower than on the mainland of the U.S. The cooperative Ph.D. degree program between the University of Puerto Rico and North Dakota State University provides an opportunity for students from Angola to conduct a portion of their dissertation research in the tropics. The project will also pursue opportunities to conduct informal training activities. Collaborators from Central America and the Caribbean will have an opportunity to visit Zamorano for short-term training to learn new bean research techniques. Project personnel will help update and expand the Bean Improvement Cooperative web site, http://www.css.msu.edu/bic/ResearchTechniques.cfm, that describes bean research techniques. Dry Grain Pulse CRSP research results from Central America and the Caribbean will be presented at the annual meeting of the PCCMCA. The meeting will also be used to exchange technical information and plan collaborative bean research activities. At least one bean researcher from Angola will be invited to attend the annual PCCMCA meetings.

6. Contribution to USAID Objectives and Initiatives (two pages)

All of the host countries participating in this Dry Grain Pulse CRSP proposal 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 having 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 can help identify emerging bean diseases and permit 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 which is in accord with the IEHA science and technology strategy.

The proposed research 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 reduce risk for bean producers in Central America, the Caribbean and Angola. Lines with resistance to bean diseases, such as rust, should also be useful germplasm for U.S. bean breeding programs. Disease and pest resistance are key components in effective crop management systems. Bean breeding lines developed by the project will be screened for tolerance to drought and low soil fertility. Bruchid resistance should improve the quality of bean seed. Participatory plant breeding methods and multiplication of basic stocks on underutilized research stations may result in more sustainable seed production and distribution systems. The proposed research project will use informal training and web sites to strengthen the capacity of the bean research programs in Central America, the Caribbean and Angola.

7. Strategy for Achieving Developmental Impacts (two pages)

The most important project output of the proposed research will be the development and release of bean cultivars with enhanced levels of resistance to biotic constraints, such as disease and pests, and greater tolerance to abiotic constraints, such as drought and low soil fertility. Results from regional performance trials conducted in the target countries in Central America (Honduras, Guatemala, El Salvador and Nicaragua) and the Caribbean

(Haiti) will be used to identify the most promising bean lines. National bean research programs will validate the performance of elite lines in on-farm trials before a new variety is formally released in a target country. The Dry Grain Pulse CRSP project will assist in the multiplication of basic seed stocks of recently released bean cultivars to increase potential impact. This strategy proved to be effective in the dissemination of small red bean cultivars in Central America by the Bean/Cowpea CRSP. The project will also assist participatory plant breeding programs in the development of improved bean cultivars for rural communities in Central America and the Caribbean. Dr. Juan Carlos Rosas will share his experiences working with participatory plant breeding with Angolan bean researchers to determine if a similar approach might be effective in that country.

8 . Annexes

CURRICULUM VITAE

Name / Title:	James S. Beaver / Professor
Mailing Address:	Dept. of Agronomy and Soils Univ. of Puerto Rico, P.O. Box 9030 Mayaguez, Puerto Rico 00681-9030
Electronic mail:	jbeaver@uprm.edu
Day phone number	787-832-4040 Ext. 2492
Citizenship:	U.S.

Education:

Ph.D. in Plant Breeding and Genetics. 1980.
University of Illinois, Urbana, Illinois

M.S. in Plant Breeding and Genetics. 1978.
University of Illinois, Urbana, Illinois

B.S. with honors in Agronomy. 1972.
Purdue University, West Lafayette, Indiana

Languages: English, Spanish and Portuguese

Duties and responsibilities:

Since 1981, I have been a common bean (*Phaseolus vulgaris* L.) breeder for the Agricultural Experiment Station of the University of Puerto Rico (UPR). A major focus of my research has been breeding beans for disease resistance. I participated in the identification of five different resistance genes for Bean Golden Yellow Mosaic Virus (BGYMV). I collaborated with USDA-ARS and University of Florida scientists in the development and release of the first BGYMV resistant snap bean cultivar. I also collaborated with Caribbean and CIAT scientists in the development of the first red mottled bean breeding lines with BGYMV resistance. I also participated in the development of improved screening techniques for BGYMV and web blight. I served as a Principal Investigator and a Regional Facilitator of a Bean/Cowpea CRSP project in Central America and the Caribbean. This project released the small red cultivars 'Tio Canela 75' 'Carrizalito' and 'Amadeus 77' which have multiple disease resistance and tolerance to high temperature. These small red bean cultivars are currently planted by > 80,000 farmers in Central America. I collaborated with researchers at the University of Nebraska and the Dominican Republic in the development of black and white bean lines that combine resistance to BGYMV, Bean Common Necrotic Mosaic Virus and

rust. In Puerto Rico, I released 'Morales' which has become a popular white-seeded variety for green-shelled bean production. During the upcoming year we plan to release the white bean cultivar 'Vera no' which combines BGYMV, Bean Common Mosaic Virus and common bacterial blight resistance. I currently serve as a member of the Editorial Board of *Field Crops Research.* I also have served as the academic advisor for > 35 M.S. degree students in plant breeding and genetics at the College of Agricultural Sciences of the UPR. Many of these trainees were from Central America and the Caribbean.

Recent publications

Acevedo-Román, M., A. Molina-Castañeda, J.C. Angel Sánchez, C.G. Muñoz and J.S. Beaver. 2004. Inheritance of normal pod development in bean golden yellow mosaic resistant common bean. J. Amer. Soc. Hort. Soc. 129(4):549-552.

Beaver, J.S., C.G. Muñoz-Perea, J.M. Osorno, F.H. Ferwerda and P.N. Miklas. 2005. Registration of bean golden yellow mosaic virus resistant dry bean germplasm lines PR9771-3-2, PR0247-49 and PR0157-4-1. Crop Sci. 45:2126.

