EXTERNAL EVALUATION PANEL

FIVE-YEAR TECHNICAL REVIEW (2002-07)

OF THE

BEAN/COWPEA COLLABORATIVE

RESEARCH SUPPORT PROGRAM (CRSP)

September 2006

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THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)

Regional partnerships to enhance bean/cowpea consumption and production in Africa and Latin America

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TABLE OF ACRONYMS

AATG	African Agriculture Technology Foundation
AFLP	Amplified Fragment Length Polymorphisms
ALS	Angular Leafspot
BCMNV	Bean Common Mosaic Necrosis Virus
BCMV	Bean Common Mosaic Virus
BCNM	Bean Common Necrotic Mosaic
BGYM	Bean Golden Yellow Mosaic
BHA	Beans for Health Alliance
BIFAD	Board for International Food and Agricultural Development
CabMV	Cowpea Aphid Borne Mosaic Virus
CA/C	Central America/Caribbean
CBB	Common Bacterial Blight
CGIAR	Consultative Group for International Agricultural Research
CIAL	Committees of Local Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CRSP	Collaborative Research Support Program
DR	Dominican Republic
EAP	Escuela Agricola Panamericana
EEP	External Evaluation Panel
ELISA	Enzyme-Linked Immunosorbent Assay
ESA	East and Southern Africa
FAO	Food and Agriculture Organization
FFS	Farmer Field Schools
HB	Halo Blight
HC	Host Country
IARC	International Agricultural Research Centers
ICTA	Instituto de Ciencia y Tecnologia Agricolas
IITA	International Institute of Tropical Agriculture
INERA	Institut de l'Environnement et de Researches Agricoles
INIAP	Instituto Nacional de Investigaciones Agropecuarias
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias
INRAN	Institut National de Recherches Agronomiques du Niger
IPM	Integrative Pest Management
IRAD	Institut de la Recherche Agronomique pour le Developpement
IRM	Insect Resistance Management
IRRI	International Rice Research Institute
ISRA	Institut Senegalais de Recherches Agricoles
LAC	Latin America/Caribbean
LDC	Less Developed Country
MAS	Marker-Assisted Selection

ME	Management Entity
Mn	Manganese
MO	Management Office
MSU	Michigan State University
MTC	Management and Technical Committee
NARPS	National Agricultural Research Programs
NARS	National Agricultural Research Systems
NCFAP	National Center for Food and Agricultural Policy
NDSU	North Dakota State University
NGICA	Network for the Genetic Improvement of Cowpea for Africa
NGO	Non-Governmental Organization
OSU	Ohio State University
P	Phosphorus
PI	Principal Investigator
PR	Participatory Research
QDS	Quality Declared Seed
QTL	Quantitative Trait Locus
RIL	Recombinant Inbred Line
RT-PCR	Reverse Transcription-Polymerase Chain Reaction
SARI	Savanna Agricultural Research Institute
SABRN	South African Bean Regional Network
SRO	Sub-regional Organizations
SUA	Sokoine University of Agriculture
TLC	Total Land Control
TOSCI	Tanzania Official Seed Certification Institute
TC	Technical Committee
UC-R	University of California-Riverside
UGA	University of Georgia
UHWI	University Hospital of the West Indies
UN-L	University of Nebraska-Lincoln
U.S.	United States
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WA	West Africa
WID	Women in Development
WM	White Mold

PREFACE

An External Evaluation Panel (EEP) was a key feature of the original CRSP concept. This external body, composed of "internationally recognized experts" who have no personal connection with the participant institutions or research projects, could provide donors and administrators with objective, evaluative information on a continuous basis thereby helping to sustain support over a long period of time, so the reasoning went. To prevent the EEP from becoming too close to the program to act as an "outside critiquer" and to provide an orderly flow of "new blood" but also maintain some continuity, a system of staggered fixed terms was established. The current EEP which produced this report has only one member who has served for the entire period of this five-year grant.

This Five-Year Technical Report of the Bean/Cowpea CRSP takes a longer term view of the program in addition to the normal five-year review of the current grant. We chose to review selected impacts since the program began more than a quarter of a century ago. This approach reveals impacts that often are not apparent over a five-year time span. We believe this longer term assessment will provide additional useful information for the decision-making process regarding the future of this program.

The Bean/Cowpea CRSP was an experiment in forging partnerships. It was first a new partnership between USAID and U.S. universities, with each investing resources and receiving benefits. Later, developing country institutions became full members of the partnership, significantly leveraging and contributing substantial amounts of their own resources, even though they were not required to do so by the legal terms of the partnership. Still later, the U.S. dry bean industry joined the partnership, recognizing the important role that USAID has played through the CRSPs in maintaining strong bean/cowpea research programs at U.S. universities and providing opportunities for scientists to be internationally engaged. Remarkably this broadened partnership is even stronger after a quarter of a century!

As Chair of the EEP, I wish to sincerely thank the other four members who lent their considerable expertise and gave so generously of their time to this effort. They deserve credit for the quality of this report. The Chair is solely responsible for any mistakes or statements that are off the mark. Dr. Irvin Widders, the CRSP Director, was exceedingly helpful to us but always knew where to draw the line without meddling or applying inappropriate pressure. Dr. Jiryis Oweis, USAID Cognizant Technical Officer, always provided sound advice which occasionally prevented us from wondering too far a field.

John G. Stovall
Chair, EEP

External Evaluation Panel Five-Year Review
Bean/Cowpea CRSP
September 2006

I. Introduction

The Bean/Cowpea CRSP, now in its 26th year, will complete the current five-year grant in 2007. By tradition and in accord with the contractual agreement between USAID and the CRSP Management Entity and the CRSP Guidelines, issued by USAID and BIFAD, the External Evaluation Panel (EEP) conducts a review near the end of the grant period to provide USAID and BIFAD with evaluative information for use in making decisions about the future of the program.

The EEP was a key feature of the original concept of the CRSP. The reasoning was that an external body composed of "internationally recognized experts" that monitored the program continuously would help assure funders and administrators that the research was sound and that it deserved continued support. To prevent the EEP from becoming too close to the CRSP, to serve as an "outside critiquer," and to provide an orderly flow of "new blood" but also maintain some continuity, a system of staggered fixed terms was established. The current EEP which produced this report has only one member who has served for the entire period of this five-year grant.

The EEP chose to broaden the scope of this review (see EEP Scope of Work; Appendix A) since it appears likely that significant changes will be made in the program for the next grant period. Unlike previous reports, we have included a brief review of the Bean/Cowpea CRSP since it began in 1981 and offered our collective judgment about some significant accomplishments and impacts. We believe this longer term look will provide additional useful information for the decision-making process.

Without this historical perspective, reviewers may not appreciate the extent to which this CRSP is now different from the one that began more than a quarter of a century ago and conclude that perhaps this program has been doing the same thing over this entire period. But as our review will show, the Bean/Cowpea CRSP has evolved over time to address new challenges, broaden its scope and taken advantage of scientific progress, such as the use of DNA markers in conventional breeding programs.

The EEP is basing its findings and recommendations on a number of sources of information. In addition to all the written documents (e.g., workplans, annual reports, etc.), one or more members visited ten Host Country (HC) institutions and seven U.S. universities. During these visits we met with Principal Investigators (PI), supporting staff and administrators, asking questions, listening to reports of progress, hearing their perspectives on challenges, viewing laboratories and observing field research. Trip reports on all the institutional site visits were prepared and made available to the EEP members.

The procedure by which this report was produced began with an outline prepared by the EEP Chair, with input from the Management Office (MO) and EEP members. Then each member agreed to write the first draft of one or more sections of this report prior to the EEP meeting. At that meeting at MSU on August 28-30, 2006, the EEP discussed each section of the report, agreed on modifications and developed recommendations. The final report is a consensus of the entire EEP.

This report is organized to begin with a review and evaluation of selected issues over the life of the Bean/Cowpea CRSP, including: (1) how the research program has changed since the original grant, (2) the role the program has played in the international agricultural research system, (3) progress in strengthening host country institutions, (4) contributions to the U.S. bean and cowpea sector of agriculture and (5) contributions to human capital through training and research collaboration.

Next, we present a review and evaluation of each of the three regional projects, including assessments on the individual components and activities that make up the regional projects. Finally, the report presents a brief review and evaluation of the governance and management of the Bean/Cowpea CRSP. Recommendations will be included in each section to which they apply and more general recommendations appear at the end of the report.

The EEP's findings and recommendations, in brief are:

- After more than a quarter of a century of effort, the program has been highly successful in strengthening the capacity of nearly 30 institutions in developing countries to conduct research on beans and cowpeas and academically prepare future leaders for the respective subsectors.
- The CRSP has made significant contributions to the U.S. by developing improved varieties and knowledge that not only benefit producers in developing countries but also U.S. farmers and consumers as well.
- Over 600 persons from around the world have received degrees from Bean/Cowpea CRSP-supported training. Nearly all HC students have returned to their home country and many are now leaders or senior scientists in NARS, universities or the private sector in developing countries.
- The regional project in LAC which has a long record of success has reached a stage of maturity such that it can be downsized relative to Africa and the program redesigned to retain a breeding program and participate in a global network to benefit Africa.
- The West Africa Regional project also has made excellent progress in research, training and institution strengthening but it still has many challenges ahead. Collaborative research with U.S. institutions and training needs to continue in order to fully exploit past progress.
- The East Africa Regional Project still lags the other two regions in terms of effectiveness although participating institutions now are staffed with competent scientists, many of which have been trained with CRSP support. The needs of this region are great, some problems seem intractable but it would be a mistake to give up now. The EEP recommends a reorganized program in the next grant in which other countries and institutions would be invited to participate in a renewed effort to improve the production and consumption of beans and cowpeas.
- The Management Entity, MSU, has given strong and sustained support to the Bean/Cowpea CRSP and the MO has been staffed with quality, competent people. The director has provided excellent technical and managerial leadership. He enjoys the respect and support from all participating institutions.
- Recognizing that the next phase of the Bean/Cowpea CRSP will be implemented in a different environment, the EEP recommends that the organizational structure for assisting and advising the Management Entity should be simple and low cost. We believe that one advisory body would be sufficient to provide the ME with both technical and administrative advice. A Management and Technical Committee (MTC) could replace the functions previously performed by the Technical Committee (TC), Board of Directors and the External Evaluation Panel (EEP).

II. A Quarter of a Century of Evolutionary Change

Although the Bean/Cowpea CRSP has provided continuity of purpose and opportunities for continued involvement of many of the same institutions, there have been significant changes over the years. The EEP believes it would be useful to examine some of these changes, explore their implications and assess their impact. Understanding how the program has built on "lessons learned," responded to changing priorities, taken advantage of advances in science and dealt with the emergence of new challenges is an important consideration in judging the program's long-term performance and success.

A first step is to take a brief look at the composition of the Bean/Cowpea CRSP program during the first grant. After a two-year planning grant under which the design for the proposal was developed in close cooperation with USAID and BIFAD, MSU was awarded the first grant in 1980. This initial program included 10 U.S. institutions, 13 developing countries and 18 projects which were bilateral in nature, meaning that projects usually consisted of one U.S. institution paired with one country to work on a component of the overall CRSP plan. There was no responsibility for or mechanism to work on regional problems, although the 18 bilateral projects constituted the "global plan."

The research program was designed to remove the major barriers to bean/cowpea production and utilization and not surprisingly, its primary research focus was aimed at developing new and improved bean and cowpea cultivars. It is understandable then that plant breeders were the dominant discipline of participating scientists and over half of the funds were allocated to plant breeding projects. Coping with pests and diseases accounted for about 16 percent and farming systems research made up another 22 percent of total funds. Farming Systems Research, very much in vogue during the 1980s, was normally multidisciplinary involving sociologists, agronomists and sometimes breeders or economists. There were few if any agricultural economists serving as PIs during the first grant.

