Impact Assessment of Bean/Cowpea and Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination in Africa, Latin America and the U.S.

Principal Investigator
Mywish K. Maredia, Michigan State University. USA

Collaborating Scientists
Richard Bernsten, Michigan State University, USA
Eric Crawford, Michigan State University, USA
Jim Beaver, UPR, Haiti
Juan Carlos Rosas, EAP, Haiti
Eduardo Peralta, INIAP, Haiti
Emmanuel Prophete, Haiti
Mathew Blair, CIAT
Ndiaga Cisse, ISRA, Senegal
Issa Drabo, INERA, Burkina Faso
Phil Roberts, University of California, USA
Jeff Ehlers, University of California, USA

Abstract of Research Achievements and Impacts
The project team completed the compilation of two databases: a) Database of improved varieties of beans and cowpeas in countries where the Bean/Cowpea CRSP has been historically involved in crop improvement research, and b) the database of socio-economic studies and impact assessments conducted by the DGP (and its predecessor) CRSP to date. Both these databases have been developed in MS Access with reports generated and available in MS Word and Excel. The database on improved varieties and the impact studies will be further scrutinized as part of the meta-analysis planned in FY 12

The impact pathway analysis for each of the Phase 2 and 3 projects was completed in FY 11 and results presented to the MO. Based on this analysis, the 10 CRSP Phase 2 and 3 projects can be grouped into three types—1) projects for which the prognosis for achieving development impacts is positive contingent upon successfully scaling up the application of outputs; 2) projects for which the potential for long-term impacts is low based on their current scope and scale; and 3) projects for which the potential for long-term impacts is uncertain because the realization of the vision of success depends on many factors outside the control of researchers or the scale at which the research is conducted may not generate a critical mass of knowledge/evidence needed to influence major policy decisions (required to achieve the vision of success).

Field research and analysis towards two ex post impact assessment studies was conducted as planned. This included the adoption and impact study on bean improvement research in Central America and Ecuador and cowpea improvement research in Senegal. Past and current research conducted by the Bean/Cowpea and Pulse CRSP on value addition, food science and human nutrition was reviewed with the aim of documenting all the outputs, outcomes and impacts from such investments. This enquiry did not lead to any new or encouraging information on the

commercial application of research outputs generated from CRSP research projects or evidence of their uptake/utilization by various actors in the value chain (i.e., processors, traders, consumers).

Towards implementing an integrated impact evaluation strategy as part of the CRSP project design, the lead PI of this project interacted with several CRSP project PIs to explore opportunities and feasibility of conducting impact evaluation research. Four such opportunities for data collection and investigative research with the aim of addressing questions of what works, where, why and why not, were identified and included as part of the Workplan for FY 2012.

Project Problem Statement and Justification

Impact assessment is essential for evaluating publicly-funded research, capacity building and outreach programs and planning future research. Organizations that implement these programs should be accountable for showing results, demonstrating impacts, and assessing the cost-effectiveness of their implementation strategies. It is therefore essential to document outputs, outcomes and impacts of public investments in research for development (R4D) activities. Anecdotal data and qualitative information are important in communicating impact to policymakers and the public, but must be augmented with empirical data, and sound and rigorous analysis.

Impact assessments are widely recognized to perform two functions--accountability and learning. Greater accountability (and strategic validation) is seen as a prerequisite for continued support for development assistance. Better learning is crucial for improving the effectiveness of development projects and ensuring that the lessons from experience – both positive and negative – are heeded. Accountability and strategic validation has long been core concerns for **ex-post impact assessments** and learning has been primarily a concern of **impact evaluation**.[1] The primary focus of this project is on ex post impact assessment. However, attention is also devoted to finding opportunities to include impact evaluation as part of CRSP projects to be implemented in Phase II and III. In addition to measuring and evaluating impacts of past research investments, this project is also concerned with increasing impacts from current investments by examining 'impact pathways' of research projects and inculcating an impact culture within the Pulse CRSP research community.

Results, Achievements and Outputs of Research

Objective 1: To build an inventory of past documented outputs, outcomes and impacts of investments by the Bean/Cowpea CRSP and develop a trajectory of outputs and potential types of impacts of investments made by the Dry Grain Pulses CRSP

Towards this objective, this project finalized the following two activities and gave an oral presentation and an overview of results to the MO staff in November 2011.

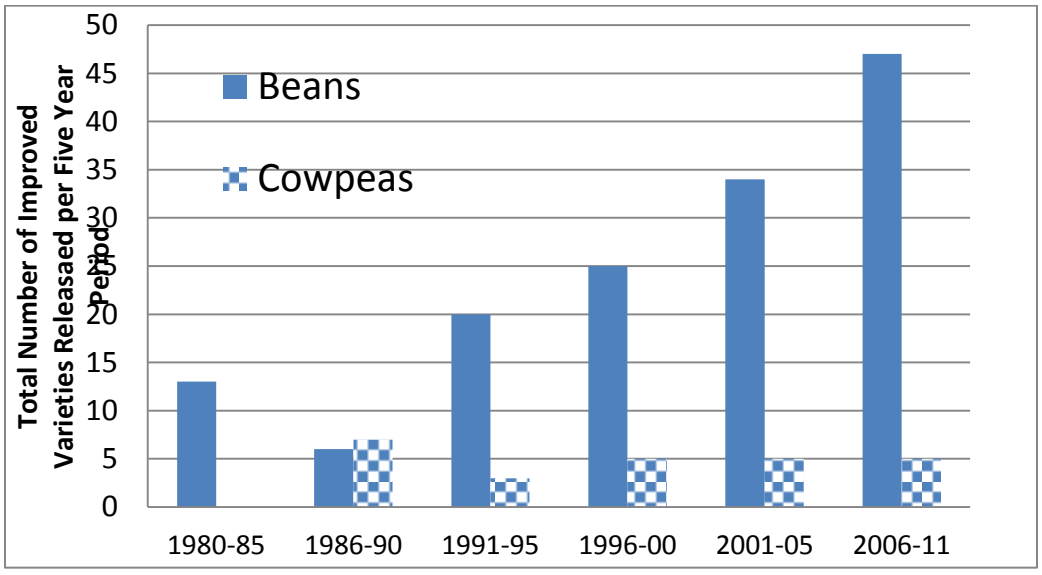
[1] Although in the evaluation profession, the terms impact assessment and impact evaluation are used synonymously, in this project we make a nuanced distinction between ex post impact assessment and impact evaluation based on the timing of when they are conducted, the scale at which they occur and the motivation for doing an assessment (Maredia 2009).

