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Staff Paper

**Impacts of U.S. Graduate Degree Training on Capacity
Building in Developing Countries:
A Case Study of the Pulse CRSP**

by

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ABSTRACT

The Dry Grain Pulses Collaborative Research Support Program (Pulse CRSP) had allocated a major part of its resources to providing graduate degree training (GDT) of scientists/researchers in order to strengthen agricultural research capacity in Africa, Latin America, and the U.S. However, no systematic attempt had been made to assess the impact of this investment.

The study adopted the Kirkpatrick framework as a guide for evaluating the impacts of GDT by the Pulse CRSP. The results were drawn from a survey of former trainees and researchers, supplemented by interviews with scientists and program administrators and an institutional case study.

An important finding was that over 86% of host country trainees returned to their home country. In their enhanced capacity, trainees made contributions to the advancement of bean/cowpea research that can be attributed to their graduate degree training. Trainees reported that their GDT was necessary for their professional development and was highly relevant to their current job responsibility.

Keywords: impact assessment, Pulse CRSP, USAID, training, graduate degree, beans, cowpeas

I. INTRODUCTION

Through funding from the U.S. Agency for International Development (USAID), the Dry Grain Pulses Collaborative Research Support Program (Pulse CRSP)¹ was established in 1980 to generate technologies and enhance the knowledge base necessary to achieve substantial improvements in addressing the constraints to bean and cowpea production, consumption, and utilization. This was to be achieved by enhancing the capabilities of host country (HC) scientists and research institutions to relax constraints related to bean and cowpea production and consumption. Thus, the CRSP² has allocated a major part of its resources (US\$ 2.55 million or 21% of total budget from 2002 to 2006) to training scientists and researchers from selected universities and national agricultural research organizations in Africa and Latin America.

To date, the contribution of these trainees and the impact of the CRSP training model on institutional capacity building have not been systematically documented. Thus, the purpose of this study is to evaluate the impacts of the graduate degree training (GDT) on trainees and on universities/research institutions in HCs--both from the perspective of the individuals who earned graduate degrees with CRSP funding and the United States (U.S.) scientists who mentored the trainees. The study used the Kirkpatrick framework, as a guide in evaluating training impacts from four different perspectives: Reaction (trainees assessment of his/her training), Learning (what the trainee learned), Performance (how the trainees applied what he/she learned), and Results (impacts on the institution/society) (Kirkpatrick, 1998). Impact on trainees includes any changes in their personal and/or professional lives as a result of their GDT. Institutional capacity building involves improvements in the ability of an organization to perform its teaching and research mandate effectively, efficiently, and sustainably.

The results reported in this study are based on the analysis of questionnaires returned by 76 former trainees and 25 former and current U.S. principal investigators (US-PI, scientist who served as the trainees' faculty advisors), supplemented by face-to-face interviews with former trainees and CRSP collaborators and a case study in a developing country institution.

II. BACKGROUND

The methodology used in this study is influenced by recent assessments and evaluations of graduate training programs, several in the area of agricultural development. These include the evaluation of training and capacity building by the Consultative Group on International Agricultural Research (CGIAR) (Stern et al., 2006), the Advanced Training for Leadership and Skills Project/ African Graduate Fellowship Program (ATLAS/AFGRAD), the Fulbright Student Program (Gilboy et al., 2004), training programs supported by the International Livestock Research Institute (ILRI) in Kenya and Ethiopia (Eley et al., 2002), and the International Rice Research Institute (IRRI) (Raab et al., 1996). These studies varied greatly in terms of the time period covered, sample size, and methodology (Table 1). In terms of magnitude, the ATLAS/AFGRAD and the Visiting Fulbright Program studies obtained responses from 1,921

¹ Formerly the Bean/Cowpea CRSP

² 'Pulse CRSP' and 'CRSP' are used interchangeably throughout the paper.

(60% response rate) and 1,609 (70% response rate) of the former trainees, respectively. The ILRI study was unique in that it extended the analysis to include trainees' supervisors to gain a more comprehensive picture on the impact of training. Both studies adopted a modified Kirkpatrick model as a methodological framework. The CGIAR study was especially comprehensive, as it looked beyond the impacts of training on the individual to include the capacity-building impacts of training on national research institutions. The Fulbright program, of which the Fulbright Student program is one component, is remarkable in that it is funded by the U.S. government for more than US\$200 million a year. Key findings of these studies included the importance of non-technical competence and non-monetary benefits that trainees gained, including critical thinking and research skills, as well as increased prestige, self-confidence, and changes in their work attitudes.

The Pulse CRSP Training Program

From 1981 to 2005, the CRSP supported a total of 496 students, who earned 554 academic degrees (an average of 22 degrees per year) in the fields of plant science, food science, and social science at universities in the U.S. and HCs. The CRSP GDT exemplifies one of the models of university engagement in long-term training (Figure 1). A salient feature of the model is that the degree training is an integral part of CRSP-supported collaborative research projects -- both in the U.S. and at HC universities. However, this study focused on the graduate degree training (M.S./Ph.D.) component that occurred in the U.S., which is only a subset of the over-all CRSP training program. In addition to U.S.-based graduate training, the CRSP supports B.S., M.S., and Ph.D. degree training in HCs and short-term non-degree training in the U.S. and HCs.