As stated in the grant document, the program was:

> *"…a long-term effort designed……to generate and apply knowledge that can assist in alleviating principal constraints to improved production, marketing and utilization of beans and cowpeas in LDCs. It is based on the assumption that there are large areas of overlap between U.S. and developing country needs for research, marketing and utilization of these two crops. Substantial mutual advantages are expected to result from joint research program efforts which cut across national boundaries and different levels of agricultural development.*"

The above description could well be used for today's program but these generalities hide some very significant changes that have occurred, including:

1. **Change in the disciplinary mix of scientists:** As progress was made in improving cultivars, non-production issues took on more importance. In response, marketing, food science, nutrition and economic studies received more emphasis and more components were added that focused on these problems. Today, in contrast to earlier times when plant breeders were the most numerous scientists, economists now outnumber plant breeders and

social scientists play a major role. This shift is consistent with a more general recognition that achieving economic development required more than increases in production. More emphasis is now given to issues up the food chain, such as consumer preferences, marketing, trade, food preparation and value-added products although bean and cowpea breeding is still a significant part of the global program. These changes are appropriate and reflect management's attention to priority setting.

2. **Focus on regions and regional problems**: Another significant change occurred when the decision was made to organize projects by region and in turn to shift the focus from countries to regions. The concept, driven by demands to do more with fewer resources and to achieve the maximum impact, was to "think regionally," to focus on regional problems and to apply research findings to a larger geographically area. This was an ambitious undertaking, perhaps more so than was anticipated.

   There is now a "Regional Facilitator" for each of the three regions and planning is conducted by Regional Project Teams. Some research activities are implemented on a regional basis but many still have a one-country focus and conducted by one U.S. and one HC institution.

   The most critical barrier to achieving more "regionalization" heard by EEP members on site visits was the difficulty of travel across the rather large regions and the limited funds for travel and to conduct the necessary workshops, short-term training activities, etc.

   The EEP commends the CRSP leadership for adopting the regional approach but suggests they carefully assess what can realistically be achieved and how best to achieve objectives with available resources.

3. **Capitalizing on scientific advancements**: As science has progressed over the past quarter of a century, new tools and advanced knowledge present new opportunities for bean and cowpea scientists. To take advantage of these, PIs and CRSP management had to actively change projects, budgets and sometimes personnel to take full advantage of cutting-edge science. The EEP concludes that the Bean/Cowpea CRSP has made this adjustment quite well and is fully exploiting opportunities in molecular science and other cutting-edge techniques, producing research results that were not possible when the CRSP began 26 years ago.

   For example, many bean and cowpea breeders now utilize Marker-Assisted Selection (MAS) techniques in their program. It is especially noteworthy that the CRSP-supported bean breeding programs at INIAP, Ecuador, and the Escuela Agricola Panamericana- Zamorano are among the few research institutions in Latin America to have developed capacity and utilize regularly MAS for genetic improvement. Selection of markers linked with known resistance genes can greatly improve breeding efficiency and accelerate the development of stable multiple resistances in new varieties.

4. **Adapting to more mature HC institutions:** When the Bean/Cowpea CRSP began, a challenge was to find HC institutions with a sufficient base of research on which to build a sustainable research program. In some instances it was deemed necessary to post an expatriate in the HC and a priority of most host country institutions was to initiate a training

plan to upgrade staff. Now the situation is quite different as a generation of U.S. university M.S. and Ph.D. graduates have returned to their home country and are occupying senior positions. A number of HC institutions have scientists on a par with their U.S. counterparts although usually lacking in comparable equipment and facilities.

One result is that these stronger institutions can benefit from a truly collaborative relationship with U.S. universities. U.S. scientists can also derive benefits from such a collaborative relationship through fresh ideas and exchange of germplasm.

In some instances, HC institutions that were a part of the original grant have since been deemed to have achieved "graduate" status and are no longer eligible for assistance. For example, Mexico's bean research program, now almost fully staffed with CRSP-trained senior scientists, no longer receives U.S. funds but continues to participate in some LAC regional project activities.

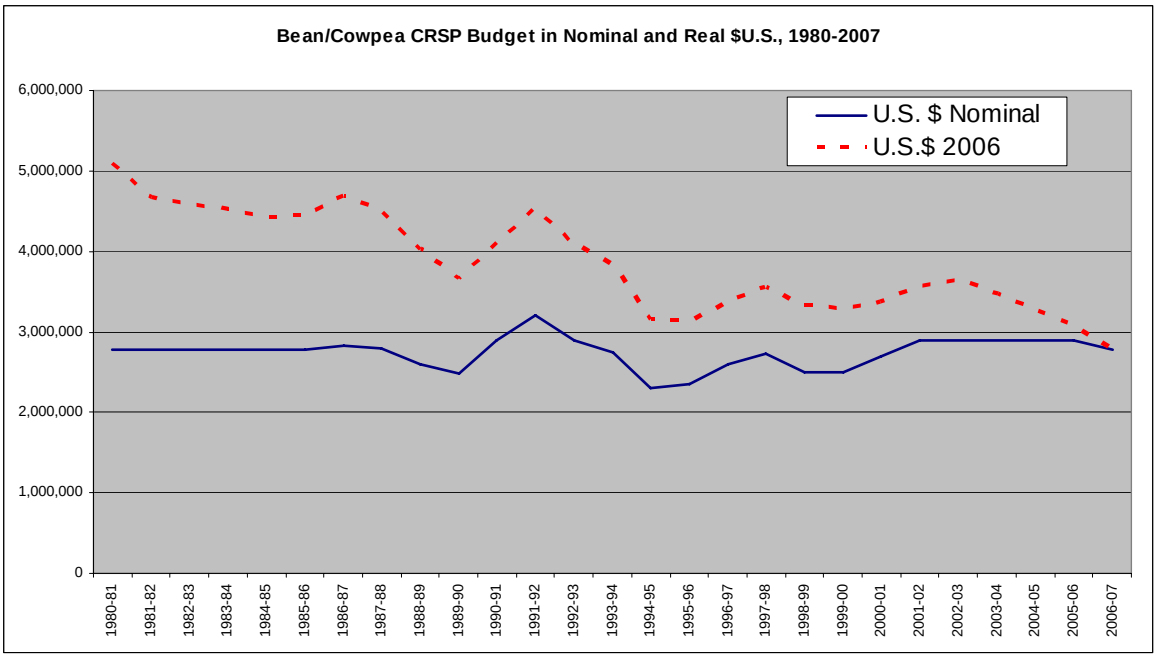
Another consequence of stronger HC institutions is that the Bean/Cowpea CRSP program receives significant in-country support, the ultimate test of a successful development project. For example, the University of Ghana-Legon receives about $40,000 per year in addition to USAID/CRSP funds to support a cowpea nutrition project. None of the CRSP funds are used for faculty salary; all of it is spent on student research and training and a support person. EEP members who reviewed this project in preparation for this report were impressed with the maturity and strength of the faculty in the Department of Nutrition and Food Science and the degree to which the CRSP project was integrated into the Department program.

Although the PI was not able to document the value of the support to the CRSP made by the University of Ghana, the EEP reviewers were convinced that it was substantial, easily exceeding the total USAID contribution. The implications of this fact are immense, far reaching and not well appreciated in the U.S. With USAID contributing something less than 50 percent to the total Ghana project; it can properly be viewed as a Ghanaian project to which the U.S. provides some critical support, not the other way around. The USAID/CRSP can take credit for helping to build and strengthen the work over the years and take pride in seeing the University of Ghana assuming ownership of it. This is the hope of all USAID development projects but unfortunately, one that is too seldom realized.

5. **Adapting to shrinking USAID support:** The Bean/Cowpea CRSP has faced shrinking budget support, requiring ingenuity to keep the program afloat at times. How to do more with less has been a continuing challenge for program directors as well as researchers.

Figure 1 shows the annual USAID funding in 2006 inflation adjusted dollars. Between 1981 and 2006 the purchasing power of the available funding has declined 47% and yet the EEP concludes that research and training effort and output has not declined but probably has actually increased. There are more HC institutions participating, more and better equipped U.S. scientists contributing their time and more leveraged support. How has this been possible? The most likely explanation is that U.S. and HC institutions find it in their interest to contribute more of their resources to the Bean/Cowpea CRSP as USAID funds have declined.

Figure 1.



These are just some of the many changes and adjustments made since the Bean/Cowpea CRSP began. They are intended to demonstrate that the program today is quite different than the one that began more than a quarter of a century ago although it retains the main objectives set forth in the first grant.

III. The Role of the Bean/Cowpea CRSP in the International Agricultural Research System

Prior to the 1960s there was little tropical food crop research and virtually none of it was avowedly international. USAID and foundations funded developing country agricultural research to address issues within their own borders. They and FAO supported industrialized country scientists to travel to developing countries on assistance missions and international cooperation took place among industrialized nation researchers with common interests. The creation of four international agricultural research centers in the 1960s and the CGIAR in 1972 greatly increased research on tropical food crops. IRRI, CIMMYT, CIAT and IITA all were charged with reaching out to developing nations where their respective research topics were important, and together they "covered" rice, wheat, maize, common bean (*Phaseolus vulgaris*), highland tropical pastures, cassava, cowpeas (*Vigna unguiculata*), and soybeans. Sister centers covered peanuts, chickpeas, pigeon peas and most grains. All operated primarily as "centers" of research and applied training, not as research collaborators -- the funds they received were used for research and training directly conducted by their own staff.

Thus, there was a need for an international collaborative effort that involved and helped fund developing country research scientists. Starting in 1978, USAID supported the Collaborative Research Support Programs (CRSPs) to conduct research, education, and outreach collaboratively with developing country scientists. As USAID says on its web- site, "*The CRSPs harness the expertise of U.S. universities in low-cost, high-impact programs that contribute knowledge, trained personnel, and technology to agriculture worldwide in the fight against hunger and poverty.*"

The Bean/Cowpea CRSP is complementary to the work of the two international centers with special responsibility for beans and cowpea – CIAT (Centro Internacional de Agricultura Tropical; Colombia) and IITA (International Institute of Tropical Agriculture; Nigeria). Consistent with the global distribution of the crops, the cowpea work of the CRSP is concentrated in West Africa while the bean work is concentrated in Central America and South Eastern Africa. The CRSP includes countries producing about one-third of the world's total crop on one-half of the land devoted to the crop (see Table 1). CIAT bean work is distributed through Latin America and Africa while IITA's cowpea work is concentrated in West Africa. The international centers focus more sharply on genetic improvement and do relatively little on consumption and food product enhancement. Hence there is some distinction in the subjects covered, but the major distinguishing factor is the CRSP's ability to provide degree training and to provide financial support directly to host country collaborators. These give the CRSP much greater capacity to directly build research institutions in collaborating countries. Both the international centers and the Bean/Cowpea CRSP are active in networking among developing country researchers, thereby reinforcing each other in building capacity.

The flow of new technology and knowledge that has led to dramatic increases in the productivity and improvements in the well being of agricultural producers comes from a vast array of institutions all over the world. Over the past 45 years, global population has more than doubled, food production per person has more than kept up with that increase with the result that people are better off and life expectancy in the developing world has increased from 40 to 65 years. While there is

no centralized body that controls the global agricultural research system, the CRSPs have found and filled a critical role in linking together researchers with common interests together. The EEP concludes that as the CRSP has evolved and matured, it has found a niche in that system which is generally recognized by other players in the system as performing an essential role and would leave a serious gap if not continued.

Table 1. Area and Production of Dry Beans and Cowpeas by Country, 2002-2004.