1a. An Inventory of Past Outputs and Documented Impacts

Under this activity, the project team has completed the compilation of two databases: a) Database of improved varieties of beans and cowpeas in countries where the Bean/Cowpea CRSP has been historically involved in crop improvement research, and b) the database of socio-economic studies and impact assessments conducted by the DGP (and its predecessor) CRSP to date. Both these databases have been developed in MS Access with reports generated and available in MS Word and Excel.

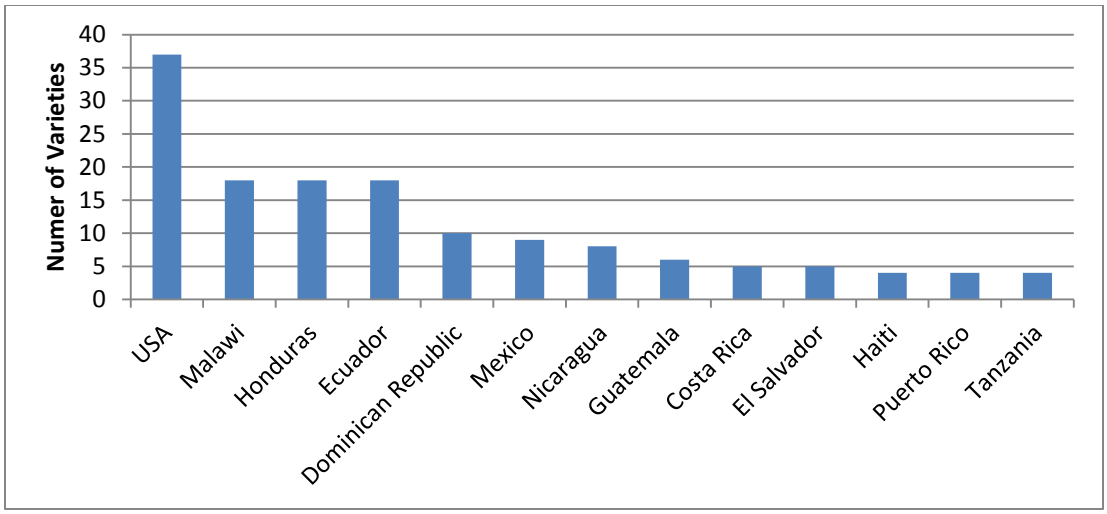
Figure 1 presents the number of bean and cowpea improved varieties released from 1980-2011 per five-year period by host country partners that received CRSP funding. Over the past 30 years, a total of 145 improved bean varieties and 25 improved cowpea varieties released in the U.S and many CRSP partner countries can be attributed as outputs of CRSP funded research projects. For beans the number of varieties released at an aggregate global level shows an upward trend, increasing from an average of about 2 varieties per year in 1980s to almost 10 per year in 2006-11. A major source of this upward trend in CRSP supported bean varietal release is the region of Central America and the Caribbean. Figure 2 shows the breakdown of the 145 bean varieties by country of release. Not surprisingly, many of the countries on the higher end are USA, Hoduras, Ecuador and Malawi where the CRSP has historically played an important role in supporting collaborative research programs in bean breeding.

Compared to beans, the number of cowpea improved varieties attributed to CRSP support has remained stable at about 5 varieties per 5 year period (or an average of 1 per year) since mid-1980s (Figure 1). Over the past 25 years, CRSP can be credited for the release of 8 cowpea varieties in Senegal (the highest in any country), 7 in Burkina Faso, 4 in the U.S., 3 in Ghana, 2 in Cameroon and 1 on Sudan (Figure 3).



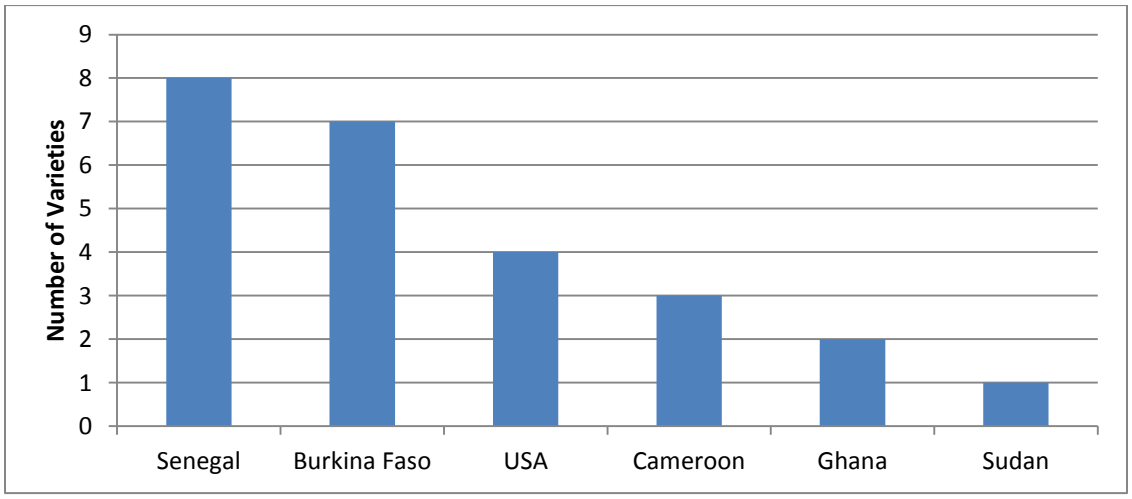
Source: Variety database compiled by CRSP IA team, 2011

Figure 1. Trend in the number of improved bean and cowpea varieties released in CRSP partner countries (including USA) by breeding programs that received CRSP funding, 1980-2011



Source: Variety database compiled by CRSP IA team, 2011

Figure 2. Number of CRSP supported improved bean varieties released in different countries, 1980-2011



Source: Variety database compiled by CRSP IA team, 2011

Figure 3. Number of CRSP supported improved cowpea varieties released in different countries, 1986-2010

The impact database contains a list of 40+ studies of varying focus and rigor on quantitative assessment of impacts. Not surprisingly, a majority of studies assess the ex post adoption or farm level benefits of varietal outputs of CRSP research. However, there are also a few studies that examine the impact of cowpea storage technology in Africa and IPM research. The database on improved varieties and the impact studies will be further scrutinized to conduct the meta-analysis planned in FY 12.