In the CRSP model, collaborators (i.e., U.S. and HC scientists) identify the trainees, based on the HC training needs and university admissibility criteria. Training occurs under the direct supervision of the US-PI, which ensures that the training directly contributes to the CRSP's research goals and objectives, as well as to institutional capacity building in partner host countries. The trainees' involvement in CRSP research also fosters the student-mentor relationship between the trainee and his/her university professor, which leads to a continued collaborative research relationship between the U.S. and the HC institution after the formal training program is completed. In many cases, the integration of training with a professor's ongoing research program leads to cost-leveraging (e.g., reduced tuition costs, reduction in overhead costs and/or partial support from other sources to fund the trainee's thesis research costs).

While training per se does not automatically lead to institutional capacity building, it is one of the cornerstones of organizational capacity development. Horton, et al. (2003) referred to organizational capacity as the "resources, knowledge and processes employed by the organization to achieve its goals". GDT contributes to capacity development by selecting highly qualified individuals for training and through the application of their knowledge, skills and attitudes upon completing their GDT.

Table 2 illustrates the salient features of the CRSP training model, which is significantly different than the training programs supported by donors, discussed in the previous section. By

recruiting trainees based on the demand of CRSP projects, the training program provides internal synergies and support for accelerating changes in targeted research institutions. Also, the CRSP model posits that targeting individuals from collaborative institutions increases impact and helps sustain capacity-building. In most cases, trainees are working on a bean/cowpea-related topic prior to beginning GDT and are recruited based on the recommendation of U.S. and HC principal investigators who are collaborating in CRSP research projects. This training strategy enhances continued collaboration with CRSP scientists after trainees complete their CRSP-funded degree training. Moreover, it facilitates the alignment of the research program with the selection of trainees and in planning their respective programs of study.

III. METHODOLOGY

Evaluation is the means used to determine the worth or value of a training program. It serves as a guide for deciding how to improve a training process or in deciding whether or not to continue it. This assessment study mainly employs Kirkpatrick's evaluation framework, one of the most widely-used models for evaluating training. First published by Donald Kirkpatrick in 1959 as part of his dissertation, Kirkpatrick later redefined and updated his training evaluation model -- reaction, learning, behavior, results -- in his 1998 book, "Evaluating Training Programs: The Four Levels". The four levels actually refer to different perspectives, not levels, and are not hierarchical. Rather, each level evaluates a different aspect of training and answers different questions. Figure 2 depicts the analytical framework used to evaluate the Pulse CRSP graduate degree training program, which is based on the Kirkpatrick's modified training evaluation model.

Reaction refers to the participants' opinions about the training program. Learning refers to knowledge, skills, and attitudes (KSAs) that the participants gained from the training program. Performance refers to changes in the participants' behavior that could be attributed to the training program. Results evaluation refers to the impact of the training program on the performance of the organization.

A three-pronged approach is used to evaluate impacts of training (Figure 3). This study gathered data from three sources to assess impacts of training: (1) the trainees, (2) the US-PIs involved in the CRSP GDT program, and (3) individuals at a collaborating university in a developing country (as a case study).³

The target population for the trainee survey included all of the 187 trainees who completed their GDT in the U.S. during the period 1981-2005. However, because of difficulty in getting contact information for all trainees, the population frame was redefined as all trainees with valid e-mail addresses (N=126) for the following reasons. First, for trainees without e-mail addresses, no mailing address was available. Second, since all of the population earned graduate degrees in the U.S., it was assumed that they were computer literate and had access to the

³ The survey and evaluation were conducted by a group who were 'external' to the CRSP management office, but were internal to the CRSP program, in the sense that the study was funded by the CRSP and was led by one of the CRSP US-PI.

internet. Third, e-mail correspondence is the quickest, cheapest, and the easiest way to administer a survey.

The frame population, representing 67 percent of the target population, were e-mailed the trainee questionnaire between April to July 2006. The questionnaire solicited information regarding their assessment of the impacts of GDT on their personal and professional lives (Reaction and Learning) and on the institutions where they were working (Performance and Results Evaluation). Specifically, the survey instrument asked trainees about (1) their assessment of their graduate training program, (2) their professional history (i.e., current employment, employment before and after graduate training), (3) their reasons for returning (or not returning) to their home country, and (4) constraints to and suggestions for building institutional capacity in their home country.

In addition, a key-informant questionnaire was e-mailed to all CRSP US-PIs to validate and supplement trainees' answers to questions on Performance and Results Evaluation. The study attempted a complete census of the target US-PI population (N=31), defined as all current and former US-PIs who played a role in the GDT of a CRSP trainee -- either as major professor, thesis/dissertation adviser, or as member of thesis/dissertation committee. Although including the trainees' supervisors in evaluating training is not a widely-used methodology, recent work in the area of training impact assessment emphasizes the need for and importance of this type of feedback (Abernathy, 1999). It was anticipated that the trainee's supervisor and/or adviser would reveal a complementary perspective on training impacts. The US-PI questionnaire solicited information regarding the supervisor's (1) role in the CRSP, (2) assessment of the strengths/weaknesses of the CRSP graduate training program, (3) rationale for selecting trainees, (4) assessment of the trainees' contributions to bean/cowpea research, (5) collaborative research activities (i.e., between the trainee and the CRSP supervisor), and (6) assessment of constraints faced and suggestions for building institutional capacity in countries where he/she had worked.

Finally, an institutional case study was conducted at Sokoine University of Agriculture (SUA) in Tanzania in July 2006 to further document the capacity-building impacts of the CRSP-funded training. In addition to interviewing former trainees and collaborators at SUA, interviews were conducted with key institutional administrators to obtain an independent assessment of the contribution of CRSP-supported training to capacity building at the university.