		Dry Beans-includes cowpeas	
		Area Harvested (000 Ha)	
CRSP Countries	Regional Project	Average 2002-04	Average 2002-04
Malawi	ESA	295	148
Mozambique	ESA	0	0
South Africa	ESA	64	79
Tanzania, United Rep of	ESA	521	326
Costa Rica	LAC	20	13
Dominican Republic	LAC	43	27
Ecuador	LAC	85	41
Haiti	LAC	97	65
Honduras	LAC	153	65
Nicaragua	LAC	257	200
Burkina Faso	WA	756	312
Cameroon	WA	259	280
Ghana	WA	0	0
Niger	WA	3518	509
Nigeria	WA	5236	2240
Senegal	WA	156	20
Zimbabwe	WA	65	51
United States of America	USA	586	1072
Total CRSP Countries		11525	4376
NON-CRSP Countries		23419	17053

Source: FAOSTAT (http://faostat.fao.org/site/340/default.aspx)

IV. Host Country Institution Strengthening and Special Challenges for Agricultural Research in Africa

A priority global goal of the Bean/Cowpea CRSP is to build the human and institutional capacity of agricultural universities and national agriculture research systems (NARS) in selected developing countries in Africa and Latin America. This goal is achieved through partnerships with Host Country (HC) institutions in the conduct of collaborative research and training activities which generate knowledge and technologies that benefit the bean and cowpea sectors. Over the past 26 years of effort, impressive progress has been made toward this goal in many countries of the developing world.

The Bean/Cowpea CRSP has contributed to institutional capacity building through degree and short-term training of young HC professionals (scientists), providing assistance for the purchase of laboratory equipment and vehicles, engaging in research involving modern research technologies, and providing opportunities for HC scientists to network with the international scientific community.

In this section we examine the CRSP's contribution to the strengthening of agriculture research institutions taking into consideration the current situation of agriculture research in many developing countries. Although the Bean/Cowpea CRSP has had its greatest success and impact in building the bean research programs in Latin America (e.g., Brazil, Mexico, Honduras, Costa Rica, Guatemala, Dominican Republic, etc.), the EEP has decided to focus on CRSP impacts in Africa. Africa presents a major challenge for the future since development efforts over the years have often failed, especially the strengthening of agricultural research institutions.

Contribution of Training to Institutional Capacity

One cannot emphasize enough on the value and importance of academic training and scientific collaboration opportunities offered by the Land Grant Universities of the United States. These opportunities have already made major contributions to the human capacity building of NARS and agricultural universities; it is certainly true, as stated in a Bean/Cowpea CRSP report, that "the researchers who have been trained by the Bean/Cowpea CRSP form the foundation for beans and cowpeas worldwide."

It is noteworthy that several African institutions, including ISRA-Senegal, University of Ghana-Legon, Sokoine University of Agriculture-Tanzania, and Bunda College of Agriculture-Malawi, each have a team of three to five faculty/research staff who were trained through the Bean/Cowpea CRSP and are currently working in critical positions in support of the bean/cowpea sectors. Many CRSP alumni have achieved international recognition for their research and/or are currently in positions of leadership (i.e., program/scientific directors, deans, etc.) within their respective institutions. In addition, numerous Bean/Cowpea CRSP trainees have been hired by several IARCs as research scientists where they continue to work in beans and cowpeas.

Institutional capacity building is a never-ending task due to normal attrition of staff and the emergence of new areas of scientific inquiry. Limited availability of resources for facility improvement and maintenance, purchase of new research equipment, and access to the Internet and reliable electrical power are major handicaps that many Host Country scientists face.

Facilities, Equipment and Laboratories: Special Cases of Biotechnology and Food Processing

Advances in research and training require good facilities. Many well-trained researchers and specialists become frustrated by the failure to perform adequately because they lack the necessary analytical tools or access to critical facilities (i.e., irrigation system, etc.). The Bean/Cowpea CRSP has contributed to the development of operational biotechnology laboratories in several host country institutions including INIAP/Ecuador and EAP-Zamorano/Honduras. This should be encouraged.

The focus on Marker-Assisted Selection and breeding for example will require strengthening the laboratory and training components. The genetic improvement components would benefit significantly by providing training to technical staff (support staff) to enhance the performance of laboratory technicians and field research assistants who currently need additional skills. In addition, the development of food processing facilities and analytical capabilities in several host country institutions enables indigenous researchers and staff to characterize the desirable consumer properties of products utilizing beans and cowpeas. Utilization of regional expertise, shared facilities, and regional training leads to enhanced interaction within the region.

Networking

A significant contribution of the CRSPs has been the opportunity for researchers to develop networks both nationally and internationally. Since 1997, bean and cowpea researchers meet annually as multidisciplinary regional teams to report on research progress and findings, to receive short-term training in areas of need, and to coordinate future research activities. Because of the long-term nature of CRSP projects, these networks are enabling HC scientists to work together toward major research goals that will ultimately have regional impacts.

Strengthening Links with Subsectors in Bean/Cowpea Value-Chains

Through studies on market structure, food processing, seed multiplication/dissemination systems, and participatory plant breeding, the Bean/Cowpea CRSP has contributed to the strengthening of linkages between NARS/universities and subsectors within bean and cowpea value-chains. These linkages enable stakeholders to have input and provide guidance to CRSP scientists regarding needed research that will benefit the subsector, and to ensure that outputs of research (i.e., improved varieties, etc.) will be transferred and hopefully adopted achieving the intended developmental impacts. CRSP research activities promote and facilitate working relationships with farmer organizations, agribusinesses, grain traders, entrepreneurial women micro-food processors, and other relevant players in the value-chain. It is expected that these links will contribute to strengthening the capacities of African NARS and most importantly, their sustainability, through integration in the overall government and private sector economic strategies and programs.

Future Role of CRSP

The Bean/Cowpea CRSP can play an important role in ensuring a strong and productive future for the NARS within Africa through its collaborative research and training programs. U.S. universities which follow the land-grant model should continue to assist NARS in cultivating strong working

relationships with both public and private sector groups that contribute to the vitality of agro-industries participating in commodity value-chains. These relationships can be the foundation for the development and implementation of research and training agendas that address the strategic needs for growth of the bean and cowpea sectors as well as the greater welfare of Host Country societies in terms of an adequate, affordable, safe and health-promoting food supply.

V. Assessing the U.S. Benefits

U.S. farmers have received substantial direct benefits from 26 years of CRSP research because research results are often applicable to U.S. bean and cowpea growers as well as growers in developing countries. Several improved bean varieties developed to resist diseases and boost yields in developing countries were also used to improve yields in the U.S. For example, CRSP-developed varieties Jaguar, Red Hawk, Chinook 2000, Beluga and Matterhorn are becoming the dominant varieties in their respective market classes in the U.S. Also, the improved red kidney bean variety "Red Jamaica," a red kidney bean identified by CRSP researchers as a source of heat tolerance was used in the U.S. as a parent to improve heat tolerance of kidney beans grown in Washington and California. No wonder U.S. bean growers support the Bean/Cowpea CRSP! It is providing mutual benefits just as Title XII intended.

In addition to farmers, the U.S. bean industry has benefitted from CRSP research. When the industry group learned of research indicating a link between bean consumption and reduced incidence of colon cancer, a new partnership was born. The "Beans for Health Alliance" (BHA) was formed and soon thereafter received a USAID grant to support a global education and research program. The BHA subcontracted the administration of its Bean Health Research Program to the Bean/Cowpea CRSP MO at MSU because of the CRSP recognized leadership in health and nutrition research. The BHA currently has over 70 private and public sector members, including the CRSP, and has provided over $2,000,000 of in-kind contributions in support of the BHA's grant from USAID.

The strong support of the U.S. bean industry did not come quickly or easily in the history of the Bean/Cowpea CRSP nor would it have done so without the proper groundwork. A review of how it came about may offer useful clues to the strategy of other efforts for forming public-private partnerships.

The history of this partnership begins with Title XII of the Foreign Assistance Act. This Title establishes the basis for the CRSPs to design research for the benefit of U.S. agriculture as well as farmers in developing countries. Section 297(b) of Title XII states that:

> "*…programs under this title shall be carried out so as to….. (2) take into account the value to the United States agriculture of such programs, integrating to the extent practicable the programs and financing authorized under this title with those supported by other federal or state resources so as to maximize the contributions to development of agriculture in the United States and in developing nations.*"

The rationale was that there are increasingly large overlaps of the subject matter and problem areas between the U.S. and the rest of the world so that there is a potential mutual advantage of research program efforts which cross national boundaries and cut across different levels of agricultural development.

This mutual benefits feature was also a justification for the provision in the CRSP Guidelines requiring that participant U.S. universities contribute a minimum match of 25 percent of USAID

direct funds for research to the CRSP. If U.S. agriculture was to benefit, state or other non-federal funds supporting the CRSP should total at least 25 percent of the USAID grant. Developing countries were not required to match since the purpose of the USAID funds was to assist them and they generally did not have funds to do so anyway. Nevertheless, many HC institutions contribute significantly because they find it in their self interest to do so.

During the 1980's when most of the CRSPs were initiated, much of U.S. agriculture was either skeptical of or hostile to USAID agricultural projects, because of the belief that assisted countries might become competitors in international markets and/or that these projects would divert agricultural researchers away from domestic issues to those of developing countries. Some commodity groups were quite vocal in attacking international agricultural projects and certain such projects were "killed" by Congress at their urging. For understandable reasons, the "domestic benefits" feature of the CRSP was a sensitive issue, usually not actively "marketed."

The Bean/Cowpea CRSP was also cautious in this environment. The Management Office at MSU had little contact in the early years with the bean industry even in Michigan, which at that time was the largest in the U.S. Little or no effort was devoted to educating bean growers about the benefits that the CRSP collaborative research on beans with developing country institutions could provide. Clearly the U.S. dry bean industry was benefitting from the access that U.S. scientists had to genetic material and resistance genes and to knowledge of disease and insects pests that were afforded through U.S. university participation in the Bean/Cowpea CRSP.

Attitudes about international agricultural development in the U.S. agricultural community began to change in the 1990's as various educational efforts focused on U.S. agriculture, the leadership began to realize that the threat by aid-induced developing country competition was greatly exaggerated and that there were indeed U.S. benefits. During this time period, USAID sensed the need for "development education" and decided to focus on the agricultural community, designating a Foreign Service Officer assigned to the administrator's office to work full time as a liaison to U.S. agricultural interests.

In an important milestone in the shift in attitudes, a commission made up of influential people from academia, former high-level government officials, agribusiness CEOs and farm leaders was organized by the National Center for Food and Agricultural Policy (NCFAP) to provide advice to public policy makers on international agriculture and trade. The report by the commission in 1997 surprised most observers by its strong endorsement of more USAID agricultural development programs. Among the report's recommendations:

- The Administration should elevate agricultural research to a higher level in the federal government, with clear national commitments, designated leadership and effective coordination.
- The Congress should increase the budget for International Affairs (150 account) by three percent per year over the next five years. One-half of the increased funds should go to agricultural research and rural economic development.

For the first time in memory, the presidents of the two largest general farm organizations in the U.S. (American Farm Bureau and the Farmer's Union), both members of the commission, had gone on record together endorsing the benefits of international agricultural research and recommending its expansion. Taking full advantage of the improved climate, the Bean/Cowpea CRSP began a series of interactions with the U.S. bean industry that would result in a strong and mutually beneficial partnership. In 2000, the Executive Director of the Michigan Bean Commission spoke at a gathering of CRSP researchers strongly supporting a shift in priorities from productivity to utilization and consumption. When the "value-chain" approach was adopted in the new USAID grant, the stage was set for a close and supportive relationship with the umbrella groups representing the major bean/cowpea industry in the U.S.

As a result of the cultivation of common interests, the bean industry has changed from a skeptic to an ardent and vocal supporter of the CRSP. An industry representative (see letter from Cindy Brown, President of USDBC; Appendix C) now serves on the CRSP TC and the CRSP director participates in activities of the umbrella industry group, the U.S. Dry Bean Council, which was formed to replace three separate organizations to serve as a more unified effective force.

The CRSP has gained an important U.S. clientele group and the bean industry reaps some of the benefits that were aimed primarily toward food problems faced by developing countries. This surely is a good example of what the Title XII framers had in mind when they encouraged research activities that benefit both U.S. agriculture and developing countries. And, it serves as an excellent example of public/private partnerships that USAID encourages.

VI. Evaluation of Regional Projects

A. Latin America/Caribbean Basin Regional Project

Summary of LAC Regional Project

The Latin America Regional Project includes work on the value-chain for dry beans, from germplasm characterization to final food products, under the direction of the regional project team comprised of 11 U.S. PIs from 7 universities and 14 host country PIs and collaborators from Ecuador, Honduras, Guatemala, Costa Rica, Haiti, El Salvador, Nicaragua, Jamaica, and the Dominican Republic (see Table 2).