Beaver, J.S. and J.C. Rosas. 2003. Investigación colaborativa de frijol en Centroamerica y el Caribe. Invited paper presented at the III Seminario de Judía de la Península Ibérica held in Lourená (Lugo), Spain in October 2003.

Beaver, J.S., G. Godoy-Lutz, J.C. Rosas y J.R. Steadman. 2001. Estrategias para seleccionar frijol común con mayor resistencia a mustia hilachosa. Agronomía Mesoamericano 13(1):67-72.

Beaver, J.S., J.C. Rosas, J. Myers, J. Acosta, J.D. Kelly, S. Nchimbi-Msolla, R. Misangu, J. Bokosi, S. Temple, E. Arnaud-Santana, D.P. Coyne. 2003. Contributions of the Bean/Cowpea CRSP to cultivar and germplasm development in common bean. Field Crops Research 82(2-3):87–102.

Blair M.W., J.S. Beaver, J.C. Nin, E. Prophete and S.P. Singh. 2006. Registration of PR9745–232 and RMC-3 red-mottled dry bean germplasm lines with resistance to bean golden yellow mosaic virus. Crop Sci. 46: 1000-1001.

Bracero, V., L. Rivera and J.S. Beaver. 2003. DNA analysis confirms *Macroptilium lathyroides* as alternative host of *Bean golden yellow mosaic virus*. Plant Disease 87:1022-1025.

Coyne, D.P, J.R. Steadman, G. Godoy-Lutz, R. Gilbertson, E. Arnaud-Santana, J.S. Beaver and J.R. Myers. 2003. Contributions of the Bean/Cowpea CRSP to management of bean diseases. Field Crops Research 82:155-168.

Durán, L., M.W. Blair, M.C. Giraldo, R. Macchiavelli, E. Prophete, J.C. Nin and J.S. Beaver. 2005. Morphological and molecular characterization of common bean landraces and cultivars from the Caribbean. Crop Sci. 45:1320-1328.

Macchiavelli, R. and J.S. Beaver. 2001. Effect of number of seed bulked and population size on genetic variability when using the multiple-seed procedure of SSD. Crop Sci. 41:1513-1516.

Osorno, J.M., C.G. Muñoz, J.S. Beaver, F.H. Ferwerda, M.J. Bassett, P.N. Miklas, T. Olczyk and B. Bussey. 2007. Two Genes from Phaseolus coccineus confer

resistance to Bean Golden Yellow Mosaic Virus in common bean. J. Amer. Soc. Hort. Sci. 132(4):530–533.

Román Avilés, B. And J.S. Beaver. 2003. Inheritance of heat tolerance in common bean of Angean origin. J. of Agric. Univ. of Puerto Rico. 87113-121.

Rosas J.C., J.S. Beaver, M. Alameda-Lozada D. Escoto, J.C. Hernandez, and R. Araya .2005. Registration of 'Carrizalito' Small Red Bean. Crop. Sci. 45:2656-2657.

Rosas, J.C., J.S. Beaver, S. Beebe, A. Viana. 2004. Nomenclatura de variedades de frijol común liberadas en Centro América y el Caribe. Agronomía Mesoamericana 15:221-224.

Rosas, J.C., J.S. Beaver, D. Escoto, C.A. Pérez, A. Llano and J.C. Hernández. 2004. Registration of 'Amadeus 77' small red bean. Crop Sci. 44:1867-1868.

Smith JR, SJ Park, J.S. Beaver, P.N. Miklas, C.H. Canaday, and M. Zapata. 2007. Registration of TARS-SR05 multiple disease-resistant dry bean germplasm. Crop Sci. 47:457–458.

Steadman, J.R., G. Godoy-Lutz, J.C. Rosas and J.S. Beaver. 2002. Uso de un vivero móvil para obtener patrones de virulencia de la roya del frijol común. Agronomía Mesoamericana 13:37-39.

Takegami, J.C., J.S. Beaver, G. Godoy-Lutz, R. Echávaz-Badel and J.R. Steadman. 2004. Inheritance of web blight resistance in common bean. J. of Agric. of the Univ. of Puerto Rico. 88:45-54.

CURRICULUM VITAE

Name: *JUAN CARLOS ROSAS*
Date/Place of birth: January 12, 1945. Lima, Peru (Peruvian citizenship)
Family: Romeri (wife); Carlos, Juan and Alejandra (Children)
Address: Escuela Agrícola Panamericana/Zamorano, P.O. Box 93, Tegucigalpa, Honduras.
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E-Mail: jcrosas@zamorano.edu

Education (graduate and undergraduate):

Ph.D. (1983) and M.Sc. (1982) degrees in Plant Breeding and Plant Genetics, University of Wisconsin, Madison, U.S.A.
B.S. and I.A. undergraduate degrees (1969) in Agronomy, National Agrarian University, Lima, Peru.

Professional positions held:

1999- To date	Professor, Agricultural Science and Production, Escuela Agricola Panamericana (EAP), Zamorano, Honduras.
1992- 1999	Head, Agronomy Department, EAP, Zamorano, Honduras.
1996-1997	Visiting Professor, Department of Plant Pathology, University of Wisconsin, Madison.
1988-1992	Assistant Head, Department of Agronomy, EAP/Zamorano.
1985-1988	Associate Professor, Department of Agronomy, EAP/Zamorano.
1983-1985	Research Associate, Department of Horticulture, University of Wisconsin.
1979-1983	Research Assistant, Department of Horticulture, University of Wisconsin.
1975-1978	Research Assistant, Soil Microbiology, Bean Program, CIAT, Cali, Colombia.
1972-1973	research Assistant, Agronomy and Physiology, Cassava Program, CIAT, Cali, Colombia.
1970-72; 74	Specialist, Cassava and Sweet Potatoes Program, Research Division, Ministry of Agriculture, Peru.