1b. Trajectory of Outputs and Potential Outcomes/Impacts of Ongoing Investments by the Pulse CRSP

This activity, completed in FY 11 and presented to the MO in November 2011, was similar in scope to activity 1a, except that it was a forward looking exercise, since the focus was on ongoing CRSP projects in Phase 2 and 3. Table 1 gives a summary of the impact pathway analysis for each of the Phase 2 and 3 projects. This analysis is based on the information provided by individual project team in a spreadsheet that was developed to capture the project's outputs, outcomes and impact. The impact pathway analysis gives a synopsis of the types of outputs to be generated by different research projects by the end of FY 2012, potential scale or impacts envisioned by the research team in the next five years, impact pathway and indicators along that pathway to achieve developmental outcomes (in the form of impacts at the beneficiary/adopter level). The last column of this table presents our subjective assessment of the potential for realizing the long-term impacts in the form of aggregate level benefits to the society at large. Based on this analysis, the 10 CRSP Phase 2 and 3 projects can be grouped into three types—1) projects for which the prognosis for achieving development impacts is positive contingent upon successfully scaling up the application of outputs; 2) projects for which the potential for long-term impacts is low based on their current scope and scale; and 3) projects for which the potential for long-term impacts is uncertain because the realization of the vision of success depends on many factors outside the control of researchers or the scale at which the research is conducted may not generate a critical mass of knowledge/evidence needed to change major policy decisions (required to achieve the vision of success).

Table 1. Impact Pathway Analysis of the Dry Grain Pulses CRSP Phase II and Phase III Projects – Prognosis for Development Impacts

Project (Name of Lead PIs)	Types of outputs	Potential Scale of impacts envisioned by PIs in the next 5 years	Impact indicators and pathway to achieve developmental outcomes	Potential for long-term impacts (per USAID's expectations) (subjective analysis)
PII-ISU-1 (Mazur)	New methods and approaches	Small--District level (Kamuli, Uganda)	Higher yield→increased income	Yes—if the methods/approaches are scaled up by the NGO (currently this vision is not explicit)
PII-MSU-2 (Bernsten / Donovan)	Information systems	Small—pilot scale (regions within a country)	Increased access to market at higher price→increased income	Yes—if the system is scaled up by partners (currently this vision is not explicit) and if research shows evidence of impact indicators and pathway
PII-PSU-1 (Lynch / Findeis)	New materials for breeding programs and Knowledge on seed system	Not specified Local impacts in bean growing region (Mozambique)	Improved materials→adopted by breeders→new varieties with root traits→increased yields by adopted farmers→increased income and production Changes in national policy→reduction in constraints to low-P bean seed diffusion	Yes—if breeders integrate the materials in bean breeding program. But PI expressed frustration on the lack of interest from breeders Low--Difficult to change policy with one small scale study
PII-UCR-1 (Roberts)	New materials (advanced lines and varieties)	Medium—sub-regions in multiple countries (Senegal, BF, Mali, Niger)	Increased productivity → increased income and production	Yes – if breeders play an active role (as a partner) in seed multiplication and dissemination efforts
PII-UIUC-1 (Pittendrigh)	New materials released (Biocontrol agents) And New strategies, information systems and extension materials	Medium—thousands of farmers across multiple countries (BF, Mali, Niger, Nigeria)	Biocontrol agents→ decrease in pests →increased yield → increased income and production New information→adoption of new on-farm practices→decrease in yield loss→increased income and production	Yes—if research shows evidence of impact indicators identified in the pathway
PII-UPR-1 (Beaver)	New materials (markers, parental lines and varieties)	Large (100,000 farmers in multiple countries)	Increased adoption→increased yield→increased income and production	Yes—if the FtF technology transfer project in Central America is successful

Project (Name of Lead PIs)	Types of outputs	Potential Scale of impacts envisioned by PIs in the next 5 years	Impact indicators and pathway to achieve developmental outcomes	Potential for long-term impacts (per USAID's expectations) (subjective analysis)
PIII-ISU-2 (Westgate)	New knowledge, recommendations (innoculums) and materials (QTLs and germplasm)	Large (multiple countries, 15% of farmers)	Adoption of recommendations and materials→increased productivity→increased income/production, environmental impacts	Yes—if research shows evidence of impact indicators and pathway (and adoption occurs as predicted)
PIII-MSU-3 (Bennink)	New knowledge on how pulse consumption reduces markers of chronic disease and New knowledge on how pulse consumption reduces markers of chronic disease improved nutritional and immunological status	None (PI sees this project as achieving impacts over long-term—30-35 years)	Consumers and commodity advocates instigate change in nutritional recommendations by national and international agencies→ recommendations are implemented at grassroots→ Changes in food choices→improved health and reduction in health costs Donors provide funds for large scale multi-national testing of nutritional intervention for PLHA→ policy change and commitment of resources for nutritional support and not just for drugs→ changes in food choices and increased consumption of pulses and essential nutrients → improved health and reduction in health costs	Uncertain—it depends on changing behavior and attitudes of many players along the pathway. Also, not sure if the knowledge generated by one study at such a small scale can influence national and international policies; Need a critical mass of 'knowledge' pool to influence change in policy and consumer behavior
PIII-KSU-1 (Amanor-Boadu)	New information, knowledge and ideas (on bean and cowpea supply chains and adoption protocols to enhance the relationship	None	New information→ improved governance system in supply chain → higher value accretion→ higher income accruing to female producers→ improved household food and nutrition security	Uncertain—not sure about the realization of the pathway from outputs to impacts

Project (Name of Lead PIs)	Types of outputs	Potential Scale of impacts envisioned by PIs in the next 5 years	Impact indicators and pathway to achieve developmental outcomes	Potential for long-term impacts (per USAID's expectations) (subjective analysis)
	between value accretion and gender)			
PIII-TAMU-1 (Awika)	New knowledge (effect of food processing on cowpea bioactives) New materials (cowpea lines, improved varieties with bioactivity traits)	None None	Community outreach targeting consumers, policymakers and farmers→Increase in demand and use of cowpeas with enhanced health attributes→ Improved health and food security among vulnerable groups and Improvement in income for cowpea farmers Development of varieties with high phytochemical content and enhanced health benefits → adoption by farmers →increased production and consumption of nutritionally enhanced cowpeas	Uncertain—it depends on many factors outside the control of researchers. Also, not sure if the knowledge generated by this one study can influence consumers.

The impact pathway analysis and the prognosis for development impacts of current research projects presented in Table 1, highlights the fact that the CRSP portfolio is made up research projects that fall on different trajectories of types of outputs, outcomes and impacts and are at varying distance from the goal of achieving development impacts. Since the Pulse CRSP is funded by USAID under the banner of 'development assistance,' this prognosis has important implications on funding decisions and balancing the research portfolio along the spectrum from research to development. Some type of research supported by the Pulse CRSP by nature is fundamental/basic research and thus farther away (in time dimension) from the vision of achieving large scale development impacts. This type of research is critical in advancing the knowledge frontier in small increments, which cumulatively and over time may lead to applications, technologies, practices and policies that can positively impact people's lives. But can the CRSP afford to invest in research that has a 25-35 year time horizon for achieving impacts? What should be the mix and balance between applied research that can lead to development impacts within the life span of a CRSP grant and basic research that may not even generate outputs in 5 years? These are the types of questions which the Pulse CRSP MO will be facing in the coming year as it prepares for the next five year phase. We hope the impact pathway analysis of the current and prospective research projects can serve as an input in guiding research investments in pulse crops for the next five years.