The objectives of the project are: to assess constraints to increasing the supply of beans; identify sources of resistance to biotic and abiotic stresses using modern molecular tools; increase the involvement of women in the participatory evaluation of varieties; develop sustainable disease management systems for major diseases; improve the sustainability of production systems; enhance the demand and use of beans, increase knowledge of the nutritional and health benefits; and create new bean varieties better suited to low fertility soil, higher production in lowland and highland production systems.

The Latin America/Caribbean Basin CRSP project has been very productive. In the five years under review, building on earlier Bean/Cowpea CRSP investments, the program has generated over 14 bean varieties that have been released in the host countries of Central America, including six in Honduras, three in Costa Rica, four in Nicaragua, and one in El Salvador. These have been well accepted by farmers. In Honduras by 2001, four years after the first release, about 40% of farmers reported adoption of the new variety; a variety released in 2004 was planted on 70% of Costa Rica's main bean producing area by 2006. The present value of the increased production made possible by that variety was estimated at about $30 million, well in excess of the total research costs, including those of CIAT, the national program and the CRSP.

Currently, releases of small red beans cultivars with seed types known in Central American and U.S. markets as "Rojo de Seda" are programmed for 2005-06 in all countries of Central America with the exception of Guatemala. Seed of the white cultivar 'Morales,' the red mottled line PR 9745-232 and the small black lines EAP 9712-13 and DOR 390 are being increased in Haiti for release in 2006.

CRSP-funded work has demonstrated in peer-reviewed research the cancer tumor-depressing effect of bean consumption in animal models.

Nearly 40 students have completed their degree work between 2002 and 2005 and another 23 are currently studying for their degrees with CRSP support. Over 60 published peer-reviewed scientific papers and approximately 40 other publications have been produced with support from the current regional project. During the current grant period, $3,862,163 was obligated for the Latin America and Caribbean Basin Regional Project to support research and training activities at the participating Host Country and U.S. universities.

LAC1-A1: Assessment of Constraints to Expanding Bean Supply in Central America

Principal Investigators and Institutions:

Richard Bernsten, Michigan State University, U.S.; Abelardo Viana Ruano, Guatemala

Collaborators and Institutions:

Juan Carlos Rosas, EAP-Zamorano, Honduras; Jim Beaver, University of Puerto Rico, U.S.; Eric Crawford and Russ Freed, Michigan State University, U.S.; Peter Jones, CIAT; Juan Carlos Hernandez, INTA/MAG, Costa Rica

Total Activity Budget[1]: $263,583

Background, Objectives and Progress

This activity has focused on what bean farmers will need to do to remain competitive in an increasingly globalized world – to acquire new technologies that increase productivity by increasing yields and/or reducing costs. The research activity analyzes varietal adoption, assesses seed supply options, compiles data for setting research priorities, and assesses the potential of available technologies to increase bean profitability.

Specific research objectives are:

- Adoption of improved bean varieties in Central America (El Salvador, Costa Rica).
- Strengthening bean seed supply and distribution in Honduras.
- Characterizing the dispersion of abiotic and biotic constraints in the Americas.
- Constraints to higher bean yields in Honduras.
- Assessing the socioeconomic impact of participatory plant breeding in Honduras.
- Assessing the potential for bean crop insurance for increasing productivity and farmers' incomes.

In Costa Rica, farmers have widely adopted three recently-released improved bean varieties (Beribi, Cabecar, Telire), which were planted (2004) on 70% of the bean area in the country's main bean producing areas. Farmers cited yield, disease resistance, and adaptation to diverse growing condition as reasons for adoption. Participatory plant breeding and collaboration with farmer organizations enhanced the speed and depth of adoption.

In Honduras, farmers have limited access to seed of improved bean varieties, due to the high cost of certified seed and a weak distribution system. The study found that it is feasible to contract small farmers (supervised by EAP) to multiply seed of improved varieties and market the commercial quality seed through a local input supplier (DUWEST). Over 45% of the surveyed farmers (2002) were willing to pay Lp. 12/lb for the improved variety Amadeus 77—a price which was substantially below the cost of certified seed (Lp 17/lb) but above the cost of producing and marketing commercial quality seed, which will give the seed growers and DUWEST acceptable profits.

[1]The "total activity budget" reported here and in other activities reflects the total sum of USAID funds budgeted for research and training in the grant period under review (from FY 02B-03 to FY 07).

To set bean research priorities, scientists require better information on the distribution of stresses that constrain bean yields. This study uses GIS and key informants to characterize bean growing environments (agroclimatic condition, biotic and abiotic stresses) in Central America (primary foci) and other countries in the Americas. The maps, plus descriptive/statistical data are included in "A Bean Atlas of the Americas," a valuable tool for plant breeders, policy makers and industry.

While experimental data indicates that Honduran farmers could increase their bean yields and profit by adopting recommended technologies, most farmers have not adopted these recommendations. This study conducted farmer-managed on-farm trials and farmer surveys to assess the performance of recommended technologies (variety, fertilizer, herbicide) and to identify why farmers did not adopt the recommendations. Initial results showed that recommendations were profitable under favorable environmental conditions, but not so in drought conditions; that farmers believed that they were using optimal amounts of fertilizer whereas they were not; and that farmers liked the growth characteristics of improved varieties, but not their market characteristics.

Observations and/or Recommendations

This project has demonstrated how economists and plant breeders can effectively collaborate to advance the development of appropriate technology. It has used CRSP financial resources exceedingly well, mobilizing matching funds and other resources to complement limited CRSP funds. The studies have documented the impact of CRSP research in Central America and have documented a model for strengthening seed production systems. Unfortunately, it has not been possible to identify an agricultural economist counterpart for the regional work because of the high demand by the international donor agencies for such persons.

LAC1-A2: Enhancement of the Sustainability of Bean Production Systems through Technology and Policies that Improve Production Management

Principal Investigators and Institutions:

Scott Swinton, Michigan State University, U.S.; Eduardo Peralta, INIAP, Ecuador

Collaborators and Institutions:

Julio Lopez, EAP-PROMIPAC, Nicaragua; Alredo Rueda, EAP, Zamorano, Honduras; Christian Subia, INIAP, Ecuador

Total Activity Budget: $271,111

Background, Objectives and Progress

It is perceived that bean growers spray large amounts of pesticides at considerable cost to control a range of insect pests including slugs ("babosa" or *Vaginilus plebelus fisher*), caterpillars ("gallina ciega" or *Phyllophaga spp.*) and bean pod weevils ("picudo" or Apion godmani; Apion aurichalceum). Some of the pesticides used to control these pests pose hazards to the health of the farm households that use them. Integrated pest management (IPM) is widely expected to reduce the

misinformed use of pesticides in beans and other crops, and hence pesticide-related health risks. Both traditional IPM extension programs and farmer field schools (FFS) have been used to disseminate IPM. Due to significant resources invested in IPM extension via both FFS and other methods, there is considerable interest in whether these programs have been effective at combating poverty and reducing the health and environmental risks associated with pest management. In order to assess the effectiveness of the farmer field school approach to IPM training, a household survey was conducted in 66 communities in Honduras in 2004.

Results indicated that the field schools are effective at inducing adoption of IPM methods, especially insect scouting, botanical insecticides, and yellow sticky traps. Although farmers are largely aware of pesticide risks to human health, only farmers exposed to IPM training can recognize beneficial insects (a necessary condition for protecting these environmental assets). Bean farmers use fairly modest applications of highly toxic pesticides but, despite widespread adoption of IPM practices, farmers exposed to field school training use no less toxic pesticides, and their reported incidence of pesticide poisoning is no lower than among farmers exposed to other extension IPM approaches. The study also finds that NGOs extending IPM methods differ substantially in their success at increasing farm incomes and reducing pesticide risk exposure. NGOs that are larger and have a longstanding commitment to agricultural pest management are more effective than others.

The impact of new disease-resistant bean varieties in the Chota and Mira river valleys of Ecuador are also being assessed in collaboration with the agriculture economists of INIAP/Ecuador. The current and future adoption rates of new INIAP bean varieties are being estimated as well as their impact on family incomes and on family health through comparing improved variety adopting households to non-adopting households. It is hypothesized that the adopters of new varieties will use less pesticides, which will reduce bean production costs as well as environmental pollution and health risks to farmers.

Observations and/or Recommendations

These studies provided needed insights into the potential environmental and health risks of pesticide use in bean production systems and the benefits to the use of improved varieties which possess effective disease resistances. The justification for investments in this research area should be re-evaluated especially if the availability of future research funding is limited.

LAC1-A3: Enhancement of Demand and Market Opportunities for Beans and Value-Added Products from Central America and the U.S.

Principal Investigators and Institutions:

Richard Bernsten, Michigan State University, U.S.; Abelardo Viana Ruano, PROFRIJOL, Guatemala

Collaborators and Institutions:

David Schweikhardt and Chris Peterson, Michigan State University, U.S.

Total Activity Budget: $206,961

Background, Objectives and Progress

In recent years, U.S. bean exports have declined and imports of beans from abroad have increased. Thus, the U.S. bean industry is increasingly concerned about the competitiveness of the U.S. bean industry. An analysis of recent trends in bean imports/exports was conducted to document the magnitude of these changes (by market class), identify which countries are increasing their market shares in traditional U.S. export markets, countries capturing an increasing share of the U.S. domestic market and identify factors associated with these trends.

Competitive capacity was found to be closely related to policy factors in importing countries, U.S. domestic farm policy, NAFTA and other policy factors as well as relative to production efficiency among growers from Canada, the U.S. and Mexico.

Observations and/or Recommendations

This research has been extremely well received by the U.S. bean industry. The U.S. industry not only appreciates the biological research supported by the CRSP, which provides a kind of early warning system for potential insects and pathogens that may affect the U.S. industry in the future, it also appreciates the kind of industry-wide economic outlook provided in this project.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
LAC1	Horacio	Gonzalez	Mexico	MSU	Ph.D.	Ag Economics	1998	2003
LAC1	Wolfgang	Pejuan	Honduras	MSU	Masters	Ag Economics	2001	2005
LAC1	Lourdes	Martinez	Paraguay	MSU	Masters	Agricultural Economics	2001	2003
LAC1	Ricardo	Labarta	Peru	MSU	Masters	Agricultural Economics	2002	2004
LAC1	Miguel	Zamora	Ecuador	MSU	Masters	Agricultural Economics	2002	2004
LAC1	Feliciano	Mazuze	Mozambique	MSU	Masters	Agricultural Economics	2002	2004
LAC1	Orlando	Mejia	Honduras	MSU	Masters	Agricultural Economics	2003	Active
LAC1	Jamie Gustavo	Puente Asquet	Ecuador	MSU	Masters	Agricultural Economics	2003	2005
LAC1	Ricardo	Labarta	Peru	MSU	Ph.D.	Agricultural Economics	2004	Active
LAC1	Wolfgang	Pejuan	Honduras	MSU	Ph.D.	Agricultural Economics	2005	Active
LAC1	Byron	Reyes	Ecuador	MSU	Masters	Agricultural Economics	2005	Active
LAC1	Crystol	Jones	U.S.	MSU	Masters	Agricultural Economics	2005	Active
LAC1	Daniel	Mooney	U.S.	MSU	Masters	Agricultural Economics	2005	Active
LAC1	Lara	de Ville	Philippines	MSU	Masters	Agricultural Economics	2006	Active

\a Degree completion status as of reporting year FY05.

LAC2-A1: Enhanced Bean Utilization in the U.S. and Central America

Principal Investigators and Institutions:

Suzanne Nielsen, Purdue University, U.S.; Ana Ruth Bonilla, Universidad de Costa Rica, Costa Rica

Collaborators and Institutions:

Richard Bernsten, Michigan State University, U.S.; Gladys Flores, EAP-Zamorano, Honduras; Industrial Advisory Board Members; Consumer Focus Groups

Total Activity Budget: $380,458

Background, Objectives and Progress

Past CRSP research on bean nutrition and utilization has focused largely on nutrient bioavailability (especially of protein, starch, and minerals), cooking time, and using germination or fermentation processing technologies to develop bean-based weaning foods. These aspects of bean utilization remain relevant for bean breeders as they screen germplasm for various traits.