Teaching experience:

Courses: Plant Breeding (15 years); Agronomy I (8 years); Basic Grain and Industrial Crops (15 years); Applied Biotechnology (5 years); Genetics (5 years).

Textbooks published (in spanish): Principios y Prácticas para la Producción de Cultivos (1991); Principios y Prácticas para el Mejoramiento de Plantas (1992); El Cultivo de la Soya (1993; 1998); El Cultivo del Frijol Común en América Tropical (1998); Principios de Genética y Mejoramiento de Plantas (2002; 2005).

Student advisory: more 60 students at the B.S. degree level (as main advisor on thesis research and on in-service training).

Research experience:

International Projects: Leader of more than 20 research projects funded by the Bean/Cowpea CRSP-USAID, PSTC/USAID, National Academy of Sciences, Profrijol/Swiss Corporation, PRIAG/European Economic Community; Norwegian Development Agency, CIAT, IPGRI, CGIAR and others. Collaborations with more than 15 U.S. and Latin American universities, international centers and research programs from C. America and the Caribbean.

Societies Membership:

American Society of Agronomy; Crop Science Society of America; Bean Improvement Cooperative Group; Latin American Society of Rhizobiology; Central American Cooperative Improvement of Crops and Animals; and Gamma Sigma Delta.

Common bean cultivar and germplasm releases:

"Tio Canela-75" in Honduras (1996), El Salvador, Nicaragua and Panamá (2000), and Haití (2003); "Bribri" in Costa Rica (2000); "Amadeus 77" in Nicaragua, El Salvador, Honduras and Costa Rica (2003); "Carrizalito" in Honduras and Costa Rica (2003); "Macuzalito" in Honduras (2004); "Palmichal 1" and "Nueva Esperanza 01" in Honduras (2005); "INTA Precoz" in Nicaragua (2005); "CENTA Pipil" in El Salvador (2005); "Gibre", "Curre" and "Tongibe" in Costa Rica (2006); "Cardenal" , DEORHO", "Victoria" and "Don Cristóbal" in Honduras (2007).

Professional Awards:

Certificate of membership in recognition of high scholarship, outstanding achievement or service to Agricultural Science by The Honor Society of Agriculture Gamma Sigma Delta on October 1989 .

Distinguished achievement award in recognition of outstanding accomplishments related to bean (*Phaseolus vulgaris*) improvement by the Bean Improvement Cooperative on November 2001.

Language Skills:

Spanish: native; English: excellent; and Portuguese: read and understand well.

Recent publications :

Beaver, J.S., J.C. Rosas, J. Myers, J. Acosta, J.D. Kelly, S. Nchimbi-Msolla, R. Misangu, S. Temple, E. Arnaud- Santana and D. P. Coyne. 2003. Contributions of the Bean/Cowpea CRSP to cultivar and germplasm development in common bean. Field Crops Research 82: 87-102.

Graham, P.H., J.C. Rosas, C. Estévez de Jensen, E. Peralta, B. Tlusty and J.A. Acosta-Gallegos. 2003. Addressing edaphic constraints to bean production: Bean/Cowpea CRSP perspective. Field Crops Research 82: 179-192.

Frahm, M.A., J.C. Rosas, N. Mayek-Pérez, E. López –Salinas, J. A. Acosta-Gallegos and J.D. Kelly. 2003. Resistencia a sequía terminal en frijol negro tropical. Agronomía Mesoamericana 14 (2):143-150 (in spanish).

Frahm, M.A., J.C. Rosas and J.D. Kelly. 2003. Drought resistance of black bean evaluated in a lowland tropical environment. Ann. Rep. of the Bean Improv. Coop. 45: 56-57.

Frahm, M.A., J.C. Rosas and J. D. Kelly. 2003. Field resistance to *Macrophomina phaseolina* in black bean populations. Ann. Rep. of the Bean Improv. Coop. 45: 148-149.

Rosas, J.C., J.C. Hernández and R. Araya. 2003. Registration of 'Bribri' small red bean (race Mesoamerica). Crop Science 43 (1): 430-431.

Mather, D.L., R. Bernsten, J.C. Rosas, A. Viana and D. Escoto. 2003. The economic impact of disease- resistant beans in Honduras. Agricultural Economics 29:343-352.

Mather, D.L., R. Bernsten, J.C. Rosas, A. Viana, D. Escoto and J. Martínez. 2003. The impact of bean research in Honduras. Staff paper, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 34 p.

Rosas, J.C. 2003. Management recommendations for bean crop production. Litocom Press, Tegucigalpa, Honduras, 33 p., 45 illust. (in spanish).

Rosas, J.C., O. Gallardo and J. Jimenez. 2003. Genetic improvement of common beans using participatory approaches in Honduras. Agronomía Mesoamericana 14 (1):1-9. (in spanish).

Rosas, J.C. 2003. Bean Crop in Tropical America. Pan-American Agricultural School, Zamorano, 2nd. edition, Litocom Press, Tegucigalpa, Honduras, 57 p. (in spanish).

Rosas, J.C. 2003. Soybean Crop. Pan-American Agricultural School, Zamorano, 2nd. edition, Litocom Press, Tegucigalpa, Honduras, 56 p. (in spanish).

Frahm, M.A., J.C. Rosas, N. Mayek-Pérez, E. López –Salinas, J.A. Acosta-Gallegos and J.D. Kelly. 2004. Breeding beans for resistance to terminal drought in the lowland tropics. Euphytica 136:223-232.

Rosas, J.C., J. S. Beaver, S. Beebe and A. Viana. 2004. Names of bean varieties released in Central America and the Caribbean. Ann. Rep. of the Bean Improv. Coop. 47:329-330.