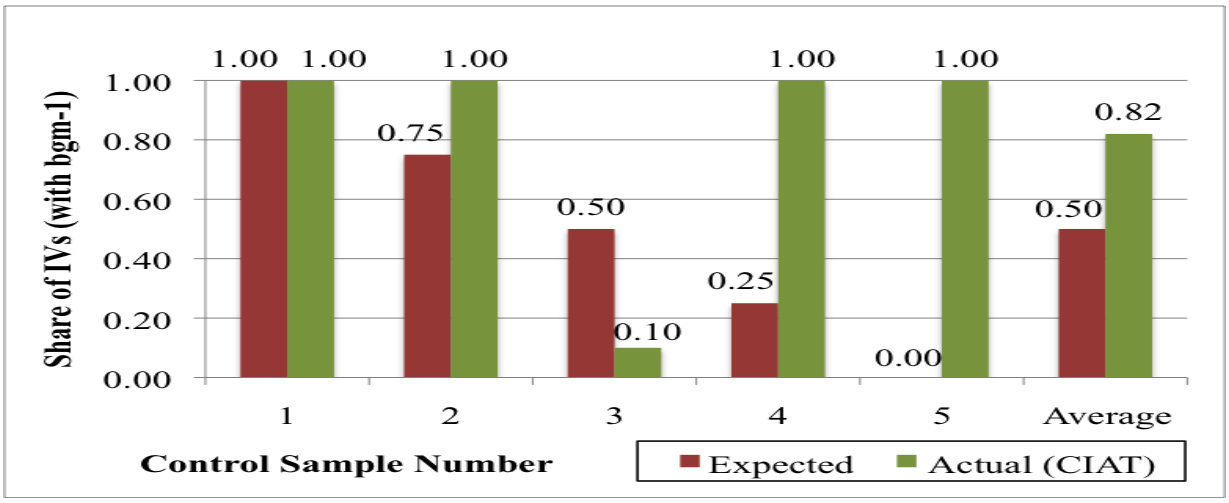
<u>Objective 2:</u> Conduct ex post impact assessment of Bean/Cowpea and Dry Grain Pulses CRSP investments in research, institutional capacity building and technology dissemination in Africa, Latin America and the U.S.

2a. Synthesis and Update Study on the Adoption and Impact of CRSP's Bean Improvement Efforts in the LAC Region.

The general objective of the study was to assess the *ex post* impact of Bean Cowpea (B/C) and Dry Grain Pulses (DGP) CRSP investments in research, institutional capacity building and technology dissemination in Latin America, focusing on Honduras, Guatemala, El Salvador, Nicaragua, Costa Rica, and Ecuador. To achieve these objectives, a rapid appraisal methodology was used: five types of bean sector key informants were interviewed and secondary data were collected from FAOSTAT and National Statistical Offices (NSO) in each country during 2010. A total of 67 key informants were interviewed and the data were analyzed using Excel and STATA. Adoption levels were estimated using (a) estimations of bean experts and (b) seed distribution / sales data. Key informants provided research cost data. To estimate the magnitude of the effect of using improved varieties (IVs) vs. traditional varieties, key informants provided estimations of yield loss averted by farmers when planting improved seed. In addition, experimental data are being analyzed to estimate yield gains over time.

As part of the impact evaluation methodology, several bean samples from three markets in Tegucigalpa were collected and sent to CIAT for evaluation of the presence of the *bgm-1* gene, which, if present, would confirm that the seed came from an IV. In addition, control samples (with known proportions of IVs and traditional varieties' seed) were included in the sample to test the accuracy of the results. This method could potentially generate information about the share of IVs sold in these markets.[2] The results suggest that, in order to be able to successfully use this technique, more research needs to be done since, as Figure 4 shows, the differences in the results of the analysis of the control samples (i.e., samples of IV provided by Dr. Rosas) and the *bgm-1* test conducted at CIAT were large. It was expected that, on average, the control samples would have 50% of the seed with the *bgm-1* gene; however, the results from CIAT estimated that 82% of the seeds in these (control) samples had this gene; thus, overestimating the share of IVs in the samples. Therefore, using this methodology in a larger scale was not pursued since the results would, most likely, overestimate the presence of the *bgm-1* gene.

[2] Since the samples were collected during one weekend, these results can not be used to make inferences regarding the adoption of IV's in Honduras. Ideally, grain samples should have been collected over the year to obtain a representative sample of grain that would allow making valid inferences.



As mentioned, bean production and trade data from two sources were analyzed. The differences between FAO vs. NSO data were small (although in a few cases statistically significant) for bean planted area, production, and exports. However, for El Salvador, Guatemala, and Ecuador, the differences between these two sources of data were statistically significant for bean imports. The data suggest that among the six countries, only Nicaragua (the largest) and Ecuador were net bean exporters.

Although all breeding programs have the same research priorities they had 20 years ago, the work in these areas has intensified and the programs have incorporated a few new research priorities. In Central America, new priorities include selecting for resistance to other biotic (e.g. Web Blight, ALS) and abiotic (e.g. droughts) stresses and high nutritional value. In contrast, in Ecuador, new priorities include research on climbing beans, additional market classes, and processing properties (for canned beans). Furthermore, in 2010, although Zamorano's breeding program in Honduras, ICTA's breeding program in Guatemala, and INIAP's breeding program in Ecuador were making crosses, only Zamorano's bean program was supplying lines to other bean programs in Central America. This highlighted the high dependence of the Central American programs on Zamorano. The main reasons why the other bean programs don't do crosses included a lack of (1) funds, since doing this activity is expensive, and (2) trained staff.

In 2010, a little more than one-half of the bean programs used molecular markers during the breeding process. Furthermore, more than two-thirds were implementing participatory breeding, which demonstrated the increased collaboration between scientists and producers (Table 2).

Table 2. Degree of farmer participation during the breeding process. 2010.