Research on bean utilization must include consideration of market potential, nutritional value and consumer acceptance. Such work will create an interest in the private sector for beans as ingredients and processed products, leading to commercialization of products and increased consumption of bean-containing products.

The overall objective of the project is to develop value-added, bean-based ingredients and final products with high nutritional value, consumer acceptance and market potential. Food product development work, whether in the U.S. or another country, must: a) determine what is already on the market (Objective 1), b) generate ideas for new products to develop (Objective 2), c) formulate the product and find the most appropriate means to process and package the product (Objective 3) and d) measure the quality attributes of the product (Objective 4). These four objectives have guided this project.

A number of products including baked bean and rice chips, low-fat bean muffins and bean cookies were developed and evaluated in Costa Rica. To evaluate the properties of the nutritious, bean-based products under development, several methods of analysis have been evaluated using the bean matrix. The protocol for the enzymatic analysis of resistant starch (AOAC Method 2002.02 and AACC Method 32-40) using the bean matrix (*Phaseolus vulgaris*, Bribri variety) was established. The protocol was established for the alpha-amylase inhibitor method.

Observation and/or Recommendations

While appreciating the potential value of such work for increasing final demand, it appears that consumer product development might better be conducted in the private sector where immediate steps to assess potential consumer demand and commercialization of resulting products would be possible.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
LAC2	Devon	Durkee	U.S.	Purdue	Masters	Food Science	2002	2004
LAC2	Yury Rodolfo	Reyes-Castillo	Honduras	UnCR	Masters	Food Science	2004	Active
LAC2	Cynthia	Machado	Ecuador	Purdue	Masters	Food Science	2004	Active
LAC2	Maria	Castro	Costa Rica	Purdue	Masters	Food Science	2006	Active

\a Degree completion status as of reporting year FY05.

LAC3-A1: Increasing Knowledge on the Nutritional and Health Benefits of Beans and Cowpeas as Related to Reducing the Incidences of Cancers and Chronic Diseases

Principal Investigators and Institutions:

Maurice Bennink, Michigan State University, U.S.; Helen Jacobs, University of West Indies, Jamaica

Collaborators and Institutions:

Maria Jackson, University of West Indies, Jamaica

Total Activity Budget: $301,660

Background, Objectives and Progress

Many countries in the Caribbean region have experienced an unprecedented epidemiological transition in the last 35 years. During this transition, total food availability has greatly improved, but much of the increase in caloric intake is due to fat. Increased caloric and fat intake has led to a dramatic rise in heart disease, stroke, diabetes, obesity and cancer (i.e., chronic diseases). Age standardized cancer mortality in the English-speaking Caribbean is comparable to the U.S. where cancer is the second leading cause of death and accounts for 23% of all deaths. Unfortunately, the Caribbean economies have not improved much and the majority of the population cannot afford cancer treatment making prevention extremely important in countries in the LAC region.

Extensive research has identified dietary components that enhance or decrease cancer at various sites in the body. In a few instances, clear cause and effect have been established. Also, during the past two decades, several consensus reports by large groups of experts in the area of diet and cancer have been published. The World Health Organization recommended daily consumption of 30g of pulses (including nuts and seeds) to reduce the occurrence of cancer.

This research seeks to:

- Determine the efficacy of beans to inhibit colon cancer.
- Delineate anti-cancer action elicited by bean constituents.
- Identify potential anti-cancer constituents in beans.

To understand the importance of bean consumption to reduce chronic diseases such as colon cancer, the project is evaluating the effects of feeding beans on the incidence of colon cancer in rats. In the first study, feeding black beans or navy beans inhibited ($P < 0.05$) tumor incidence by 50–60%. Tumor multiplicity was also significantly lower ($P < 0.05$) in rats fed black (1.1) and navy (1.0) bean diets compared to rats fed the control diet (2.2). In follow-on studies to determine mechanisms to explain how eating beans could reduce colon cancer, feeding black beans decreased colon tumor incidence by 79 and 67% in a randomized feeding trial with rats, thus confirming the first study. Global gene changes associated with inhibition of colon cancer by black beans were associated with innate (anti-microbial) defense and immune response and attenuation of genes involved in inflammation, tissue repair, and cell proliferation. Transcripts repressed with increased carcinogenesis were associated with cell-cell

communication and ion transporters. Quantitative reverse transcription-polymerase chain reaction (RT-PCR) was used to confirm changes in key enzymes. The profile of gene changes suggested that feeding black beans protected against colon cancer by: 1) maintaining a better barrier against enteric microflora, 2) reducing inflammation in the colon mucosa, and 3) enhancing crypt cell differentiation.

An epidemiological study to understand the potential contribution of diet (117 food and drink items) to prostate cancer in Jamaica comprises a second aspect of the research. The Men's Prostate Health Questionnaire is being used to collect dietary data (twelve 24-hour recalls to represent all days of the week). Subjects will be followed for one year in order to obtain data on usual patterns of consumption. Data collection for the main study began in September 2004. New patients attending urology clinics at the University Hospital of the West Indies (UHWI) were recruited for enrollment in the study. One hundred and sixty two (162) males attending urology clinics at the University Hospital of the West Indies (UHWI) have been enrolled in the study to date.

Observations and/or Recommendations

These studies illustrate how a relatively small amount of well-directed funding can produce important results. If the active constituents of beans that affect cancer incidence can be identified and popular bean varieties enhanced through plant breeding, the potential public health benefits are large. Although one element of the work is located in Jamaica, by its nature it is cross-cutting and perhaps should be considered not as part of the LAC regional project but rather as an element of a global cross-cutting CRSP activity. This component also has little link to other CRSP work.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
LAC3	Elizabeth	Rondini	U.S.	MSU	Ph.D.	Food Science and Human Nutrition	2001	2005
LAC3	Sharon	Hooper	Jamaica	UWI	Ph.D.	Food Chemistry	2002	Active
LAC3	Candace	Simpson	Jamaica	UWI	Ph.D.	Nutrition Epidemiology	2004	Active
LAC3	Kathleen	Barrett	U.S.	MSU	Ph.D.	Food Science and Human Nutrition	2006	Active

\a Degree completion status as of reporting year FY05.

LAC-CC1-A2: Gender and Participatory Research in the Improvement of Bean Varieties (Phaseolus vulgaris L.) and Seed Production Systems in the Andean Highlands of Ecuador

Principal Investigators and Institutions:

Anne Ferguson, Michigan State University, U.S.; Eduardo Peralta, INIAP, Ecuador

Collaborators and Institutions:

Diane Ruonavaara and James Kelly, Michigan State University, U.S.; Nelson Mazon, INIAP, Ecuador

Total Activity Budget: $153,728

Background, Objectives and Progress

One-third of Ecuador's people live in extreme poverty and another one-third is in such poverty that they also cannot afford a basic basket of goods. In the rural sector, particularly in Afro-Ecuadorian and indigenous communities, 60% are in extreme poverty and nearly all the rest in poverty. In these communities, women's role in agriculture is becoming increasingly important as men migrate in search of employment. The state has systematically neglected the countryside while at the same time, the globalization of markets has led to rapid and profound changes in agriculture and rural development. Participatory Research (PR) is one model that may help offset some of these factors and contribute to more sustainable development.

The CRSP has supported such a PR approach in Ecuador, where Committees of Local Agricultural Research (CIAL) are established to provide research services through a partnership of farmers, scientists and agricultural technicians to identify potential solutions to local agricultural problems. Problems are identified through a participatory evaluation process, agricultural technologies are tested and findings are reported and disseminated to farmers. In the valleys of Río Chota and Río Mira, approximately 7000 ha of beans are planted annually. Beans are the most important crop, the main source of protein and carbohydrates in the local diet, as well as a source of family income. CIALs have been established in four communities in the valleys: La Concepción and Santa Lucía, El Tambo and San Clemente. These have facilitated PR with the objectives of:

- Evaluating bean lines and varieties with genetic resistance to biotic and abiotic factors.
- Improving production and distribution of seeds selected for the local farming systems.
- Identifying best practices for participatory research and evaluation with women and men of marginalized communities.

The CIAL methodology consists of eight steps: Motivation, Election of the CIAL officers, Participatory Rural Diagnostic, Planning of the Trial, Evaluation of the Trial, Analysis of the Results and Dissemination of Information to the Community.

Since 2002, the four communities evaluated 31 red mottled, seven yellow and seven white lines or varieties of bush bean. In La Concepción, farmers evaluated red mottled lines and varieties. The other communities evaluated yellow and white lines and varieties. In all four communities, the main selection criteria identified by men and women farmers during flowering and/or pod set were resistance to disease, plant development, number of seeds per pod, size of pod, number of pods per plant and early maturity. Criteria for the evaluation of seeds were size, health, color, shininess (*brillo*) and yield. Men and women were both involved in the activities and identified lines that were best for their communities. The CIALs subsequently planted to multiply and produce good quality seeds of the selected materials which were then distributed to the community.

Observations and/or Recommendations

The project has demonstrated that poor farmers can be empowered to select varieties and learn about production practices quickly and effectively, and that they can influence breeders thinking about the importance of specific traits such as early maturity and seed quality. Linking closely with plant breeders

who have crossed promising materials to generate a set of lines from which the CIALs can make selections is a rapid and efficient approach to participatory research. Spreading such varieties widely beyond the selecting communities will depend on how similar other communities are and whether seed multiplication can be added to the new skills of variety selection.

LAC4-A1: Genetic Improvement of Bean Adaptation to Low Fertility Soil

Principal Investigators and Institutions:

Jonathan Lynch, Pennsylvania State University, U.S.; Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano, Honduras; Nestor Felipe Chavez, University of Costa Rica, Costa Rica

Collaborators and Institutions:

James Beaver and David Sotomayor, University of Puerto Rico, Puerto Rico; Stephen Beebe, Matthew Blair and I. Rao, CIAT, Colombia; Kathleen Brown, Pennsylvania State University, U.S., Emmanual Prophete, MAG, Haiti

Total Activity Budget: $383,220

Background, Objectives and Progress

The overall goal of this project is to realize the promise of developments in scientific understanding of root biology and plant nutrition that make it possible to breed crops with greater nutrient efficiency and acidity tolerance. Such crops will improve productivity, increase economic returns to fertility inputs, and may enhance overall system sustainability, without requiring additional inputs. Two specific objectives are to improve genetic adaptation to low phosphorus availability and manganese toxicity.

Progress has been constrained by a limited understanding of the specific root traits that enhance phosphorus acquisition, their metabolic costs, genetic control, and potential agro-ecological impacts, thereby limiting the ability to select and breed superior genotypes and the ability to predict the impact of such genotypes on bean production systems. This activity identifies specific root traits that enhance phosphorus acquisition and characterizes the genetic control of these traits. It evaluates the effect of these traits in crosses between potential genetic sources of low P and drought tolerance with small red and black elite lines through selection in P-limited soil conditions.

Manganese (Mn) toxicity is an important constraint to bean production in the tropics. Bean genotypes vary substantially in their tolerance to Mn toxicity. This activity systematically characterizes bean breeding lines for Mn toxicity, to identify sources of Mn tolerance as well as to aid in the interpretation of field screening results in low fertility environments, where Mn toxicity is often a serious but intermittent stress factor. Seventy genotypes of regional importance were studied in field and greenhouse studies identifying substantial genetic variation in Mn tolerance. Comparison of several seasons of results indicates that a rapid field screening method is capable of detecting coarse differences in Mn tolerance. This is particularly important for Mn since the severity of Mn toxicity is influenced by rainfall and light intensity and thus is very difficult to control in field conditions.