Rosas, J.C., J. S. Beaver, S. Beebe and A. Viana. 2004. Nomenclature of bean varieties released in Central America and the Caribbean. Agronomia Mesoamericana 15 (2): 221-224 (in Spanish).

Rosas J.C., J. S. Beaver, D. Escoto, C.A. Perez, A. Llano, J.C. Hernandez and R. Araya. 2004. Registration of "Amadeus 77" small red common bean. Crop Sci. 44:1867-1868.

Rosas, J.C. 2004. Genetic Resources of the Genus *Phaseolus* in Honduras. Litocom Press, Tegucigalpa, Honduras, 40 p (in spanish).

Rosas, J.C. 2004. Macuzalito: small red bean variety developed by participatory plant breeding. Tech. Bull., Litocom Press, Tegucigalpa, Honduras, 4p. (in spanish).

Zamora, M. and R. Bernsten. 2004. Evaluation of the demand of beans from El Salvador, Guatemala Honduras and Nicaragua in ethnic communities of the U.S.A. Agronomía Mesoamericana 15 (2): 131-143 (spanish translation by J.C. Rosas)

Martinez L., R. Bernsten and M. Zamora. 2004. Market strategies for Central American beans. 2004. Agronomía Mesoamericana 15(2): 121-130 (spanish translation by J. C. Rosas).

Ho M. D., J.C. Rosas, K.M. Brown and J.P. Lynch. 2005. Root architectural tradeoff for water and phosphorus adquisition. Functional Plant Biology 32:737-748.

Acevedo M., J.R. Steadman, J.C. Rosas and J. Venegas. 2005. Characterization of virulence diversity of the bean rust pathogen *Uromyces appendiculatus* in wild bean populations as a tool for effective resistance gene deployment. Ann. Rep. of the Bean Improv. Coop. 48:132-133.

Gonzalez-Martinez N., F.H. Fewerda, M. Alameda, J.C. Rosas and J.S Beaver. 2005. Identification of new sources of resistance to web blight of common bean. . Ann. Rep. of the Bean Improv. Coop. 48: 130-131.

Rosas J.C., O. Gallardo and J. Jiménez. 2006. Mejoramiento de maíces criollos de Honduras utilizando metodologías de fitomejoramiento participativo. Agron. Mesoamericana 17(3):375-383.

Porch, T., R. Bernsten, J.C. Rosas and M. Jahn. 2007. Climatic change and common bean production on the North Coast of Honduras. J. Agric. Univ. Puerto Rico (accepted for publication).

Porch, T., R. Bernsten, J.C. Rosas and M. Jahn. 2007. Cost benefit analysis of the introduction of heat tolerant bean varieties in Atlantida, Honduras. Ann. Rep. of the Bean Improv. Coop. 50:199-200.

CURRICULUM VITAE

Name: Timothy G. Porch

Present address: USDA/ARS/TARS, 2200 P.A. Campos Ave, Suite 201,
Mayaguez, PR 00680
787-831-3435 x 254, 787-831-3386 (Fax), maytp@ars-grin.gov

Education: Ph.D., Cornell University, 2001; Plant Breeding and Genetics, Minor in Plant Pathology

Dissertation Title: Genetics and applications of heat tolerance in common bean

B.S., Cornell University, 1996

Languages: English, Spanish, Russian

Citizenship: U.S.

Work experience:

- Research Geneticist, USDA/ARS, Tropical Agricultural Research Station
  July, 2003 to present

  Breeding and genetics of common bean for photoperiod conversion, common bacterial blight resistance, heat tolerance, drought tolerance and root rot resistance using molecular and classical approaches. Development of molecular marker, mutagenesis, and transformation systems for the rapid identification of QTL/genes associated with stress tolerance using forward and reverse genetics.

- Postdoctoral Associate, University of Florida, Gainesville, Dr. Mark Settles
  January, 2002 to July, 2003

  Performed the cloning of *vp13/vp10* in maize using a novel PCR-based method to clone a transposon tagged allele. Characterized the role of *Vp10* in maize development showing that *Vp10* encodes the ortholog of *Cnx1*, which catalyzes the final common step of Moco synthesis, an ABA cofactor.

- Postdoctoral Associate, Cornell University, Ithaca, NY, Dr. Molly Jahn
  May, 2001 to November, 2001

  Studied the quantitative genetics of heat tolerance in bean.

- Consultant, Winrock International Institute of Agricultural Development, Tajikistan, June, 1996 to August, 1996

  Analyzed the condition of higher agricultural education in Tajikistan.

- Research Assistant, Cornell University, Ithaca, NY, Dr. Elizabeth Earle
  January, 1995 to May, 1996

  Bred for resistance to black rot and *Alternaria* leaf spot in *Brassica.*
- Research Assistant, Cornell University, Ithaca, NY, Dr. Roger Spanswick
  September, 93 to March, 1995

  Studied ion cotransport in the root cortical cells of maize.

Accomplishments:

USDA Postdoctoral Grant Awardee, 2003

Munger/Murphy Award for Excellence in Plant Breeding, Cornell University, 2001

Outstanding Plant Breeding Department Teaching Assistant, Cornell University, 2000

Bradfield Award, Cornell University, 1999

National Science Foundation Graduate Fellow, 1997-1999

Plant Cell and Molecular Biology Fellowship, Cornell University, 1996-1998

New York State Seed Association Student Award, 1995

Cornell Tradition Scholar, 1995-96

PUBLICATIONS

Blair M.W., Porch T.G., Cichy K., Galeano C.H., Lariguet P., Pankurst C., and Broughton W. Induced mutants in common bean (*Phaseolus vulgaris*), and their potential use in nutrition quality breeding and gene discovery. (Submitted, Israel J. of Plant Sci., 6/2007)

Ramirez V.H., Porch, T.G., and Harmsen, E.W. Development of linear models for non-destructive leaf area estimation in common bean (*Phaseolus vulgaris* L.) using direct leaf measurements. (Submitted to Agronomy Journal, 6/2007).