IV. RESULTS AND DISCUSSION

A. Trainee survey

Table 3 provides an overview of the target population, frame population, and respondents. Seventy-six trainees (60%) returned the e-mail survey. More than one-half of the respondents were male (66%), from host countries (55%), and had specialized in plant sciences (61%). About 62 percent of the respondents were supported for Ph.D. degrees, while 46 percent were fully funded by the CRSP during their graduate study.

1. Reaction and Learning

a. Trainee assessment of graduate program and their CRSP research

Following Kirkpatrick's model, questions were included to determine trainees' general satisfaction with their GDT (Reaction). Almost all respondents considered their graduate program (97%) and CRSP research (99%) as interesting and challenging, that they received sufficient professional guidance from their CRSP supervisors (86%) and major professors (95%), that their graduate program (92%) and CRSP research (83%) was relevant to their current work/job responsibility, and that their graduate program (100%) and CRSP research (97%) provided excellent preparation for their future work.

b. Acquisition of KSAs

Trainees must first acquire the knowledge, skills, and attitudes (KSAs) from the training program before any impacts can occur. Questions were included in the survey to identify the KSAs that trainees acquired during training and determine any problems they encountered during their training (Learning).

Seventy-five out of 76 respondents identified at least one KSA acquired during their GDT (Table 4). Trainees considered the ability to "design/conduct/analyze scientific research" (87%) as the most important KSA acquired from their GDT. About one-half (51%) reported "analytical/critical thinking" in solving problems, followed by "scientific methods and tools" (47%). Nearly one-third of the respondents cited "language fluency and communication skills". Similarly, about one-third of the trainees identified "attitude towards work" as an important KSA.

To validate respondents' answers, trainees were also asked to select from a list of specific items how they applied the acquired KSAs. About two-thirds of the trainees said that they shared their KSAs through seminar/conference (70%), research supervision of students (66%), and publication (66%).

2. Performance and Results Evaluation

a. Employment Status

Eighty-eight percent of the respondents were currently employed, either full-time (84%) or part-time (4%). Almost all U.S. respondents were working in the U.S (97%) and most of the HC respondents were working in a host country (81%). The largest share of trainees worked at universities (44%). Most were doing research (84%), coupled with some administration/management work (40%), while some were teaching (29%) in conjunction with their other assignments. Forty-nine percent of the currently-employed respondents (69% of HC trainees and 23% of U.S. trainees) were still conducting research related to beans/cowpeas—typically in plant breeding/pathology. About 26 percent of the respondents reported that they supplemented their income from their primary job with outside consulting.

b. Impacts by degree

As it is usually at least twice as expensive to fund Ph.D. degree training, compared to M.S. degree training, it is sometimes argued that training funds should be prioritized towards funding M.S. students. This study recognized the differences in impact according to the graduate degree obtained.

Most of the M.S. respondents were from the U.S (61%), while most Ph.D. respondents came from host countries (60%). At the time the survey was conducted, about one-half of the respondents with Ph.D. degrees were working at a university (50%). The other half of the respondents with Ph.D. degrees were working for the government (23%), in the private sector (9%), or at an international organization (12%). In contrast, the M.S. graduates were working in the private sector (31%), for the government (25%), at a university (25%), and at an international organization (12%). Notably, most Ph.D. respondents (57%) were still active in beans/cowpeas-related activities, compared to only one-fourth of the M.S. trainees (24%). In addition, only 6 percent of M.S. graduates sought outside consultancy to augment their income from their principal job, compared to 32 percent of the Ph.D. respondents.

While Ph.D. training is more expensive than M.S. training, the study suggests that Ph.D. graduates might have a greater impact in the long-run. First, most CRSP-funded Ph.D. graduates secured an academic position at a university. Consequently, they serve as multipliers, training future generations of students. Second, M.S. trainees, who most often took positions in the private sector, seldom continued to collaborate with their CRSP supervisor. Finally, a higher percentage of Ph.D. graduates continued to work on beans/cowpeas.

c. Impacts by discipline

Fields of study are broadly grouped into three categories: plant science (PS), food science (FS) and social science (SS). As a majority of CRSP trainees were in the field of PS, it is not surprising that more than one-half of the respondents specialized in this field (61%). Most of the PS and SS respondents came from LAC and the U.S, while most FS trainees were from the U.S (69%). More than 60 percent of the FS respondents were female, while about three-fourths of the PS (70%) and SS (76%) respondents were male. Sixty-two percent of the FS trainees were fully supported, compared to 46 percent of the PS and 35 percent of the SS trainees.

When surveyed, the largest share of the PS (50%) and SS (40%) trainees were working at a university, while most of the FS trainees (46%) were employed in the private sector. Remarkably, more than one-half of the PS respondents (61%) were still active in beans/cowpeas-related research, compared to 41 percent of the SS and only 17 percent of the FS respondents. Furthermore, about one-third of the FS (33%) and PS (28%) trainees reported having outside consultancy projects, compared to 13 percent of the SS trainees.

d. Impacts by participant location

Since 1980, the CRSP has supported collaborative projects in LAC, ESA, WA, and the U.S -- the main bean/cowpea-consuming regions of the world. Where the trainees found employment after completing their GDT varied by location. Most U.S. (66%) and ESA (70%) respondents were working in universities, while the largest share of the LAC (45%) and WA

(35%) trainees were employed by the government. Overwhelmingly, most HC trainees (69%) were still active in beans/cowpeas research (74% LAC, 60% ESA, 67% WA), compared to only 23 percent of U.S. trainees. Furthermore, 31 percent of the HC respondents had outside consulting jobs (10% LAC, 56% ESA, 56% WA), compared to 19 percent of the U.S. trainees. To a large extent, these differences reflect where the trainee was recruited, as most trainees returned to the institution where they worked (e.g., university, NARS) prior to beginning their GDT.

e. Monetary impacts

Respondents were asked to estimate the annual salary (US\$) that they earned from their previous job (i.e., job prior to GDT), their first job after completing their GDT, and when surveyed. Prior to their GDT, a large share (64%) of the trainees earned less than US\$15,000 per year. At their most recent job during the time of survey, a majority (73%) of the respondents reported earning more than US\$15,000.