Country	Program Name[1]	Does PB?[2]	If NO, Why not?	If YES,[2] Does PPB?	Does PVS?	# groups doing PB in 2005	# groups doing PB in 2010
Costa Rica	INTA-CR	YES		Rarely	YES	6	6
Ecuador	INIAP	YES		Rarely	YES	4	6
El Salvador	CENTA	YES		NO	YES	0	3
Guatemala	ICTA	NO	Only include farmers in acceptability trials; no connections with farmer groups.				
Honduras	DICTA	NO	Lack of time and staff				
Honduras	Zamorano	YES		YES	YES	15	15
Nicaragua	INTA	YES		NO	YES	40	40

Sources: DGP CRSP Key Informant Interviews (2010a).

[1] All programs except Zamorano's are government programs.

[2] PB = Participatory Breeding; PPB = Participatory Plant Breeding; PVS = Participatory Varietal Selection.

The bean programs had between two and four sources of funding. As expected, the program with the most funding was Zamorano's, followed far behind by INIAP's and CENTA's. In contrast, DICTA's bean program had the least funds available for bean research (Table 3). Furthermore, while INTA-CR's[3] three sources of funding have all increased over time, all of DICTA's funding sources have decreased over time. Clearly, the financial stability of Zamorano's bean program has allowed it to provide the necessary germplasm for the region's bean programs (i.e. regional nurseries) and to assist them in other research areas.

On average, each bean program was collaborating with six institutions in research-related activities. The main factors that have positively affected this collaboration include: (1) common research interests; (2) a constant flow of funding; (3) the availability of good personal and professional relationships; (4) the availability of good materials (i.e. varieties); and (5) the availability of trained human resources and access to experts' technical assistance (e.g. INIAP-MSU relationship). However, several factors threat future collaboration, including: (1) institutional instability regarding the continuity of staff and the focus of the research; (2) a lack (discontinuity) of funding; (3) a high dependence on Zamorano for germplasm; and (4) donors' lack of interest in the region overall (Central American case).

[3] The cost data presented only reflects INTA-CR's budget. It excludes the budget of the University of Costa Rica and other members of the PITTA-Frijol network. Thus, these budget data greatly underestimates Costa Rica's investment in bean research.

Table 3. Bean programs' funding in 2010.

Country	Program Name[1]	Total # of sources of funding	Total USD funds available in 2010	% of sources of funding that have: Decreased	Remained constant	Increased / New funds	Total USD includes salaries?
Costa Rica	INTA-CR	3	23,000	0	0	100	NO
Ecuador	INIAP	3	72,000	33	33	33	NO
El Salvador	CENTA	3	52,200	33	33	33	NO
Guatemala	ICTA	4	39,658	0	25	75	YES [2]
Honduras	DICTA	2	5,992	100	0	0	NO
Honduras	Zamorano	3	215,339	0	33	67	YES [3]
Nicaragua	INTA	4	35,500	25	75	0	NO

Sources: DGP CRSP Key Informant Interviews (2010a).

[1] All programs except Zamorano's are government-sponsored programs.

[2] Only includes the salary of one of the researchers, excludes all other salaries.

[3] Excludes salary of breeder, but salaries of all other staff are included.

In 2010, there were a total of 124 people (76% permanent and 24% temporary) working on bean-related activities in these programs--approximately 90% were male and on average, these staff devoted 72% of their time to bean-related activities. The programs with the highest percent of (total) female staff were Zamorano's (25% female) and INIAP's (19% female). In contrast, none of CENTA's or DICTA's staff was female. In 2010, INTA had the highest number of permanent staff (total and bean time-equivalents) and DICTA had the lowest number of permanent staff working on bean research (Figure 5). Furthermore, among all staff working on bean research, almost 54% had earned a bachelor's degree, which proves that the quality of the human resources in these programs is high.

While job stability and collaboration with other institutions have strengthened the bean programs, the size of the staff and small budget were the major weaknesses of these programs. Furthermore, the major threats to the programs' success included the difficulty of renewing personnel (especially program leaders who will soon retire) and the possibility that collaboration with other institutions could be interrupted.

Although 99 IVs were released in the six countries between 1990-2010, several varieties were released in more than one country. Thus, 85 unique bean IVs were released during the period, most of which were small red (N=46), followed by black (N=13), and red mottled (N=10) varieties. Furthermore, 53% of the 85 IVs were developed using direct or indirect CRSP funding. While Ecuador was the country with most IVs released (N=26) during the period, El Salvador (N=9) and Guatemala (N=9) released the fewest IVs. While El Salvador has released half of its IVs after 2000, Guatemala has not released any new IV since 1998 because the government cut its support to the bean program in 2002.

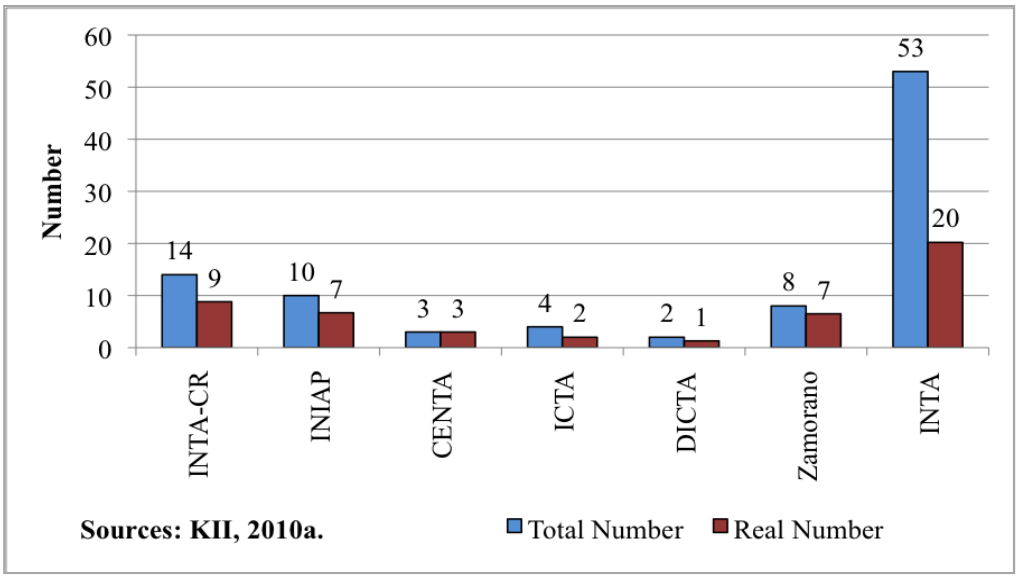


Fig. 1b

Fig. 1a

While farmers could access certified seed in most countries, in Ecuador and El Salvador, alternative seed types exist because the cost and requirements needed to certify seed make it impractical to produce certified seed. Since purchasing seed is expensive (regardless of the type), alternative ways of making high-quality, low-cost seed available to farmers are necessary. In Costa Rica and Nicaragua, the bean programs are already promoting the production of alternative (low cost) types of seed.