Porch T.G., Bernsten R., Rosas J.C., Jahn M. 2007. Cost benefit analysis of the introduction of heat tolerant bean varieties in Atlántida, Honduras. Annual Report of the Bean Improvement Cooperative 50:199-200.

Zapata M., Beaver J., and Porch T. 2007. Foliage, pod and internal seed infection of selected common bean lines when inoculated with two strains of *Xanthomonas axonopodis* Pv. phaseoli. Annual Report of the Bean Improvement Cooperative 50:117-118.

Porch T.G., Bernsten R., Rosas J.C., Jahn M. 2007. Climate change and the potential economic benefits of heat tolerant bean varieties for farmers in Atlántida, Honduras. (Accepted, Journal of Agriculture of the University of Puerto Rico, 10/2007).

Gepts P., Aragão F., Blair M., Brondani R., Broughton W., Hernández G., Kami J., Lariguet P., McClean P., Melotto M., Miklas P., Pedrosa-Harand A., Porch T., Sánchez F. Genomics of Phaseolus Beans, a Major Source of Dietary Protein and Micronutrients in the Tropics, In Genomics of Tropical Crop Plants (Eds. PH Moore and R Ming). Springer, US (in press).

Aranda L., Porch T.G., and Bassett M.J. 2006. Initial AFLP tagging of the gene (Cl) for circumlineated pattern. Annual Report of the Bean Improvement Cooperative 49:55-56.

Porch T.G. 2006. Application of stress indices for heat tolerance screening of common bean. Journal of Agronomy and Crop Science 192:390-394.

Porch T.G. and Erpelding J.E. 2006. Low-cost conversion of the Polaroid MD-4 land camera to a digital gel documentation system. Journal of Biochemical and Biophysical Methods 67:1-5.

Porch T.G., Tseung C-W., Schmelz E.A., Settles A.M. 2006. The maize *Viviparous10/Viviparous13* locus encodes the *Cnx1* gene required for molybdenum cofactor biosynthesis. The Plant Journal 45:250-263.

Suzuki M., Settles A.M., Tseung C-W., Li Q-B., Latshaw S., Wu S., Porch T.G., Schmelz E.A., McCarty D.R., James, M. 2006. The maize *viviparous15* locus encodes the molybdopterin synthase small subunit. The Plant Journal 45:264-274.

McCarty D.R., Settles A.M., Suzuki M., Tan B.C., Latshaw S., Porch T.G., Robin K., Baier J., Avigne W., Lai J., Messing J., Koch K.E., Hannah C. 2005. Steady-state transposon mutagenesis in inbred maize. The Plant Journal 44:52-61.

Porch T.G., Dickson M.H., Long M.C., Viands D.R. and Jahn M. 2004. General Combining ability effects for reproductive heat tolerance in snap bean. The Journal of Agriculture of the University of Puerto Rico 88:161-164.

Porch T.G. and Jahn M. 2001. Effects of high temperature stress on microsporogenesis in heat sensitive and heat-tolerant genotypes of *Phaseolus vulgaris*. Plant Cell Environ. 24:723-731.

Porch T.G. 2001. Genetics and applications of heat tolerance in common bean. Ph.D.Dissertation. Cornell University, Ithaca, New York.

CURRICULUM VITAE

Emmanuel PROPHETE
National Seed Service
CRDA, Ministry of Agriculture
Road No. 1, P.O. Box 1441
Port-Au-Prince, Haiti
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Key Qualifications:

- A bean researcher with 32 years of relevant work experience in Haiti.
- Experience working directly with Haitian farmers for the past twenty years
- Project and budget management skills.
- Established and maintained collaborative relationships with international research organizations, including CIAT, PROFRIJOL and the Bean/Cowpea CRSP.
- Evaluation of the performance and promotion of the adoption of disease resistant bean varieties in Haiti.
- Speaks fluent French, English, and Spanish

Education :

- Master of Sciences, Horticulture, Texas A&M University, 1982-1984
- BS in Agriculture, Faculté d'Agronomie et de Médecine Vétérinaire, Université d'Etat d'Haïti, 1971-1975

Experience :

- Director, National Seed Service, April 2003 to present: We promote the multiplication and use of good quality and improved botanical seeds of basic food crops, including the common bean, *Phaseolus vulgaris L.* In cooperation with the Central American bean research network, the Bean Cowpea CRSP and CIAT, improved varieties 'Arroyo Loro Negro', 'Tio Canela', 'ICTA Ligero' and 'Morales' have been introduced in Haiti
- Bean Researcher, January 1990 to March 2003: As a member of the Haitian Agricultural Research Service, CRDA, I participated in the introduction, testing and increase of seeds of improved bean varieties. I also participated in farmer training as well as research on improved bean production practices.
- Research Agronomist, February 1985 to January 1990: I participated, in Northern and Northwestern Haiti, in the development of improved production practices for common bean, peanuts, cassava,maize, banana and plantain for small farmers.
- Research Agronomist, January 1979 to December 1981: As a member of the Haitian Agricultural Research Service, I introduced, tested and increased seeds of improved maize, bean and sorghum varieties.

- Agricultural Extension Agent, November 1975 to December 1977: As an employee of the Ministry of Agriculture, I worked with Farmer Groups to promote the use of improved production techniques for beans, maize, cassava, banana and plantains.

Languages:

- Fluent in French, English and Spanish.