However, as the cost of living and the salaries differ widely, it is necessary to distinguish between salaries received by HC and U.S. nationals. When surveyed, the average salary of a U.S. trainee was double the average salary of a HC trainee. As expected, the acquisition of a graduate degree greatly increased trainees' salaries – both for U.S. and HC nationals – and differed greatly by academic degrees. Before GDT, a HC respondent with a B.S. degree earned about US\$9,000 a year. At their most recent job, HC respondents with M.S. degrees earned US\$21,000 a year, while those with Ph.D. degrees earned US\$35,000 a year. On the other hand, U.S. nationals with a B.S. degree earned about US\$19,000 a year prior to GDT. At their most recent employment, U.S. trainees with a M.S. degree earned US\$65,000 a year, while those with Ph.D. degrees earned US\$81,000 a year.

It is important to note that all of the difference between the salaries that the trainees earned prior to GDT, compared to their salaries at the time of the survey, cannot be attributed to training alone. First, salaries that trainees reported prior to GDT are for different years. Also, even if the trainees had not earned a graduate degree, their salaries would have increased due to additional time in service. Finally, trainees reported their salaries prior to and after GDT in nominal dollars. Thus, some of the increase in their salaries can be attributed to inflation.

f. Non-monetary Impacts

Respondents were asked to describe and give concrete examples of changes or impacts on their personal and professional lives that they could attribute to their CRSP-funded graduate degree. Sixty-four of the 76 respondents (84%) cited at least one positive impact of the GDT. With respect to changes on their personal lives, most of the responses cited improved financial status, greater self-confidence, an opportunity to learn a second language, and making new friends from outside their home country. Professionally, aside from the KSAs that they acquired from their GDT, trainees frequently reported that GDT was an important factor that enabled them to secure their desired job. In addition, the respondents noted that their GDT helped them to develop or widen their professional networks, particularly among beans/cowpeas scientists. Further, many U.S. trainees reported that as a result of having been involved in research in a developing country, they were able to broaden their perspective on agricultural development.

g. Achievements/Contributions

Respondents were also asked to describe their significant accomplishments -- especially those related to the bean and cowpeas sectors. This question sought to identify impacts of training beyond the individual level. Forty-three out of 76 respondents (57%) reported at least one bean/cowpea-related accomplishment. Significant accomplishments that trainees cited included their role in the release of improved crop varieties, awards or recognition received for their contribution to bean/cowpea research, papers published, and the important positions or jobs they held as a result of their GDT.

Research outputs from the trainees' CRSP-supported research (during their degree program) were also analyzed. Most of the M.S. and Ph.D. trainees published their research in journals/books (83% for Ph.D., 58% for M.S.) and also presented their research at a conference/seminar (89% for Ph.D., 76% for M.S.). As expected, this impact is greater for Ph.D.-supported trainees.

3. Return rate to home country

Brain drain is a matter of great concern to program administrators and donors, since the goal of capacity building in developing countries is not achieved if trainees remain in the U.S. after completing their training (UN Economic Commission for Africa, 2000). The questionnaire asked trainees if they returned to their home country immediately after the GDT and if not, where they went and why they did not immediately return to their home country. It is important to note that while some former trainees did not return home immediately, almost all eventually returned and were working in their home country or at another country in the region when surveyed.

Eighty-six percent of the HC respondents (36 out of 42) returned to their home country or found employment in another developing country after completing their GDT. Out of the six respondents who did not return, four stayed in the U.S. permanently and two are still in graduate school. Three trainees who remained in the U.S. cited having work opportunities or job offers in the U.S. as the major reason for not returning home after completing their GDT.

Most of the trainees who returned home earned a Ph.D. degree (89%) and specialized in plant sciences (89%). With respect to the return rate by region, all of the nine respondents from West Africa (WA), nine out of ten respondents (90%) from East and Southern Africa (ESA), and 18 of the 23 respondents (78%) from Latin America and the Caribbean (LAC) returned to their home country.

HC trainees who returned to their home country were also asked whether or not they returned to the same institution where they were employed prior to studying in the U.S. Out of the 29 responses, 23 trainees (79%) returned to the same institution -- mainly the government (36%) or a university (31%) -- and 72 percent were working in a bean/cowpea-related field. Furthermore, about one-half of the returnees (43%) were involved in a bean/cowpea-related organization (e.g., the Bean Improvement Cooperative) and 62 percent had collaborated with their former CRSP supervisor on at least one research project after completing their GDT. These results demonstrate that the CRSP GDT program has been successful in strengthening the

capacity of host countries to carry out bean/cowpea-related research. Moreover, 36 percent of the returnees found outside consulting opportunities to supplement their income from their primary job. Salary differences between jobs in the U.S. versus their HC may explain why some trainees choose to stay in the U.S. Forty-four percent of returnees were earning less than US\$15,000 per year, while three of the non-returnees (excluding the two trainees who are still in graduate school) reported earning more than US\$45,000 per year.