In four of the six countries, the governments have implemented free or subsidized seed-distribution programs, which have greatly contributed to increasing the adoption rates. However, some of these programs are distributing low-quality (see Figure 6) seed and have transparency

problems. Thus, there is a need to invest resources in guaranteeing the quality of the seed that is distributed through these programs. Furthermore, the existence of these programs (which are unsustainable in the long term) may discourage farmers from purchasing seed and has created artificial seed markets (i.e. bubble markets). Moreover, farmers who produce seed for these (government) programs complained that it take months for them to get paid after they deliver the seed to these programs.

Bean experts (key informants) estimated that in the 09/10 AY, on average, 54% of the bean area was planted to IVs. In contrast, seed production data suggest that, on average, only 19% of the bean area was planted to IVs. Furthermore, both the expert's estimations and seed data suggest that Guatemala had the lowest adoption rates. In contrast, while expert estimates suggest that Nicaragua had the highest adoption rate (80%), seed data suggest that Honduras has the highest adoption rate (37%). It is suspected that expert's estimates of the adoption rates in Nicaragua are overestimated. Seed production data suggest that *Amadeus 77* was the most widely-planted IV in the region--approximately 52,520 ha or 6.8% of the total bean area in the Central American countries[4] was planted to this IV in 2010.

Bean experts estimated that the most important biotic stresses affecting the bean crop were Web Blight (WB), Angular Leaf Spot (ALS), Bean Golden Yellow Mosaic Virus (BGYMV), and Common Bacterial Blight (CBB). Among these, the former two stresses are important in all countries and the latter two are important in four of the six countries. While BGYMV was not a problem in Costa Rica and Ecuador, CBB was not a problem in Costa Rica and Nicaragua. For Web Blight, bean researchers estimated that in a typical year, on average,[5] farmers could lose 77% of their production if they planted susceptible varieties vs. only 40% if they planted resistant IVs, representing a 37% production loss averted by planting resistant IVs. For ALS, on average,[6] farmers could lose 33% of their production if they planted susceptible varieties vs. only 23% if they planted resistant IVs.

Similarly, on average,[7] farmers could lose up to 78% of production to BGYMV if they planted susceptible varieties vs. zero percent if they planted IVs. Finally, on average,[8] farmers could lose up to 29% of their production to CBB if they planted susceptible varieties vs. 21% if they planted resistant IVs, representing an eight percent production loss averted planting resistant IVs (Table 3). However, bean experts reported that, during the last ten years, there have been no major outbreaks of these stresses.

Although there were no abiotic stresses common to all countries, key informants reported that intra-season drought was the most important factor affecting the bean crop in three of the six countries (i.e., Ecuador, Guatemala and Nicaragua). In contrast to biotic stresses, outbreaks of abiotic stresses are more common. For example, intra-season drought was a serious problem, on average, in one of the last ten years. Bean researchers estimated that in a typical year, on

[4] Sum of area planted in Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua.
[5] Average excludes Costa Rica because the bean breeder couldn't estimate the share that could be lost to Web Blight if farmers planted susceptible varieties (thus, N=5).
[6] Average includes all countries (i.e. N=6).
[7] Average excludes Nicaragua because the bean breeder couldn't estimate the share that could be lost to BGYMV if farmers planted susceptible varieties (thus, N=3).
[8] Average includes all countries where CBB is important (N=4).

average,[9] farmers could lose up to 64% of their production due to intra-season droughts if they planted susceptible varieties vs. only 17% if they planted resistant IVs, representing a 47% production loss averted by planting resistant IVs (Table 4). Although there were outbreaks of drought during the last ten years, breeders could not estimate the share of production lost to this stress in these special cases. Thus, one can only assume that, during years with severe inter-seasonal drought, production losses are greater than during a typical drought year.

Table 4. Production lost (%) to the most important biotic and abiotic stresses when planting susceptible vs. resistant varieties. 2010.

	Average production lost (%) with […] varieties		Production loss averted (%) when
Most important stress [1]	**Susceptible**	**Resistant**	**planting IVs [2]**
Biotic:			
Web Blight	77	40	37
ALS	33	23	10
BGYMV	78	0	78
CBB	29	21	8
Abiotic:			

Currently, experimental data is being analyzed to estimate yield gains associated with IVs released since 1999. Furthermore, adoption curves are being estimated for the most widely-adopted IVs in each country. Using the above information, within the next month, the graduate student in charge of this study will be able to estimate the economic impact of bean research in these countries.

[9] Average includes all countries where intra-season droughts are a problem (i.e. N=3).

Intra-season Droughts	64	17	47

Sources: DGP CRSP Key Informant Interviews (2010a).

[1] ALS = Angular Leaf Spot; BGYMV = Bean Golden Yellow Mosaic Virus; CBB = Common Bacterial Blight.

[2] Difference in production loss by planting susceptible vs. resistant varieties.

2b. Global Contribution of CRSP to Genetic Improvement of Common Bean (Including the U.S., LAC and SSA)

The CRSP varietal database described under objective 1a was assembled to make an inventory of varietal outputs in major bean producing countries around the world. This database includes 525 varieties (some may be multiple releases of the same genetic material in different countries) identified from literature review and personal contacts with bean breeders from the CRSP community and CIAT. The database includes the name of the variety, country of release, year of release, releasing institution, parental line, characteristics, and other observations/notes. Unfortunately, we could not collect information on all the variables for all the 525 varieties. For the CRSP funded varieties, the information is more complete than the non-CRSP varieties. Also, for varieties releases in LAC and North America, the data is more complete than for varieties released in SSA.

Due to early and pre-matured departure of the graduate student from MSU who was going to lead this study as a thesis research, this study has not progressed as planned. We plan to use the data and information gathered thus far to do a descriptive analysis of the database and use the information as an input in the meta-analysis study planned in FY 12.

2c. Benefits of Genetic Improvement of Cowpea in Senegal and West Africa.