Published articles

- Blair M. W., Beaver J. S., Nin J. C., Prophete E., Singh S. P. (2006) Registration of PR9745-232 and RMC-3 red-mottled dry bean germplasm lines with resistance to Bean Golden Yellow Mosaic Virus. Crop Sci. 46 :100-1002.
- Robert G. Nelson, Curtis M. Jolly, Margaret J. Hinds, Yanick Donis, Emmanuel Prophete (2005) Conjoint analysis of consumer preferences for roasted peanut products in Haiti
  International Journal of Consumer Studies 29 (3), 208–215.
- Durán L.A., Blair M.W., Giraldo M.C., Machiavelli R., Prophete E., Nin J.C., Beaver J.S. (2005) Morphological and molecular characterization of common bean (*Phaseolus vulgaris* L) landraces from the Caribbean. Crop Sci. 45: 1320-1328.
- Morales, F., Donis, J. and E. Prophete (2005) Haiti. p 226-229 *In* P. K. Anderson and F. Morales (eds.) Whiteflies and whitefly-borne viruses in the tropics: Building a knowledge base for global action. CIAT, Cali, Colombia.
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CURRICULUM VITAE

1. Personal data

Name:	António Chicapa Dovala
Date of birth:	07-29-1956
Address:	Bairro Cassequel, Rua 55, casa nº 28 R/C, Luanda.
Cell phone:	00244-923-414259
Email:	chicapa29@hotmail.com
Present position:	Leader of the Scientific Department-IIA and Leader of the Legume Research Program
Nationality:	Angolan

2. Academic training

2.1. Undergraduate education

1974/75: Secondary school - Kuito (ex-Silva Porto), Bié.

1979: Agricultural Technical Engineer degree studies: Tchivinguiro, Huila

1988: Agronomic Engineer degree studies: Faculdade de Ciências Agrárias-UAN, Huambo

1990: Specialization in Plant Pathology – EAN, Oeiras – Portugal

2.2. Graduate education

1991: Specialization in Plant Virology

2006: M.S. in Agronomy and Natural Resources Thesis entitled "*Striga in the Production of Maize in Angola*. Control with *Desmodium intortum* and *D. uncinatum*"

3. Professional career

1979: Admission to the Instituto de Investigação Agronómica (IIA)

1979/81: Study and control of *Cercospora angolensis* Carv. & Mend

1981/92: Identification and evaluation of legume (common bean, cowpea, peanut and soybean) diseases

1981/85: Leader of the Plant Pathology Division

1986/92: Collaborator in phytosanitary practices for disease Sanidade Vegetal-I and II, FCA

1986/94: Leader of the Department of Phytosanitary Sciences

1994/2002: Rural Extension Program - Sector Camponês and NGOs

4. Courses and training

1979: Training dealing with citrus diseases in Angola, 12 months

1980: Training dealing with soil conservation and soil erosion control, 3 months

1981: Potato disease course, Gdanski, Polónia, 1 month

1981: Training dealing with plant disease diagnosis

1983:	Course dealing with potato nematodes, 1 month
1989/91:	Training in plant virology - EAN, Oeiras, Portugal
1992 :	One month training in peanut and pigeonpea diseases - Lilongwe, Malawi
1995 :	FAO course dealing with the identification and implementation of projects
1996 :	Course dealing with the identification and implementation of projects of the socio-economic re-integration of the demobilized, Ministério da Reinserção Social do Governo de Angola e PNUD
1997 :	Training dealing with the identification and implementation of projects, (FONGA)
2004 :	Course dealing with the identification and implementation of projects, DW-Canada

5. Publications and scientific presentations

Chicapa-Dovala, A. (1990) –*Estudo de uma Virose Detectada em Plantas de* 'Zucchini' *Cucurbita pepo* L. Relatório do fim de curso. Universidade Agostinho Neto, Faculdade de Ciências Agrárias, Huambo, 97 pp.

Chicapa-Dovala, A. (1991) – *Vírus do mosaico amarelo do "Zucchini" caracterização parcial.* Relatório de síntese do estágio realizado no Departamento de Fitopatologia da EAN, Oeiras, Potugal. Huambo, 23pp.

Chicapa-Dovala, A. (1992) - *List of plant diseases in Angola*. Apresentado ao principal Fitopatologista do Programa das Leguminosas na região Austral de Africa, Malawi

Chicapa-Dovala, A. (2007) –Annual report. Grain Legumme Programme of Angola. Southern Africa Bean Research Network and East Central Africa Bean Research Network (SABRN & ECABREN) Steering Committee, Nyeri-Kenya.

Chicapa-Dovala, A.; Castame-francisco, A. & Gongolo, G. (2006) –Annual report. GrainLegumme Programme of Angola. Southern Africa Bean Research Network-SABRN, Lilongwe, Malawi.

Chicapa-Dovala, A. & Conceição, C. (1988) – *List of plant pests in Angola*, 5pp, publicado no relatório do wokshop realizado em Babane, Suazilândia, de 1 a 5 de Agosto de 1988.

Chicapa-Dovala, A. (2005) – Striga na cultura de milho em Angola. Controlo com adubações azotadas e consociação com *Desmondium intortum* e *D. uncinatum.* Dissertação do Mestrado em agronomia e Recursos Naturais. Faculdade de Ciências

Agrárias, Universidade Agostinho Neto, Angola e Instituto Suprrior de Agronomia, Universidade Técnica De Lisboa, Portugal. 97 pp.