Observations and/or Recommendations

This work is one of the very few such serious, high quality research projects on plant roots world-wide. The genetic control over root traits that are being identified may have applicability to a wide range of crops thereby multiplying the impact far beyond beans. The U.S. researchers have a comparative advantage in such work and have leveraged outside funding. The CRSP is commended for its inclusion. It illustrates how a diverse set of researchers from different institutions can advance knowledge more rapidly by working together on a problem than they could have by working alone. This component might well be one categorized as a cross-cutting activity rather than one specific to LAC.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
LAC4	Ivan	Ochoa	Colombia	PSU	Ph.D.	Horticulture	2000	Active
LAC4	Magalheis	Miguel	Mozambique	PSU	Masters	Horticulture	2002	2004
LAC4	Laurie	Morrow de la Riva	U.S.	PSU	Masters	Horticulture	2002	Active
LAC4	Ann	Widrig	U.S.	PSU	Masters	Horticulture	2004	Active

\a Degree completion status as of reporting year FY05.

LAC5-A1: Develop Improved Bean Cultivars for the Lowland Production Regions of Central America and the Caribbean

Principal Investigators and Institutions:

James Beaver, University of Puerto Rico, Puerto Rico, U.S.; Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano, Honduras

Collaborators and Institutions:

Aurelio Llano, INTA, Nicaragua; Danilo Escoto, DICTA, Honduras; Carlos Atilio Pérez, CENTA, El Salvador; Juan Carlos Hernandez, INTA, Costa Rica; Emmanuel Prophete, CRDA, Haiti; Julio Cesar Villatora, ICTA, Guatemala; Feiko Ferwerda, University of Puerto Rico; Jonathan Lynch, Pennsylvania State University; Rick Bernsten, Michigan State University; James Steadman, University of Nebraska; Graciela Godoy, CEDAF, Dominican Republic; Eladio Arnaud-Santana, IDIAF, Dominican Republic; Tim Porch, USDA-ARS/TARS, U.S.; Phil Miklas, USDA, WA

Total Activity Budget: $584,591

Background, Objectives and Progress

The development of bean cultivars with enhanced levels of disease resistance and abiotic stress tolerance has proven to be effective for increasing bean production in both the U.S. and the Central America/Caribbean region. The development and release of improved bean cultivars is the result of the collaborative effort of a team of plant pathologists, agronomists and plant breeders supported by the Bean/Cowpea CRSP.

Each year, over 60 regional performance trials including small red, black and red mottled bean lines are distributed to collaborators in Central America and the Caribbean. Results from regional performance trials, which are used to justify the release of future cultivars, are a valuable tool to maximize the impact of the lowland bean breeding team. Bean breeding lines developed from recurrent selection and interspecific crosses have greater web blight resistance than the check cultivar 'Talamanca.' Marker-assisted selection was used to develop red mottled, black- and white-seeded lines that combine bean golden yellow mosaic (BGYM), bean common necrotic mosaic (BCNM) and rust resistance. White and small red breeding lines have been developed that combine BGYM and common bacterial blight resistance. Resistance to pod deformation caused by BGYM was found to be controlled by a single dominant gene (*Bgp-1*).

Research on pathogen biology and variation has been critical for devising disease management strategies for two disease constraints to bean reproduction in LAC and ESA regions. Studies using disease reactions of isolates of the rust pathogen on differential bean genotypes have been conducted both in greenhouses and by deployment of mobile nurseries. High virulence diversity found in Honduras is likely due to the proximity of wild, weedy and landrace beans to small and large landholder production fields. Isolates from Africa in general were less virulent than those from Middle America. Resistance gene deployment strategies such as using Middle America origin genes for Mozambique and Andean countries and needing to pyramid genes from both origins for Honduras and other Middle American countries were derived from virulence diversity information.

Observations and/or Recommendations

Well-adapted, productive varieties are the delivery mechanism for much of the knowledge developed in the biological research of the Bean-Cowpea CRSP. This project has been highly effective over the years, delivering many varieties that are being adopted and grown by farmers in Central America. The regional program's record of progress was possible because of good organization, continuity of support and strong collaboration. The importance of continuity of support is illustrated by looking at the tale of one variety: Amadeus 77, the variety released in Honduras in 2003, had been entered in the regional yield trials in 2000, distributed as one of the entries in regional breeding nurseries in 1998, selected in 1997 from the F_7 generation of a cross made in 1995. The 1995 cross was between Tio Canela, the variety released in 1996, and CIAT breeding lines developed to have pod weevil resistance and good seed type. Those breeding lines, in turn, had been developed over the previous several years and, of course, Tio Canela itself was the result of a similar process involving CIAT, U.S. universities and national programs. This one variety, Amadaus 77, thus embodies the work of many different scientists and organizations over several decades, and it continued, having been released in four additional countries since 2004. This is a powerful testimony to the power of sustained agricultural research in the CRSP mode.

LAC5-A2: Development of Sustainable Disease Management Strategies for Bean Rust and Web Blight

Principal Investigators and Institutions:

James Steadman, University of Nebraska, U.S.; Graciela Godoy-Lutz, CEDAF, Dominican Republic

Collaborators and Institutions:

Juan Carlos Rosas, EAP-Zamorano, Honduras; James Beaver, University of Puerto Rico, U.S.; Eduardo Peralta, Jorge Venegas and Angel Murillo, INIAP, Ecuador; James Kelly, Michigan State University, U.S.; Fernando Aldana, ICTA, Guatemala; Lindsay Hansen, Maricelis Acevedo, Celestina Jochua, University of Nebraska, U.S.; Soon Park, Texas A&M University, U.S.; M.S. Pastor Corrales and Cathie Aime, ARS, USDA, Beltsville, U.S.; Angela Alleyne, Edward Waters College, U.S.

Total Activity Budget: $430,223

Background, Objectives and Progress

Diseases are the major factor reducing bean yields and Central America is a center of genetic diversity for both the common bean and its pathogens. Some of the most virulent patho-types of the bean rust and web blight pathogens are found in Central America/Caribbean (CA/C). This diversity provides an ideal environment for plant pathologists to study pathogen variability and design strategies for resistance gene deployment.

Information derived from anastamosis grouping, phylogenetic analysis and virulence tests of the web blight pathogen has guided disease management options. New subgroups of the web blight pathogen have been found with implications for epidemiology and disease management, e.g., some are seed transmitted and have variable virulence. Subgroup specific DNA primers are used to test seed health and pathogen variation. Knowledge of local subgroups is necessary for disease management through deployment of disease resistance genes. A third disease constraint, bean common necrosis mosaic, appeared in the Dominican Republic after 2000. This disease is also a major problem in parts of Africa. The detection and confirmation of a new necrotic strain of bean common mosaic virus was possible because of institutionalization of the bean research program in the Dominican Republic. Enzyme-linked immunosorbent assay (ELISA) was used to assay foundation seed lots and eliminate 454 MT of contaminated seeds from the market. Contaminated foundation seed is a source of the virus in many developing countries, such as Haiti, that lack seed certification programs. LAC breeding programs have introduced resistance genes (*I* with *bc-3* or *bc-12*) into different seed classes to prevent spread of the virus.

Mobile nurseries allow characterization of pathogen variability in the field and improved techniques have been developed for screening for web blight and rust resistance. In addition to studying virulence patterns in the field, the University of Nebraska-Lincoln (UN-L) and Dominican Republic (DR) scientists have unique and comprehensive collections of the rust and web blight pathogens that have permitted preliminary characterization of these pathogens using classical and molecular techniques.

Observations and/or Recommendations

This CRSP project has brought the knowledge and commitment of the world's leading bean pathologists to bear on problems in LAC with excellent effect. The research has led to the development of bean germplasm and cultivars for CA/C and the U.S. with enhanced levels of rust resistance. The close interaction of pathologists with plant breeders and the use of modern molecular approaches to develop markers for important diseases provide an effective approach to fight against such diseases. This project might also be considered cross-cutting, rather than LAC specific.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
LAC5	Juan Manuel	Osorno	Colombia	UPR	Masters	Plant breeding/ genetics	2000	2003
LAC5	Angel	Murillo	Ecuador	UPR	Masters	Agronomy	2001	2003
LAC5	Jose	Aponte	U.S.	UPR	Masters	Plant Breeding and Genetics	2002	2004
LAC5	Celestina	Jochua	Mozambique	UN-L	Masters	Plant Pathology	2002	2004
LAC5	Sylvia	Chacon	El Salvador	EAP	B.S.	Food Technology	2003	2003
LAC5	Jaime	Salazar	Ecuador	EAP	B.S.	Plant Science	2003	2003
LAC5	Jover	Martinez	Paraguay	EAP	B.S.	Plant Science	2003	2003
LAC5	Samata	Zeledon	Ecuador	EAP	B.S.	Plant Science	2003	2003
LAC5	Marecelis	Acevedo	U.S.	UPR	Masters	Agronomy/Soil Science	2003	2004
LAC5	Nancy	Gonzalez	U.S.	UPR	Masters	Plant Breeding and Genetics	2003	2004
LAC5	Becky	Herrera	Ecuador	EAP	B.S.	Plant Sciences	2004	2004
LAC5	Fabian	Arroyo	Ecuador	EAP	B.S.	Plant Sciences	2004	2004
LAC5	Marecelis	Acevedo	U.S.	UN-L	Ph.D.	Plant Pathology	2004	Active
LAC5	Lindsay	Hanson	U.S.	UN-L	Masters	Plant Pathology	2004	Active
LAC5	Gasner	Demosthene	Haiti	UPR	Masters	Agronomy & Soils	2005	Active
LAC5	Fernando	Pulla	Ecuador	EAP	B.S.	Plant Sciences	2005	Active
LAC5	Damián	Pulla	Ecuador	EAP	B.S.	Plant Science	2005	2005
LAC5	Victor	Taleón	Honduras	EAP	B.S.	Food Technology	2005	2005
LAC5	Nelson	Proaño	Ecuador	EAP	B.S.	Plant Sciences	2005	Active
LAC5	Nancy	Gonzalez	U.S.	UN-L	Ph.D.	Plant Pathology	2005	Active
LAC5	Ronald	Dorcinville	Haiti	UPR	Masters	Soil Science	2006	Active

\a Degree completion status as of reporting year FY05.

LAC6-A1: Development of Improved Bean Cultivars for Highland Production Regions

Principal Investigators and Institutions:

James Kelly, Michigan State University, U.S.; Eduardo Peralta, INIAP, Ecuador; Julio Villatoro, ICTA, Guatemala

Collaborators and Institutions:

Matthew Blair, CIAT; James Beaver, University of Puerto Rico; Angel Murillo, INIAP, Ecuador; George Abawi, Cornell University, U.S.

Total Activity Budget: $348,779

Background, Objectives and Progress

The most serious constraints to bean productivity in Ecuador and other highland areas in Latin America are anthracnose, rust (biotic stress factors) and drought (an abiotic stress factor), according to recent surveys conducted by the national research program and CIAT. Other factors contributing to reductions in bean yield and quality in the region include: halo blight, virus, mildew and low soil fertility. Drought, whether intermittent or terminal, negatively affects >70% of the bean production area in the LAC region, and can be intensified by high temperatures, shallow infertile soils and root rotting pathogens.

This research aims to:

- Establish field screening nurseries in Ecuador and Guatemala to evaluate performance, adaptation, disease resistance and to better understand consumer markets through stronger collaborative ties with CIAT.
- Broaden the genetic base of the regional drought screening nursery and evaluate the nursery at sites in Ecuador and Guatemala.
- Initiate the introgression of new resistance sources into local germplasm.

Observations and/or Recommendations

Hundreds of new crosses are made each year to introduce new genetic variation that holds promise. Evaluation of the products of such crosses made in 1996 in collaboration with several CIALs facilitated participatory research with farmers and led to the selection and release of three varieties in Ecuador. Seed multiplication of improved varieties and its distribution has provided farmers in the CIALs with income from seed production and the opportunity to grow more productive, better adapted varieties.