4. Continued collaboration with Pulse CRSP

This section analyzes the characteristics of respondents who did and did not continue to collaborate with a CRSP scientist (i.e., their U.S. GDT supervisor) after completing their GDT. Twenty-nine out of 74 (39%) trainees reported that they had collaborated with their supervisors at least once since completing their GDT. Most of these trainees were plant science graduates (76%) and from host countries (60%). In contrast, most U.S. trainees (29 of 34, 85%) reported that they did not collaborate with a CRSP scientist after graduation. However, as one trainee commented, non-collaboration does not necessarily mean that a trainee did not want to collaborate. In some cases, there are limited opportunities to collaborate, due to differences in career advancement, change in career priorities, and the difficulty of long-distance collaboration.

When surveyed, a majority of the trainees who had collaborated with a CRSP scientist at least once since completing their GDT were either employed by the government (38%) or a university (38%), whereas most of those who had not collaborated were either employed by a university (49%) or in the private sector (20%). Eighty-six percent of the trainees who had collaborated with their former CRSP supervisor were working on a bean/cowpea-related project. Furthermore, 55 percent of those who collaborated were associated with one or more bean/cowpea-related organizations.

B. Principal Investigator Survey

A complementary survey was sent out to US-PIs and other scientists who had supervised or supported at least one graduate student under the CRSP graduate degree training program. The results of the PI survey are based on information provided by 25 current and former US-PIs who returned the questionnaire. The PIs, who responded to the survey, matched 117 students with their respective supervisors and provided contact information for many 'lost' trainees.

The PIs were asked to describe the major constraints to institutional capacity building and propose suggestions for relaxing these constraints in up to three host countries where they had worked most intensively. The PIs most frequently cited (44 responses) administrative difficulties in dealing with host country governments (91%), particularly with regards to the bureaucracy and political uncertainty, insufficient funding (61%), very low wages in developing countries (30%), and poor level of infrastructure (43%). Regarding suggestions for strengthening capacity building, many PIs cited the need for greater funding to support training (26%) and research (35%). Almost all PIs (91%) explicitly cited the need to train more HC nationals, particularly at the Ph.D. level.

As US-PIs are primarily responsible for recruiting trainees, PIs were asked to identify the factors that influenced their decision to fully or partially support a trainee under the CRSP. The

primary reasons cited for fully supporting a trainee was because the individual was from a host country (31%) and that he/she could not pursue a graduate program without full funding (27%). The main reason PIs gave for partially supporting a trainee was because leveraged funds were available, either from the department (39%) in which the trainee was enrolled, or from an external source (25%), such as foreign scholarship or another research grant.

PIs were asked to identify bean/cowpea-related achievements or accomplishments of their former trainees. Many of the PIs (64%) reported significant jobs held by their former trainees, including positions such as ‘Dean’, ‘Department Chair’, ‘Director’, ‘Manager’, ‘Professor’. Several PIs cited specific research contributions (15%) (e.g., ‘*becoming the authority in bacterial disease research in Dominican Republic*’, ‘*contribution to the understanding of root rot mechanisms and the role of nitrogen fixation and bio-control agents in root rot control*’) and publications and awards that resulted from the trainees’ bean/cowpea-related research (6%).

Most of the PIs (79%) recognize the capacity-building impacts of GDT on the trainees and on the institutions where they were employed after completing their graduate study (Table 5) opportunities for future collaboration between the PIs and their former trainees (32%). Furthermore, the CRSP’s strong commitment to long-term training (42%) facilitated the recruitment of excellent students around the world, who are now distinguished agricultural scientists and research collaborators of the CRSP. In many instances, PIs noted that the CRSP supported both the trainees’ coursework and thesis or dissertation research (32%), which enabled the trainees “*to work on real problems and research topics relevant to the needs of the host country*”.

C. Institutional Impact Case Study

A case study was carried out to assess to what extent trainees had enhanced teaching and research capacity building at a partner HC institution and to document the kind of collaboration that had occurred between former trainees and U.S. and HC institutions. The institution selected for the case study was Sokoine University of Agriculture (SUA, in Tanzania). In partnership with the National Beans Research Program, SUA has a mandate to develop varieties, test lines, and conduct performance trials for the low altitude ecosystem (<1,000 meters). It also contributes and exchanges germplasm with other national bean program partners. CRSP scientists have collaborated with SUA’s faculty since 1981, when it is still part of the University of Dar es Salaam. While the program initially focused on plant breeding, its research focus expanded in subsequent years. An important question is -- what would have been SUA’s capacity to carry out teaching and research -- if the CRSP had not funded GDT for SUA?

Prior to 1980, very little bean research was conducted in SUA and in Tanzania, in general. Largely as a result of CRSP support, SUA has become the key institution in Tanzania for bean-related degree training. To date, the CRSP has supported a total of 20 students from Tanzania, who completed 25 academic degrees. Eleven of these trainees went to the U.S. for their graduate study, while the other eight pursued their graduate degrees at SUA. For U.S.-based degree training, the US-PIs, in collaboration with SUA staff, identified the training and research

needs of the project. For SUA-based degree training, HC-PIs identified disciplines and departments with a shortage of bean scientists.