Chicapa-Dovala, A.; Monteiro, A.; Tomás, A. A. & Moreira, I. (2006) *Striga* na cultura do milho em Angola. Controlo com adubações azotadas e com a consociação milho-*Desmodium* spp. *In* Ilídio Moreira, *Angola, desenvolvimento, Agricultura e Recursos naturais*. ISA PRESS

Chicapa-Dovala, A.; Monteiro, A.; Tomás, A. A. & Moreira, I. (2007) *Striga* na cultura do milho em Angola. Controlo com adubações azotadas e com a consociação milho-*Desmodium* spp. *In Esporo* 80.

Nolasco, G. B.; Sequeira, J. C.; Dovala, C. & Sequeira, O. A. (1991) – Zucckin yellow mosaic vírus – The causal agent of a new disease of *Cucurbita pepo* L. in Portugal.*I Coloquio Franco-Ibérico de Microscopia Electrónica*, PB24: 126.

6. Participation in seminars

- 1988 : Seminar dealing with agricultural research in Mozambique, Maputu, Março.
- 1988: Integrated pest management in small holder farmers, August. Babane, Suazilândia.
- 1989: First meeting dealing with agricultural research in Angola. Instituto de Investigação Agronómica, Huambo.
- 1989: First meeting of Portuguese plant pathologists. Summary of communications. Estação Agronómica Nacional, Oeiras- Portugal. 14-15 December.
- 1992: Seminar dealing with agricultural research systems, ISNAR/SADCC, Lubango, Março.
- 1992: SADCC region peanut disease workshop, March, Lilongwe, Malawi.
- 1992: Pigeonpea improvement in the SADCC region, March. Lilongwe, Malawi.
- 1992: Second meeting dealing with agricultural research in Angola. Instituto de Investigação Agronómica, Huambo
- 2005: XV meeting of the AULP, Universidade Técnica de Lisboa, 22-24 May.
- 2005: Workshop dealing with transgenic crops – Presentation of results of project No. 17. 'A study of the impact of genetically modified corn on agricultural ecosystems' supported by the General Direction of Crop Protection. Oeiras, Portugal, 24 June.

a. Letters of willingness to collaborate

Please refer to the attached documents

b. Plans for leveraging additional resources

The Dry Grain Pulse CRSP will have 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 would indirectly benefit the research goals stated in this proposal. Promising bean breeding lines are already in an advanced stage of development which will enable the project to achieve significant impact in a short period of time. Ing. Emmanuel Prophete is the leader of the Ministry of Agriculture seed program in Haiti which will provide resources for the multiplication and distribution of bean cultivars developed by the proposed Dry Grain Pulse CRSP project. The EAP is an active participant in the Central American bean research network supported by IICA/COSUDE which 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. The University of Puerto has a pigeon pea breeding program that has developed breeding lines with resistance to the pod fly which will be made available to collaborators in Haiti. Dr. Beaver plans to prepare a proposal to the USDA *Phaseolus* Crop Germplasm Committee to support the collection and evaluation of *P. lunatus* landraces from the Caribbean. Project personnel will attempt to obtain additional support for research and training activities from USAID Missions. Dr. Rosas recently provided seed of a promising black bean cultivar to USAID personnel in Haiti for seed multiplication and on-farm evaluation trials. The project will also seek opportunities for support or collaboration with NGO's and private companies. For example, we recently discussed the possibility of testing a BGYM resistant snap bean cultivar in Costa Rica with a private company.

c. Literature cited

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Beaver, JS, Muñoz Perea CG, Osorno JM, Ferwerda FH, Miklas PN (2005). Registration of *Bean golden yellow mosaic virus* Resistant Dry Bean Germplasm Lines PR9771-3-2, PR0247-49, and PR0157-4-1. Crop Sci. 45:2126-2127

Blair MW, Beaver JS, Nin JC, Prophete E, Singh SP (2006) Registration of PR9745–232 and RMC-3 Red-mottled dry bean germplasm lines with resistance to *Bean golden yellow mosaic virus*. Crop Sci 2006 46:1000-1002.

Bradeen JM, Simon PW (1998) Conversion of an AFLP fragment linked to the carrot *Y2* locus to a simple, codominant, PCR-based marker form Theoretical and Applied Genetics 97:960-967.

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Smith JR, Park SJ, Beaver JS, Miklas PN, Canaday CH and Zapata M (2007) Registration of TARS-SR05 multiple disease resistant dry bean germplasm. Crop Science 47:457-458.

Wortman CS, Kirkby RA, Eledu CA, Allen DA (1998) Atlas of common bean (*Phaseolus vulgaris* L.) production in Africa. CIAT, Cali, Colombia.

Budget narrative- University of Puerto Rico

a. Personnel costs:

Funds will be used for 20% of a salary for a technician and field workers to assist in the conduct field and greenhouse research and to multiply seed of promising breeding lines.

b. Travel:

Funds for travel include annual trips to Honduras and Haiti to review ongoing research and to plan future research and training activities. A portion of the funds will also be used to attend the annual meeting of the PCCMCA.

c. Equipment:

No item with a value > $ 5,000 will be purchased during this 30 month period.

d. Supplies:

- Materials (primers, gels, buffers, enzymes, etc) for the molecular laboratory to conduct marker-assisted selection
- Materials (fertilizer, pesticides , sprayers, stakes, paper bags, etc.) to conduct field research at the Isabela Substation
- Greenhouse materials and supplies (pots, substrates, benches, tags, etc.)
- Office supplies to prepare reports and scientific publications

e. Training:

None

f. Other costs:

a. Funds to be used for shipping seed to collaborators and coordinating regional performance trials for Andean beans.

g. Indirect cost:

- An indirect cost rate of 25%.