LAC6-A2: Identification and Deployment of Resistance Genes for Anthracnose, Rust and Drought in Beans for the Highlands Using Modern Molecular Genetics Tools

Principal Investigators and Institutions:

James Kelly, Michigan State University, U.S.; Julio Villatoro, ICTA; Guatemala; Eduardo Peralta, INIAP, Ecuador

Collaborators and Institutions:

Dr. George Abawi, Cornell University, U.S.; Jose Ochoa and Angel Murillo, INIAP, Ecuador; Francisco Ibarra, INIFAP, Mexico

Total Activity Budget: $346,696

Background, Objectives and Progress

The characterization of the race structure of the major fungal pathogens, chiefly anthracnose and rust in Ecuador, and the development of gene deployment strategies to extend genetic resistance to both pathogens is needed. Both anthracnose and rust are well known for their pathogenic diversity that can render a cultivar resistant in one location and susceptible in another. Based on extensive research on the variability present in *C. lindemuthianum* in certain Latin American countries, it is believed that the anthracnose races present in Ecuador would most likely be Andean in origin. However, surveys need to be conducted to confirm these preliminary observations and access the genetic diversity of the pathogen present in Ecuador and Guatemala.

The success of any collaborative program depends on the ability to develop, multiply and distribute germplasm in sufficient quantities for testing. Since drought is a focus of this activity, the Bean/Cowpea CRSP LAC scientists continue to collaborate with regional programs and CIAT to

gain access to expertise, germplasm and facilities to assist in breeding drought resistance into improved bean varieties for the highlands of LAC. In Ecuador, efforts are being made to transfer the molecular technologies to the local level in terms of personal training and institutional development for educational and research purposes. To facilitate the pyramiding of resistance genes, linked molecular markers are being deployed in breeding for rust, anthracnose resistance and QTL for root rot and drought resistance. This work will ultimately have to be conducted by scientists in Ecuador, so training and institutional building is an essential part of this research component to ensure the future success of the program.

The research focuses on the following objectives:

- Collect isolates of anthracnose, rust and root rot pathogens in Ecuador.
- Characterize pathogenic variability of anthracnose, rust and root rot isolates collected in Ecuador.
- Develop drought tolerant recombinant inbred line (RIL) populations for testing in Ecuador, Central America and East Africa.

Observations and/or Recommendations

Assisting Ecuadorian researchers to use modern molecular markers to characterize two anthracnose resistance genes from the Andean and Middle American gene pools and to use those genes in breeding is a significant accomplishment. The Ecuadorian lab has considerable capacity and might be funded to work with collaborators. Likewise, working to improve the drought tolerance traits of potential bean varieties is likely to generate useful results in the longer term. As with several other projects, the CRSP faces the challenge of building sustainable institutional linkages with programs that are not yet mature enough to be self-sustaining.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
LAC6	Veronica	Vallejo	U.S.	MSU	Ph.D.	Plant breeding/ genetics	1999	2005
LAC6	Robyn	Cotting (nee Engleright)	U.S.	MSU	Ph.D.	Plant breeding/ genetics	1999	2005
LAC6	Rigoberto	Rosales	Mexico	Colegio de Postgraduados	Ph.D.	Plant Phyisology	2001	2004
LAC6	Emmalae	Ernest	U.S.	MSU	Masters	Plant Breeding and Genetics	2002	2004
LAC6	Esteban	Falconi	Ecuador	MSU	Masters	Plant Breeding and Genetics	2003	2005
LAC6	Jennifer	Wagner	U.S.	MSU	Ph.D.	Plant Breeding & Genetics	2006	Active

\a Degree completion status as of reporting year FY05.

Table 2. Latin America Regional Project Team

United States PIs		Host Country PIs	
Dr. James Beaver (RF) University of Puerto Rico	Dr. S. Suzanne Nielsen Purdue University	Dr. Ana Bonilla Leiva (Co-Chair) CITA, Costa Rica	Dr. Graciela Godoy-Lutz CEDEF, Dominican Republic
Dr. Maurice Bennink Michigan State University	Dr. James Steadman University of Nebraska	Dr. Juan Carlos Rosas EAP, Honduras	Dr. Helen Jacobs University of West Indies, Jamaica
Dr. Richard Bernsten (Chair) Michigan State University	Dr. George Abawi * Cornell University	Ing. Eduardo Peralta INIAP, Ecuador	Dr. Nestor Chavez University of Costa Rica, Costa Rica
Dr. Anne Ferguson Michigan State University	Dr. Myrna Alameda * University of Puerto Rico	Ing. Julio Cesar Villlatoro ICTA, Guatemala	Dr. Maria Jackson * University of West Indies, Jamaica
Dr. James Kelly Michigan State University	Tim Porch * ARS/USDA, Puerto Rico	Dr. Aurelio Llano * INTA, Nicaragua	Ing. Carlos Atillio Perez * CENTA, El Salvador
Dr. Jonathan Lynch Pennsylvania State University	Dr. Diane Ruonavaara * Michigan State University	Dr. Emmanuel Prophete * CRDA, Haiti	Dr. Steve Beebe * Dr. Matthew Blair * CIAT, Colombia
Dr. Scott Swinton Michigan State University		Mr. Roberto Morales * ICTA, Guatemala	Mr. Cristian Subia * INIAP, Ecuador
		Mr. Angel Murillo * INIAP, Ecuador	Mr. Nelson Mazon * INIAP, Ecuador

* Co-PIs/Collaborators

B. West Africa Regional Project

Summary of West Africa Regional Project

Background and Rational

The West Africa regional project of the Bean/Cowpea CRSP is comprised of five components of research and training activities that engage four U.S. lead universities collaborating with national agricultural research programs (NARPs) and universities in Senegal, Ghana, Zimbabwe, Niger, Nigeria, Cameroon, Benin and Burkina Faso. This regional project provides research and training in all aspects of the cowpea value-chain to promote enhanced cowpea utilization and consumption. Specifically, the areas covered range from genetic research including biotechnology to develop improved varieties of cowpeas, increased productivity of cropping systems, value addition through processing, and economics related to distribution and marketing of cowpeas and their products.

Progress and Findings

The West Africa project has been quite successful in achieving its goals and objectives with a few exceptions. Economic studies to characterize markets and consumer attributes of cowpeas have been successfully carried out and yield data of great value to cowpea breeders. There is strong evidence that such data are being actively used in the breeding programs. The breeding program for cowpeas is making significant progress in developing and releasing cultivars of cowpeas that have market appeal. Research to identify consumer-desired characteristics of cowpeas and cowpea products is required so that ultimately marketplace consumer products can be developed. Finally, the transformation system developed in Higgins' laboratory in Australia will hopefully prove applicable in the genetic improvement of cowpeas. The identification of markers for *M. vibrata* is a significant development so that populations of this insect can be characterized and cultivars of cowpeas identified for resistance.

Observation and/or Recommendations

There are elements of this project that should be supported in a continuing phase of this project. Characterization of consumer-desired traits of cowpeas must be determined so that varieties that have market appeal are developed. Traits include functional properties for use of cowpeas in formulated foods and nutritional properties to determine health benefits and concerns of consuming cowpeas in the diet to the general and sub-populations of society. Furthermore, some activities on identifying appropriate technology for the development of cottage and entrepreneurial business is warranted. However, new product development may be an activity better left to the private sector since the private sector has consumer marketing information and capacity to produce the products within the framework of governmental regulations and accepted good manufacturing standards. The market research already completed in the region has been excellent and serves as a model for application to all countries in which cowpeas are a major human and animal food crop. Developing cultivars for specific regions, understanding the dynamics of cowpeas in crop production systems, and characterizing major pest threats to cowpeas are all worthy of continued investment in research and training in the West Africa region.

WA1-A1: Determination of the Demand and Market Opportunities for Cowpea Grain and Processed Products in West Africa

Principal Investigators and Institutions:

Jess Lowenberg-DeBoer and Joan Fulton, Purdue University, U.S.; Germain Ibro, INRAN, Niger; Mbene Faye, ISRA, Sénégal; Saket Kushwaha, Abubaker Tafawa Balewu University, Nigeria

Collaborators and Institutions:

Moussa Bokar, INRAN, Niger; Ramatou Seydou, Niger

Total Activity Budget: $629,837

Background and Rationale

This component of the Bean/Cowpea CRSP focuses on marketing and trade research with the aim of identifying new market opportunities for cowpea grain and processed products to stimulate economic growth. Research results to date have led to the following researchable hypotheses: a) producers in the western Sahel (e.g., Sénégal and Mali) are not well linked to either the Nigerian or Central African markets. It is hypothesized that use of coastal shipping could reduce transportation costs if quality could be maintained during transit; b) there is poor flow of price and quantity information between some countries. It is hypothesized that better inter- and intra-country market information would facilitate trade and improve incomes for producers and small-scale merchants. Research is needed to determine the extent to which price and quantity information improve the efficiency of markets and the best way to implement an improved market information system; and c) most cowpeas in West Africa are sold as grain and processed at home. The growing urban population and the increasing opportunity cost of women's time suggest that opportunities may exist for more value-added processing. Research is needed to determine the potential for value-added cowpea products that appeal to consumer preferences.

Objectives

Develop cowpea grain marketing opportunities by estimating the economic potential for coastal shipping of cowpeas, developing preliminary estimates of the market value of cowpea cooking time and sugar content, and describing the marketing information system in Sénégal, Niger, Nigeria and Ghana.

- Estimate potential demand for cowpea-based processed products in West Africa.

Progress and Findings

The results of the hedonic analyses provide a better understanding of how consumer preferences affect market prices and preferences. These studies should be shared with IITA and CRSP breeders to better understand traits that would help improve adoption and marketability of new varieties.

Economic research has focused mostly on cowpea grain marketing and economics of cowpea production. The project is developing cowpea grain marketing opportunities through: a) estimation of the economic potential of coastal shipping of cowpeas; b) development of preliminary estimates of the

market value of cowpea cooking time and sugar content; c) describing the marketing information system in Sénégal, Niger, Nigeria and Ghana, and d) estimating the potential demand for cowpea-based processed products in West Africa.

Observations and/or Recommendations

This project has developed a strong regional focus and the collaborators have excellent interaction. There is evidence of outstanding team leadership resulting in teamwork across the region. This work is necessary to understand the flow of cowpeas across the region and the primary consumer attributes that support the pricing structure in the region. This project has adequately addressed the issues and met the research objectives.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
WA1	Augustino	Langyintuo	Ghana	Purdue	Ph.D.	Ag Economics	1998	2003
WA1	Shehu	Musa	Nigeria	ATBU	Ph.D.	Ag. Economics	1998	2003
WA1	Mavuangi	Khonde	D.R.Congo	Purdue	Ph.D.	Ag. Economics	2001	Deceased
WA1	Mohamed	Bokary	Nigeria	ATBU	Ph.D.	Ag. Economics	2001	2003
WA1	Mbene	Faye	Senegal	UFS	Ph.D.	Agricultural Economics	2002	2005
WA1	Bokar	Moussa	Niger	Purdue	Masters	Agricultural Economics	2003	Active
WA1	Germaine	Ibro	Niger	Univ. of Ouagadougou	Ph.D.	Agricultural Economics	2006	Active

\a Degree completion status as of reporting year FY05.

WA2-A1: Development of Cowpea-Based Value-Added Foods with High Nutritive Health Values Preferred by Consumers and Food Processors

Principal Investigators and Institutions:

R. Dixon Phillips, University of Georgia, U.S.; Esther Sakyi-Dawson, University of Ghana-Legon, Ghana

Collaborators and Institutions:

K. Tano-Debrah, E. O. Afoakwa, Agnes Budu, Sam Asuming-Brempong, and O. Sakyi-Dawson, University of Ghana-Legon, Ghana; Jess Lowenberg-DeBoer, Purdue University, U.S.; Manjeet S. Chinnan and Yen-Con Hung, University of Georgia, U.S.; and Paul Houssou, PTTAA-LTA, Benin

Total Activity Budget: $746,449

Background and Rationale

The goal of this research component is to enhance the availability of nutritious, healthful, and affordable cowpea-based foods to consumers in both West Africa and the U.S., while developing prototype-products and processes that increase the income of small-scale food industry entrepreneurs. Research during the current phase of the CRSP has shown that interventions ranging from simply teaching people how to combine staples appropriately, to setting up small-scale manufacturing facilities can succeed in improving both nutrition and income among the rural and urban poor.