Trainees, who were SUA employees, were usually granted study leave before going to the U.S. for GDT. This benefited both the trainee and SUA, as it provided a significant incentive for Tanzanian trainees to return home. Contrary to the popular notion that trainees from Africa rarely return to their home countries, 10 out of the 11 CRSP-supported trainees from Tanzania returned home after completing their GDT in the U.S. and a majority were still working at SUA when the site visit was made. Furthermore, the returning trainees have become CRSP scientists' primary collaborators at SUA.

While GDT, rather than the CRSP per se, has contributed to the capacity building at SUA, the CRSP has facilitated this endeavor by awarding scholarships to SUA staff and through its support of collaborative research. Because of the scholarship opportunity that the CRSP made available to SUA, its teaching and research capacity has been strengthened. Further, through their teaching and research activities, the CRSP-supported trainees have produced "second-generation" trainees who hold key bean research-related position at the national level. Former CRSP trainees have also been successful in securing externally-funded bean-related projects to complement and enhance their existing CRSP projects. Furthermore, SUA's CRSP collaborators are active participants in other research networks in Africa, especially the Southern Africa Bean Research Network (SABRN) and the Eastern and Central Africa Bean Research Network (ECABREN) under the Pan-Africa Bean Research Alliance (PABRA). Finally, despite major infrastructure and technology challenges, SUA's CRSP trainees have published numerous research papers in major journals, proceedings, and books, have authored extension bulletins and manuals that are used by farmers and students, and have developed improved varieties in collaboration with CRSP scientists (Table 6).

On the other hand, key informants at SUA noted that time availability for conducting bean research had been limited by their heavy teaching responsibilities. They also cited unreliable access to the internet and electrical black-outs as constraints to doing research and factors that make collaboration with US-PIs difficult. Moreover, several informants had been critical of the quantifiable outputs from the 25 years of CRSP involvement at SUA, noting that the program has developed only four bean varieties, two of which were released in 2006, and farmer adoption of these varieties is, to a great extent, unknown.

D. Limitations of the study

In assessing the impact of training, the study acknowledged several issues and problems that inherently limit the analysis. First, because the lags involved in observing the impacts of training on final outcomes are substantial, it takes many years for the true quality and value of training to become evident.

Second, it is difficult to attribute outcome 'effects' to a particular training 'cause'. This is because there are many unaccounted external factors that affect impact, including the quality of training and the extent to which the trainees apply their knowledge, skills, and attitudes to

generate impacts. Moreover, it is difficult to isolate the contribution of CRSP-supported GDT from training received elsewhere.

Third, this study also anticipated the problem of separating training outputs and research outputs, since the CRSP sees training as an inherent component of the research program. For the sake of simplicity, this study assumed that training prepares individuals to utilize enhanced research methods. Therefore, enhanced research capacity can be attributed to improved individual capacity, as a result of training.

Fourth, the study recognizes that a single set of indicators may not be applicable for all disciplines. Thus, the linkages between outputs and impacts may differ across academic fields and discipline.

Finally, the study anticipated several sources of survey errors. These errors can be grouped into three major categories – coverage, non-response, and measurement (Couper, 2000). Coverage error represents the divergence between the target population and the frame population. Non-response error, sometimes considered a selection bias, is expected when certain groups of individuals return the survey and other groups do not. Measurement error refers to the deviation of the respondent's answers from their true values.

V. SUMMARY AND CONCLUSION

From 1981 to 2006, the CRSP had invested more than US\$69 million to support global bean/cowpea research. About US\$7 million of the total was spent on graduate degree training in order to develop a critical mass of bean/cowpea scientists. To this end, the CRSP supported nearly 200 students for M.S. and Ph.D. degrees at U.S. universities in the fields of plant sciences, food sciences and social sciences -- fields critical to the development of bean and cowpea research in host countries in Latin America and Sub-Saharan Africa and the U.S. The priority placed on funding training demonstrates the CRSP's long-term commitment to capacity-building at HC institutions. This study is the first major attempt to document and assess the impacts of the Pulse CRSP's graduate degree training program, from the perspectives of the trainees and the U.S. scientists who supervised the trainees.

Adopting the Kirkpatrick's framework, the assessment used several approaches to gather information about impacts from the perspectives of the trainee and the trainee's supervisor (US-PI). Two survey questionnaires were developed -- one for the former trainees and another for the US-PIs or the scientist who supervised the trainee during his/her CRSP-supported graduate degree training (GDT). In addition, a case study was carried out, which highlighted the impacts of the CRSP investment at Sokoine University of Agriculture (SUA) in Tanzania.

The results reported in this study were based on the analysis of questionnaires returned by 76 former trainees, representing 60 percent of our frame population (or 41% of our target population), and 25 former and current US-PIs, supplemented by face-to-face interviews with former trainees, university administrators, and HC-PIs at SUA.

One of the key findings is that 86% of the HC trainees returned to their home country and most of them were still involved in bean/cowpea research when the survey was carried out. Moreover, the study revealed that after completing their GDT, a much higher percentage of the HC trainees continued to collaborate with CRSP scientists and conduct bean/cowpea research, compared to U.S. trainees. A high percentage of trainees in the plant sciences were active in bean/cowpea research, compared to other fields. Similarly, a much higher percentage of Ph.D. trainees continued to collaborate with CRSP scientists and conduct bean/cowpea research, compared to M.S. trainees.