Budget narrative – USDA, Agricultural Research Service (ARS), Mayaguez, PR

a. Personnel costs:

Funds will be used to partially support a lab technician to conduct the molecular marker work in the laboratory, to assist with disease screening activities in the greenhouse, and to assist with greenhouse pollinations for the breeding objectives of the project.

b. Travel:

Funds have been set aside for travel to the annual PCCMCA meetings at which meetings with the project collaborators will take place. Travel to Angola for training and evaluation objectives will be funded from the host country budget.

c. Equipment:

No item with a value > $ 5,000 will be purchased during this 30 month period.

d. Supplies:

- Replacement of laboratory equipment as needed, including: power supplies, gel boxes and trays, gel combs, glassware, etc. (all supplies < $ 5,000).
- Qiagen DNA extraction kits in 96-well format for marker analysis, and associated supplies such as tips, DNA storage plates, and DNA quantification supplies.
- Reagents for the development of molecular makers using AFLP, including polyacrylamide, labeled primers, labeled size ladders, tips, etc.
- Marker analysis supplies such as agarose, size ladders, and tips.
- Field supplies, including: fertilizer, pesticides, herbicides, fungicides, paper bags, etc.
- Greenhouse materials and supplies for disease screening and pollination, including: pots, potting mix, tags, etc.

e. Training:

No funds have been set aside for training. Training in Angola will be funded from the host country budget.

f. Other costs:

No other costs have been budgeted.

g. Indirect cost:

The USDA/ARS indirect cost rate is 10%.

Budget narrative - Escuela Agrícola Panamericana (EAP), Zamorano

a. Personnel costs:

Funds will be used to hire a field technician and field workers to conduct hybridizations and other greenhouse activities, field trials and seed increases.

b. Travel:

Funds for travel will include visits to farmer fields and trials conducted in collaboration with researchers from the national bean research (NBR) programs in Central America, travel to the U.S. PI and Co-PI location, visits with collaborators from Haiti and Angola, and participation in regional and international meetings.

c. Equipment:

No item with a value > $ 5,000 will be purchased during this 30 month period.

d. Supplies:

- Computer and accessories, lab equipment and instruments (scales, pH meter, pipettes, microcentrifuge and others) costing < $ 5,000.
- Accessories for irrigation (pipes, sprinklers and tools)
- Field supplies (fertilizer, fungicides, sprayers, tools, paper bags, etc.)
- Greenhouse materials and supplies (pots, substrates, benches, tags, etc.)
- Diesel for pick up trucks and irrigation pumps; gasoline for sprayers

e. Training:

- Partial support for senior B.S. students (conducting research and/or receiving in service training under the project)
- Costs of informal (short) training of technical personnel (mainly housing and meals)

f. Other costs:

- Funds for regional collaboration with researchers from the national bean programs of Honduras, El Salvador, Nicaragua and Guatemala. It is estimated that at least 25% of the funds assigned to the EAP will be used to support regional bean network activities.

g. Indirect cost:

- Indirect cost rate of 20%.

Budget narrative – Ministry of Agriculture - Haiti

a. Personnel costs:

Funds will be used to hire a field technician and field workers to conduct evaluation of bean breeding lines on experiment stations and farms. Project personnel will also be responsible for seed multiplication of promising bean breeding lines and recently released cultivars.

b. Travel:

Funds for travel will include visits to farmer fields and trials conducted in collaboration with researchers from the national bean research (NBR) programs in Central America and Dry Grain Pulse CRSP personnel, and for participation in regional and international meetings.

c. Equipment:

No item with a value > $ 5,000 will be purchased during this 30 month period.

d. Supplies:

- Accessories for irrigation (pipes, sprinklers and tools)
- Field supplies, including: fertilizer, fungicides, pesticides, back pack sprayers, stakes, paper bags, hoes, etc.
- Seed cleaning and organization supplies, including sieves, trays, envelopes, bags, seed storage trays and boxes, seed treatments, etc.
- Supplies for common bean pollination and breeding, including: forceps, tags, alcohol, envelopes, etc.
- Computer and accessories, lab equipment and instruments (laptop, scales, pH meter)

e. Training:

- Costs of informal (short-term) training of technical personnel and farmers in Haiti. These funds will be used for housing and meals during the participatory plant breeding and technical training sessions.

f. Other costs: No other costs budgeted.

g. Indirect cost: None.

Budget narrative - Instituto de Investigação Agronómica (IIA) - Angola

a. Personnel costs:

No funds have been set aside for personnel costs in Angola.

b. Travel:

Funds have been budgeted for travel of the non-host country project collaborators to Angola to assist with the training and evaluation objectives of the project. Three project collaborators will visit during the first period and one collaborator will visit during the second and third periods of the project. During periods two and three, there are funds for the host country PI to visit collaborator projects and institutions and to attend the PCCMCA conference. An in depth training program for an Angolan technician will be conducted at Zamorano, Honduras for 4-5 months in the second year of the project.

c. Equipment: No item with a value > $ 5,000 will be purchased during this 30 month period.

d. Supplies:

- Accessories for irrigation (pipes, sprinklers and tools)
- Field supplies, including: fertilizer, fungicides, pesticides, back pack sprayers, stakes, paper bags, hoes, etc.
- Seed cleaning and organization supplies, including sieves, trays, envelopes, bags, seed storage trays and boxes, seed treatments, etc.
- Supplies for common bean pollination and breeding, including: forceps, tags, alcohol, envelopes, etc.
- Computer and accessories, lab equipment and instruments (scales, pH meter)

e. Training:

- A large investment in capacity development and training involve degree training of an Angolan student in the joint PhD program between the University of Puerto Rico, Mayaguez and North Dakota State University. The PhD candidate will conduct a research project focused on common bean breeding objectives that will directly benefit the breeding program of Angola.
- Costs of informal (short) training of technical personnel and farmers in Angola. These funds will be used for housing and meals during the participatory plant breeding and technical training sessions.

f. Other costs: No other costs budgeted.

g. Indirect cost: None.