Study in Senegal: Two main activities were commissioned during the reporting period:

1. A field survey to identify the current extent of adoption by farmers in Senegal of improved cowpea varieties developed under the Bean/Cowpea (now Dry Grain Pulses) CRSP. This survey was implemented by the Directorate of Analysis, Forecasting, and Statistics (DAPS) of the Ministry of Agriculture.
2. Collection of information on improved cowpea seed production and dissemination system, the costs of seed distribution activities, and the advantages (in the form of enhanced yield, quality, reduced yield variability, etc.) of improved cowpea varieties relative to traditional varieties, in order to estimate potential economic benefits of adoption of CRSP varieties. This phase of the study was carried out by Ms. Josiane Diatta, a master's student attached to the ISRA research station at Bambey

Both of the above activities were focused on the three principal regions and departments in which CRSP-produced cowpea varieties have been disseminated. These regions are Diourbel, Louga, and Thiès. The sample for survey consisted of two groups: (1) farmers interviewed during the 2010 nationwide DAPS survey who indicated that they used "improved seed" for cowpea (781); and (2) an additional sample of 584 households drawn randomly from the same survey enumeration areas, sufficient to give a total of 7 households per local enumeration area. These households were interviewed in March/April 2011. Of the total intended sample of 1,365 households, 72 were not covered, giving an actual total sample of 1,293 households. Questions asked of both sets of farmers included:

1. Name of improved cowpea variety planted.
2. What was the source of the seed?
3. Why was this variety used?
4. When was the first time the farmer used that variety?
5. Was cowpea planted in pure stand or intercropped?
6. If intercropped, what percentage of the field is in cowpea?
7. What do you believe are the advantages (drought resistance, disease or pest resistance, yield increase) of the improved variety relative to unimproved or traditional varieties?
8. How much cowpea did the farmer harvest from the plot (where improved variety was grown) last season in:
    a. Green pods
    b. As grain
    c. Any other form (i.e., fodder for animals)
9. What variety or varieties of cowpea do you intend to plant next season?
10. Reason(s) for choice of varieties to plant next season.

Delays in survey implementation and data entry resulted in delivery of the final data set in early August, rather than June as planned. Subsequent review of the data files revealed missing data. Issues involved are being compiled, and will be referred to DAPS staff in Senegal for assistance in further cleaning and recovery of missing data.

The second part of the study, carried out by Ms. Diatta, was implemented in May and June. The terms of reference for the draft report were:

<u>TOR 1: To gather information on the production and dissemination of improved cowpea seed, and the costs of these activities. Specifically:</u>

1. Description of the cowpea seed system in Senegal
2. For the three main CRSP varieties—Melakh, Mouride and Yacine—document the seed multiplication and distribution efforts in the past 5 years (or more if possible).
3. Interview each of the organizations identified in 2 to collect the following information:
    a. Their name, location, type of organization
    b. How long have they been involved in cowpea seed production/dissemination system
    c. Do they produce/distribute seeds of other crops (if so, list).
    d. What role did they play in the cowpea seed production and dissemination
    e. How much cowpea seed and what variety of cowpea seeds have they produced/disseminated in the past 5 years
    f. What type of cowpea seed was produced/multiplied –e.g., foundation, certified, quality declared, registered, etc.)
    g. How do they produce seed – for e.g., contract seed growers or other NGOs, produce on their own farms/fields, etc.
    h. To whom (i.e., geographic locations, farm communities) did they distribute the seeds?
    i. What method was used to distribute the seed (e.g., free distribution, sold to a private seed trader or sold directly to farmers, etc.)
    j. If seeds were sold, at what price were they sold?
    k. What are the organization's costs of producing and disseminating cowpea seeds?

l. Name of other organizations/groups/companies producing cowpea seed in Senegal
m. Opinions:
   i. What factors have contributed most to farmer adoption of improved cowpea varieties?
   ii. Are there any weaknesses in the cowpea seed distribution system that limit making high-quality seed available to small farmers?
   iii. What could be done to increase farmer adoption of improved cowpea varieties?
   iv. What factors could contribute most to strengthening the cowpea seed production system in Senegal?

TOR 2: To gather information on the advantages (in the form of enhanced yield, grain quality, reduced yield variability, etc.) of improved cowpea varieties relative to traditional varieties, in order to estimate potential economic benefits of adoption of CRSP varieties. Specifically:

1. Information from reports on experiments conducted on research stations or in farmers' fields
2. General information on cowpea seed planting practices at farm level.

Computer and other difficulties experienced by Ms. Diatta resulted in a delay in report preparation. The draft report was received in mid-September. The draft report is relatively complete with respect to TOR 1, but contains little related to TOR 2. This will need further attention during the next few months.

2d. Review and Assessment of Bean/Cowpea And Pulse CRSP Investments in Value Addition and Food Science Research.

Over the past 20 years, the predecessor Bean/Cowpea CRSP has made substantial investments in food science research with the aim of developing new value added products to benefit both producers of beans and cowpeas in terms of more market opportunities and consumers in the form of convenient and nutritious food products based on beans and cowpeas. To a lesser extent investments in this line of research has also continued in the new Pulse CRSP. Despite long-term investments, this type of research has not generated the same level of outputs, outcomes and measurable development impacts as investments in crop improvement research. Thus, not surprisingly, there are hardly any studies that try to document impacts of food science research on value addition. The only study conducted on this topic in the CRSP program as confirmed by the impact assessment database mentioned under objective 1b was by Tomokazu Nagai a few years ago. The results of that study basically confirmed the lack of significant impact of research on value-addition in Ghana. The lack of evidence of impact of value addition research has repeatedly raised the question—what is the value of investments by a CRSP program on food science and nutrition research?

To address this question, this project undertook a review of past and current research conducted by the Bean/Cowpea and Pulse CRSP on value addition and food science, and documented all the outputs, outcomes and impacts from such investments. The review included CRSP reports of relevant projects/components in the past 10 years, literature search using keywords (for bean and cowpea based products and research outputs identified from the CRSP reports) and authors (i.e., PIs) associated with past and current CRSP projects on food science and nutrition research. A comprehensive list of all the CRSP research activities and outputs generated from investments in

food science, food technology and human nutrition research since 1997 that fall in the four categories described in Table 5 was compiled by the project team. Principal investigators of relevant CRSP projects (i.e., led by UGA, Purdue, Texas A&M, and MSU) were contacted to enquire about the status and updates on the uptake or adoption of any outputs their research had generated in the past (esp., in categories 2 and 3--improved processing and storage technology and new bean or cowpea based food products/ingredients). However, this enquiry did not lead to any new or encouraging information on the commercial application of research outputs generated from CRSP research projects or evidence of their use/utilization by various actors in the value chain (i.e., processors, traders, consumers).