The study documents that the Pulse CRSP had played an important role in strengthening bean- and cowpea-related teaching and research capacity, both in the U.S. and in HC. A majority of the trainees reported positive changes in their personal and professional lives related to improved capacity or enhanced knowledge, skills, and attitudes to perform their jobs. These results were confirmed by the PI survey and by the case study of SUA. Thus, in order to build on and sustain these successes, the study recommends the continued commitment and increased financial support to GDT, putting high priority to supporting HC trainees.

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Table 1. Comparison of training program assessment studies

Program	Year of Study	No. of Respondents	Program Period
ATLAS/AFGRAD	2004	1,921	1963-2003
Visiting Fulbright	2005	1,609	1980-2000
ILRI: Kenya-Ethiopia	2001	60	1978-1997
IRRI	1996	374	1974-1987
CGIAR	2006	359	1990-2004

Table 2. Comparing salient features of the Pulse CRSP degree training with other training programs (Fulbright, ATLAS/AFGRAD, CGIAR)

Pulse CRSP	Fulbright / ATLAS/AFGRAD	CGIAR
<ul style="list-style-type: none"> • Trainees are usually recruited from collaborating U.S. and host country institutions. 	<ul style="list-style-type: none"> • Trainees are selected from targeted institutions (ATLAS-AFGRAD). • Trainees are selected competitively at the national level. (Fulbright). 	<ul style="list-style-type: none"> • Trainees are selected competitively at the international level.
<ul style="list-style-type: none"> • Trainees attend universities with CRSP-funded projects. 	<ul style="list-style-type: none"> • Trainees may attend any U.S. university. 	<ul style="list-style-type: none"> • Trainees may attend any university, but usually conduct their thesis/dissertation research at a CGIAR Center.
<ul style="list-style-type: none"> • Trainees' research is related to problems along the bean/cowpea value chains. 	<ul style="list-style-type: none"> • Trainees' research is not sector-specific 	<ul style="list-style-type: none"> • Trainees' research is related to the CGIAR mandated crops/themes.
<ul style="list-style-type: none"> • Trainees are selected and supervised by CRSP PIs, usually university professors, who ensure that the training/research directly contributes to CRSP research goals and objectives. 	<ul style="list-style-type: none"> • Trainees are selected by the sponsors and are supervised by a U.S. university professor. 	<ul style="list-style-type: none"> • Trainees are selected and supervised by CGIAR scientists who ensure that the research directly contributes to CGIAR research goals and objectives.
<ul style="list-style-type: none"> • Trainees work on CRSP-related topics for their thesis/dissertation. 	<ul style="list-style-type: none"> • Trainees identify the focus of their thesis/dissertation. 	<ul style="list-style-type: none"> • Trainees work on CGIAR-related topics for their thesis/dissertation.

Table 3. Overview of the Pulse CRSP trainee respondents

Region	Target population	%	Frame population	%	Respondents	%	Response Rate ^{b/}
Latin America	56	30%	41	33%	23	30%	56%
East/Southern Africa	25	13%	18	14%	10	13%	56%
West Africa	17	9%	12	10%	9	12%	75%
U.S.	89	48%	55	44%	34	45%	62%
Discipline							
Food Science	39	21%	21	17%	13	17%	62%
Plant Science	123	66%	83	66%	46	61%	55%
Social Science	25	13%	22	17%	17	22%	77%
Highest Pulse CRSP-supported degree							
Ph.D.	95	51%	71	56%	44 ^{a/}	58%	62%
M.S.	92	49%	55	44%	32	42%	58%
Funding							
Indirect	35	19%	28	22%	11	14%	39%
Partial	80	43%	51	40%	30	39%	59%
Full	72	39%	47	37%	35	46%	74%
Gender							
Female	78	42%	45	36%	26	34%	58%
Male	109	58%	81	64%	50	66%	62%
Grant Period							
1 (1981-1986)	46	25%	22	17%	14	18%	64%
2a (1987-1997)	93	50%	62	49%	30	39%	48%
2b (1998-2002)	28	15%	23	18%	15	20%	65%
3 (2003-2005)	20	11%	19	15%	17	22%	89%
Total	187		126		76		60%

a/ This number represents the trainees' highest CRSP-supported degree. Many trainees who were supported for their M.S. degrees had gone on to continue studying for their Ph.D. degrees with financial support from other sources. Considering the highest degree received by trainees, regardless of funding source, 58 (76%) respondents have Ph.D. degrees and 18 (24%) have M.S. degrees.

b/Percent of frame population who returned the questionnaire.

Table 4. Most important KSAs acquired during graduate degree training^{a/}

	Knowledge, Skills, and Attitudes	Number	Percent
1	designing/conducting/analyzing scientific research	66	87%
2	analytical/critical thinking	39	51%
3	scientific methods/tools	36	47%
4	language fluency/communication skills	27	36%
5	attitude towards work	25	33%

a/ According to frequency of mention; Total number of responses = 221 out of 76 respondents

Table 5. Selected strengths of the Pulse CRSP Graduate Degree Training, as cited by PIs

Strengths of the Pulse CRSP Graduate Degree Training	
•	Funding for conference attendance or participation in various workshops. The program recognizes that students must have the widest possible exposure to the U.S. system of research, presentations, conferences
•	Graduate student education is funded and graduate students are involved in various aspects of the projects in which they work. The program encourages the professional development of graduate students via funding for conference attendance.
•	After receiving their degrees from the U.S. institution, these students have gone back to their countries and became leaders in their respective fields of endeavor, i.e., plant breeding, nutrition, agronomy, etc.
•	Opportunity to bring bright young students to a major U.S. research institution for graduate training. Many of these students would never have the opportunity to do graduate work in their own countries or the U.S. without CRSP support.
•	Ability to work on a real problem area and research topic relevant to country needs
•	Provides long-term funding, so it is possible to plan research for a several-year horizon
•	Provision of both stipend and operating funds
•	Training students in U.S. institutions helps create an enormously strong bond between major professor and student, a bond of mutual interest, commitment and benefit that can/will often outlast the CRSP relationship and lead to additional research/training
•	Attracted high quality students who are a credit to Brazilian, African, and U.S. agricultural research.
•	Linkages/long-term relationships are established between U.S. & HC scientists.
•	The Bean/Cowpea CRSP also supports the training of U.S. students, strengthening bean research capabilities in the U.S
•	Adequate funding to train large numbers of students
•	Excellent fundamental and applied training combined in CRSP
•	Returning degree holders are able to contribute to crop improvement and institutional building

Table 6. Bean varieties developed by SUA in collaboration with the Bean/Cowpea CRSP

Variety	Year released	Characteristics
SUA 90	1990	Drought tolerance; Bean Golden Mosaic tolerant; higher yield, tan (color)
Rojo	1997	Same as SUA 90 but red (color)
Mschindi	2006	Faster cooking time; soft; good taste; gray-mottled (color)
Pesa	2006	Same as Mschindi but red (color)

Figure 1. Pulse CRSP’s U.S.-based graduate degree training model

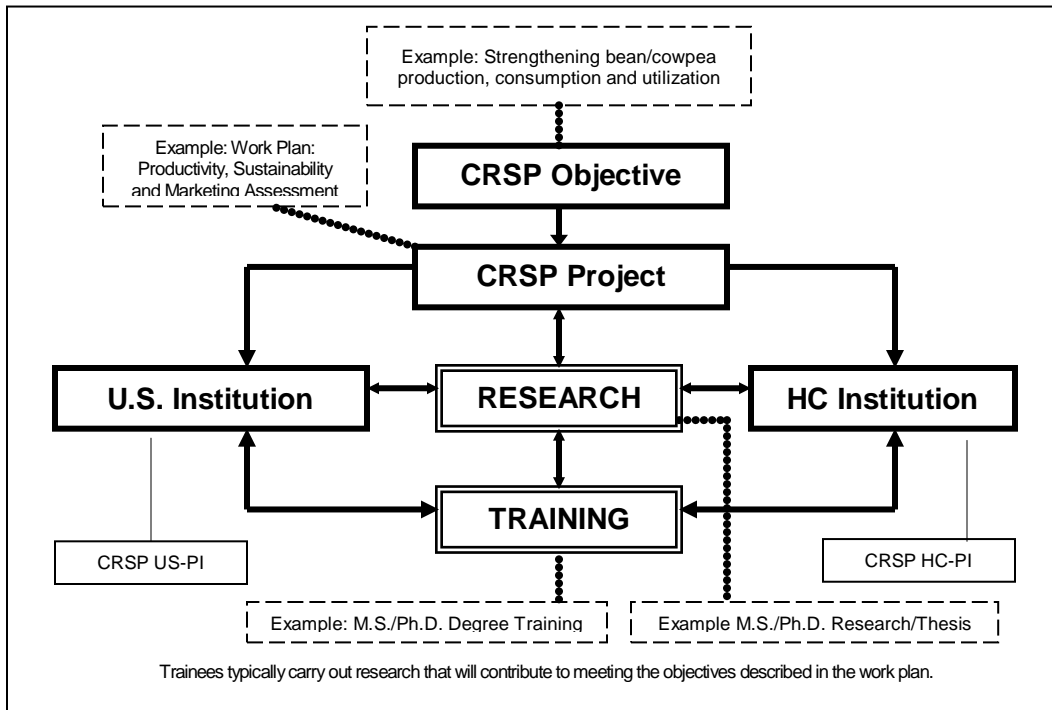


Figure 2. Training Evaluation Framework

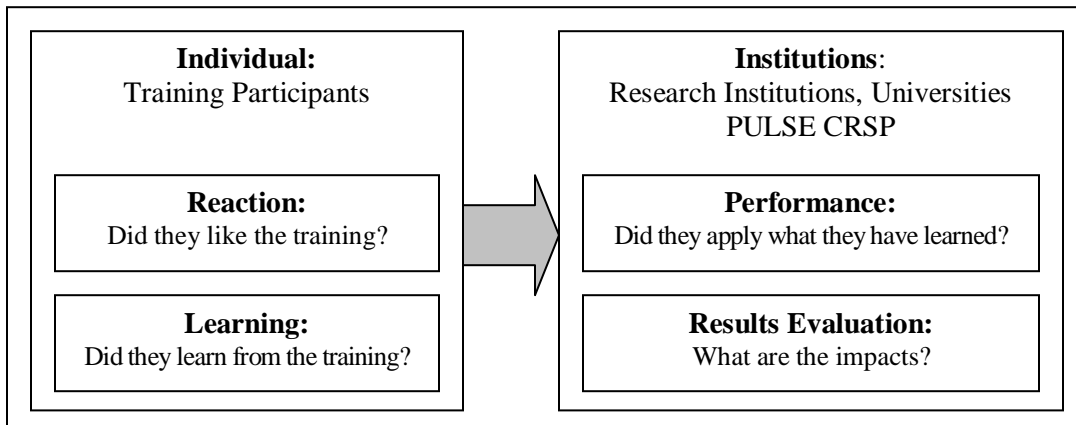


Figure 3. Training Evaluation Approach