This investigation thus confirmed the lack of documented evidence of 'adoption', 'uptake' and utilization of outputs of food science research by participants in the bean and cowpea value chains in host countries (or even in the U.S.). It should be mentioned that the research in food science and human nutrition has generated many publications and scholarly outputs both in peer reviewed venues and in the form of theses and dissertations. This speaks of the high quality of scientific research underlying the CRSP supported projects. However, the question still remains as to what is the value addition of food science research in the Pulse CRSP portfolio? We have been informed that the TMAC is planning to develop a 'white paper' on the contribution of food science research. Based on the review of past efforts conducted by this team thus far and the anticipated white paper, as a next step, we will identify factors that were present / absent in the pathway of identified research outputs to better understand why past investments were not successful in generating impacts. The goal of this exercise will be to derive lessons for guiding future investments by the CRSP in this line of research.

Table 5: Major categories of food science and human nutrition related research conducted by the Bean/Cowpea CRSP and examples of research outputs generated

Categories	Examples of research outputs
1. Analysis of chemical, functional, and nutritional characteristics of processed bean/cowpea products	• Determine protein quality and protein digestibility-corrected amino acid score and the iron and zinc bioavailability of black bean-rice-based products processed by either microbial fermentation or germination • Determine the extent of decrease in oligosaccharide content of dry beans achieved with fermentation the beans, and the acceptability of bean-rice weaning food made with fermented • Development of a method for evaluation of cooking properties of cowpeas • Effect of hard-to-cook phenomenon on cooking and physicochemical characteristics of cowpeas
2. Improvements in the technology of bean/cowpea processing and storage	• Artisanal processing of cowpeas in Nigeria • Hydrothermal processing of dry (unsoaked) cowpeas • Hydrothermal treatment of whole seeds - its impact on storage stability and food quality • Effect of tempering/pre-conditioning in a solution of monovalent cations and micronization on cooking characteristics of hard-to-cook cowpeas
3. Development of processed bean/cowpea products	• Developing and evaluating consumer acceptability of cowpea-fortified gari and cowpea-fortified fermented corn flour • Creation and testing of weaning foods • Develop a bean-based food with a stable shelf-life to be eaten in a non-traditional way • Develop nutritious, highly acceptable bean-based granola bars and cereal • Developing extruded /expanded snack/ convenience foods • Low-cost, fortified supplementary foods from locally available ingredients • Modifying/adapting traditional cowpea-based foods • Nutritious convenience/snack foods
4. Consumer/producer and demand analysis of processed bean/cowpea products	• Assessment of consumer acceptance of bean ingredients and products • Assessment of potential demand for cowpea-based processed products in West Africa • Bean use patterns and preferences of farmers • Consumer acceptability of cowpea-fortified gari and cowpea-fortified fermented corn flour at the institutional level • Consumer acceptance, nutritional value and economic potential of bean based ingredients and products • Cowpea flour production and use in Benin

<u>Objective 3:</u> Investigate opportunities to integrate baseline data collection and impact evaluation strategies as part of the CRSP project design.

As described under the impact pathway analysis activity described in 1b, CRSP investments in "research for development" (R4D) fall across the wide spectrum of activities ranging from basic/fundamental research to applied/adaptive research to technology transfer. Since resources to conduct research are scarce, many CRSP projects on the applied end of the R4D spectrum are pilot scale initiatives and programs designed to test the efficacy and effectiveness of a science-based intervention in a developing country setting with the aim of deriving lessons on what works and what doesn't. Such applied field based research initiatives are undertaken and supported by the CRSP with the goal of identifying the most effective strategy/models which can then be scaled up to achieve developmental impacts. For a research project to be successful in

achieving this goal requires some forethought on the design of field activities and a strategy for collecting appropriate data or making use of available data. The purpose of such strategizing is to make sure that at the end of an intervention/activity, opportunity to assess the cause-effect relationship between a research project and indicators of outcomes/impact is not lost. This is the underlying goal of "impact evaluation" research in the context of development projects.

Towards implementing an integrated impact evaluation strategy as part of the CRSP project design, the lead PI of this project interacted with several PIs, especially those directly related to technology transfer interventions to explore opportunities and feasibility of conducting impact evaluation research. Four such opportunities for data collection and investigative research with the aim of addressing questions of what works, where, why and why not, were identified and included as part of the Workplan for FY 2012. The research underlying these four proposed activities will be conducted in close collaboration with the respective CRSP project PIs. These activities, to be jointly conducted to address the impact evaluation questions, include:

1. Baseline assessment of the economic effects of pest problems on cowpea growing areas in Burkina Faso (with PII-UIUC-1)
2. Impact evaluation to test the effectiveness and impacts of methods of extension to disseminate materials for IPM of cowpea pests (with PII-UIUC-1)
3. Benefit/Cost (B/C) analysis of the bean-based nutrition intervention in Tanzania (with PIII-MSU-3)
4. Case study of the bean seed multiplication and distribution system in Central America (with host country partners in Nicaragua participating in the CRSP Associate Award)

Objective 4: Build institutional capacity and develop human resources in the area of impact assessment research.

Although this project does not include a host-country partner as in other CRSP projects, it does address the objective of institutional capacity building and human resource development through following methods:

1. Field activities under objective 2 were conducted in collaboration with HC PIs and partners.
2. Activities under objectives 1 and 3 are conducted in close collaboration with the U.S. and HC PIs from existing CRSP projects.
3. The activities planned under this project involved four graduate students in the planning and conduct of field research. These students were recruited from within the Department of Agricultural, Food and Resource Economics at MSU as research assistants (and not as participant trainees). They include:
    a. Byron Reyes, a citizen of Ecuador
    b. Nelissa Jamora, a citizen of the Philippines
    c. Ben Megan, a citizen of USA
    d. David deYoung, a citizen of USA

Explanation for Changes

Objective 2b will not be achieved as planned because of the early departure of Nelissa Jamora from MSU to pursue her Ph.D. degree at another institution.

Networking and Linkages with Stakeholders
None to report in FY11

Leveraged Funds
$6000 -- Dissertation Completion Fellowship from the College of Agriculture and Natural Resources, MSU for Byron Reyes

Scholarly Activities and Accomplishments
Maredia, M.K. 2011. M&E and Impact Evaluation of Agricultural Research: Challenges and Best Practices. Presentation made at the USAID/USDA/APLU organized "Feed the Future" Planning Workshop, Purdue University, January 12-13, 2011.

In April 2011 Richard Bernsten (co-PI of this project) received *The Ralph H. Smuckler Award for Advancing International Studies and Programs at MSU***,** The award recognizes and rewards a faculty member each year for his/her significant and lasting impact on the advancement of international scholarship, teaching, and public service.

Reyes, Byron. 2011. "Economic Impact Evaluation of Improved Bean Varieties in Central America." Presentation made at the Symposium "Diminishing Latin America's Inequalities: Land, Food and Human Health Strategies" April 2011. This symposium was organized by the Center for Latin America and Caribbean Studies at MSU.