Objectives

- Extend existing knowledge and determine consumer preferences and market opportunities for value-added processed cowpea products.
- Develop processed foods with high nutritive and health values, including storable snack and fast foods.

Progress and Findings

The PIs have made excellent progress on incorporating cowpeas into weaning and infant foods. The project has utilized the excellent contact that the PIs have with stakeholders in Ghana and the U.S. Unfortunately, there has not been as much sharing of information and approaches across the WA region due to language and travel problems. In addition, the project team members at the University of Ghana-Legon (UG-L) each have very heavy teaching loads that reduce the time for regional activities. The USAID mission in Ghana is very supportive of the project and suggested that UG-L contact appropriate Ghana agencies to keep them informed on progress on the WA Regional project, especially the developments of biotechnology.

Observations and/or Recommendations

The University of Ghana team is excellent and very dedicated to the project. However, the University of Georgia (UGA) and UG-L have not provided outreach assistance to other countries in West Africa.

Although the UG-L team cited language and travel problems as primary deterrents to further interaction and workshop activity with other WA countries, there is the specific issue of heavy teaching loads of the investigators that limit their time for regional activities. Some thought should be given to assisting the UG-L team so they can recommit themselves to assisting throughout the region on food science issues. The interaction between the U.S. (UGA) and Host Country (UG-L) institutions is an excellent example of peer collaboration.

With regard to product development activity within the CRSP, it is clear that food products are the mechanism to deliver the real value of cowpeas (or any food commodity) to consumers. It is also clear that the food processing industry is in the best position to develop and deliver consumer ready products. Although it is laudable to promote cottage industry activity to produce products, a greater research contribution can be made through research on the social and economic conditions of the populations and their eating habits and preferences and research on the nutritional benefits of the food commodity. Armed with such information, the private sector can then develop and produce food products that will be desired in the marketplace, contribute to economic development and stabilization, and provide healthful benefits to the population. Studies on strategies to develop a cottage-based industry by economists can then be used to encourage cottage industries to meet this market demand.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
WA2	Nicole Sharon	Komey	Ghana	UGA	Ph.D.	Food Science	2000	2004
WA2	Samuel	Yenyi	Ghana	UGL	B.S.	Food Science/ Technology	2002	2003
WA2	Mohammed	Aziz	Ghana	UGL	B.S.	Food Science	2002	2003
WA2	Priscilla	Swanzy-Baffoe	Ghana	UGL	B.S.	Food Science	2002	2003
WA2	Minerva	Plahar	Ghana	UGA	Masters	Food Science and Technology	2002	2004
WA2	Kwame	Andon-Kumi	Ghana	UG-L	Masters	Food Science and Nutrition	2002	Active
WA2	Christine	Atuobi	Ghana	UG-L	Masters	Food Science and Technology	2002	Active
WA2	Afua	Ofori Anti	Ghana	UG-L	Masters	Food Science and Technology	2002	Active
WA2	Fred	Nimoh	Ghana	UG-L	Masters	Agricultural Economics	2002	2004
WA2	Jocelyn Adeline	Lamptey	Ghana	UG-L	B.S.	Food Science and Nutrition	2003	2005
WA2	Melissa	Vanchina	U.S.	UGA	Masters	Food Science and Technology	2003	Active
WA2	Nana Adwoa	Oduro	Ghana	UG-L	B.S.	Food Science and Nutrition	2003	Active
WA2	Adwua	Oduro	Ghana	UG-L	Masters	Nutrition and Food Science	2003	Active
WA2	Mark	Jarrard	U.S.	UGA	Masters	Food Science and Technology	2004	Active
WA2	Sylvia	Sallah	Ghana	UG-L	Masters	Food Science	2004	Active
WA2	Labaran	Asiyatu	Ghana	UG-L	B.S.	Food Science	2004	2005
WA2	Kuutsford	Asiamah	Ghana	UG-L	Masters	Food Science	2004	2005
WA2	George	Annor	Ghana	UG-L	Masters	Food Science and Nutrition	2004	Active
WA2	Eric	Amonsou	Benin	UG-L	Masters	Food Science	2005	Active

\a Degree completion status as of reporting year FY05.

WA3-A1: Enhancing the Sustainability of and Intensifying Cowpea-Based Cropping Systems in Sudano-Sahelian Zones of West Africa and in the U.S.

Principal Investigators and Institutions:

William Payne, Texas A&M University, U.S.; Mohamadou Gandah, INRAN, Niger

Collaborators and Institutions:

Seyni Sirifi, Madame Hamidou Zeinabou, Madame Dahiratou Marafa, Zabieirou Tahirou and Germaine Ibro, INRAN, Niger; Jeff Ehlers and Phil Roberts, UC-Riverside, U.S.; Creighton Miller and Brent Bean, TAMU, U.S.

Total Activity Budget: $411,688

Background and Rationale

Current cowpea cropping systems in West Africa are not keeping pace with food demand, are causing soil degradation, and are becoming less productive. Under these circumstances, they are not sustainable. They must therefore be intensified in manners that meet local food demands, protect or improve the soil resource-base, and generate income. Technologies to accomplish these goals certainly exist, but they require capital and labor, which are often in short supply. Therefore, opportunities for intensification must be evaluated within the context of existing or potential markets and income generation.

Cowpeas can play a key role in intensifying cropping systems and generating income in West Africa because of its multiple uses in human and animal diets. In Niger, Ghana and other West African countries, cowpea grain and fodder are widely traded commodities. Other benefits of increased cowpea production include improved human and animal nutrition, improved soil properties to facilitate

sustainability, more efficient water use, and substantial opportunities for income generation among women, e.g., through marketing of raw or processed cowpea goods or small-scale livestock operations.

The Panhandle region of Texas is also faced with increasingly unsustainable cropping systems in terms of economics, soil degradation, and especially water supply. Drought, low commodity prices, falling water tables, and rising energy and fertilizer costs in recent years have forced many farmers to focus mostly on economic survival. The role of dryland and 'deficit irrigation' agriculture will necessarily increase within the next 20 years because of aquifer depletion and competition with urban centers. This implies reduced and more erratic agricultural production (Postel, 2000; Panhandle Water Planning Group, 2000). Additionally, the predominant wheat/sorghum/fallow dryland rotation is viewed as inefficient in terms of production and water use because of the fallow component, which relies upon tillage for seedbed rotation and fallow management. Fallowing and intensive tillage have degraded the soil resource-base. Because cowpeas are a legume that is adapted to dryland conditions and may hold market opportunities in the local cattle market, which suffers annually from fodder shortage, it has potential to render cropping systems more sustainable in the Texas Panhandle.

Objectives

- To develop and implement sustainable, intensified cowpea-based cropping systems for semi-arid West Africa and Texas. Emphasis is being placed on optimizing agronomic practices for production, sustainable management of soil and water resources, pest management and income generation.

Progress and Findings

In West Africa, alternatives to the current prevailing cropping system (low density cowpea intercropped in low density millet or sorghum) are being examined in experiments that evaluate alternatives to intercropping with fertilizer at two sites in Niger. Preliminary experiments included intercropping, strip cropping, grain-cowpea rotation, a range of planting density, pesticide use, and low, medium and higher levels of fertilizer application at two sites.

The long-term trial now underway at the Station Zootechnique in Kolo, and at the INRAN (Niger) station at Bengou is examining the cropping system, management intensity and cowpea genotype with specific treatments developed in collaboration with INRAN researchers. The experiments will continue for at least two rotations (four years). During the first year, soils were characterized for chemical, physical, and biological properties. In later years, soil organic matter, soil chemical properties, microbial populations and other indicators of sustainability have been periodically assessed. Observations are being made on insect attack, and grain and biomass yield is being measured at harvest. Economic data are generated to facilitate appropriate economic analysis.

In Texas, a cropping system study is ongoing in which cowpeas are planted instead of fallow in a three-year rotation with sorghum and wheat. In addition to yield, soil water content and cowpea fodder digestibility are measured, and disease incidence is assessed. Planning has begun for a much larger field experiment that will include a cropping system (fallow or cowpeas), stocker cattle grazing, and tillage

as treatments. In a complementary effort, the P utilization efficiency of 700 cowpea cultivars from the USDA core germplasm collection are being evaluated.

Observations and/or Recommendations

Research on cropping systems is essential to derive sustainable agricultural practices that will serve the producers well into the future. The research reported in this activity is well thought out and conducted. There is excellent communication and interaction between the investigators. The obvious limitation is that it has application in the specific region, soil type and climactic conditions under which it is carried out. Furthermore, this type of research requires many years of research to validate the findings so that environmental factors can be accounted for in the results. Consequently, in the next iteration of research on cropping systems, allowance must be made to repeat many of these studies for validation and proof of concept. Furthermore, due to microclimates and soil type difference these studies must be repeated under various conditions. The net result is that these studies are long-term, expensive, and essential.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
WA3	Sabiou	Mahamane	Niger	Texas A&M	Ph.D.	Soil & Crop Sciences	2002	Active

\a Degree completion status as of reporting year FY05.

WA4-A1: Development of Improved Cowpea Cultivars with Increased Yield Potential, Tolerance to Biotic and Abiotic Stresses, and Having Grain Quality Traits Preferred by Farmers and Consumers for Three Target Agro-Ecological Zones, the Sahel and the Sudan/Guinea Savanna Regions in West Africa and the U.S. Southwest

Principal Investigators and Institutions:

Phillip Roberts, University of California-Riverside, U.S.; Ousmane Boukar, IRAD, Cameroon; Ndiaga Cissé, ISRA, Sénégal; Issa Drabo, INERA, Burkina Faso

Collaborators and Institutions:

Jeff D. Ehlers, University of California-Riverside, U.S.; Mohammed Ishiyaku, Ahmadu Bello University, Zaria, Nigeria; Larry Murdock, Purdue University, U.S.; Francis Padi, SARI, Tamale, Ghana; Jeremy Ouedraogo, INERA, Burkina Faso; Mike Timko, University of Virginia, U.S.

Total Activity Budget: $748,842

Background and Rationale

On-farm cowpea yields in West Africa average 240 kg/ha even though potential yields in the region, as demonstrated in on-station and on-farm trials, are often five to ten times greater. Most of the loss in yield potential is due to pests, but drought and poor soil fertility are also important constraints. The goal of this research component is to develop improved cowpea cultivars that resist or tolerate these biotic

and abiotic stresses for three target agro-ecological zones, the Sahel and the Sudan/Guinea Savanna regions in West Africa and the U.S. Southwest.

Objectives

- Identify and characterize cowpea germplasm for resistance to insect pests and diseases.
- Develop high yielding, pest resistant cowpea varieties with improved grain quality adapted to the Sahelian and Savanna zones of West Africa and to the U.S.
- Develop and characterize genetic populations and molecular tools necessary for implementation of marker-assisted selection (MAS).

Progress and Findings

In this activity, molecular markers for diseases are being developed and applied for breeding. All participating scientists are making excellent progress. At ISRA in Senegal, Dr. Cisse is participating in the exchange of cowpea germplasm through the CRSP core collection. Early maturing varieties have been developed that are unique in increased grain size and taste. SARI is actively promoting consumer-driven breeding that relies on understanding local markets and tastes. This practice promotes localization, but not regionalization.

In Burkina Faso, dual purpose (grain and hay) breeding lines BC3-1-1-1 and BC3-6-7-2 were found to be immune to *Striga* and performed well. The program in Burkina Faso also multiplied hundreds of kilograms of breeder seeds of eight released INERA varieties for distribution to cooperating village-level Certified Seed Producer Groups. The CRSP has supported the final development and testing of four lines now about to be released; their breeding and selection extends back before the CRSP involvement with the program in 2002.

In Senegal, the variety 'Yacine' was released by ISRA in 2004 following three years of successful on-farm evaluations. Yacine has large brown seed, resistance to cowpea aphid, bacterial blight, and cowpea aphid borne mosaic virus (CAbMV), and is early maturing. Also in Senegal, ISRA 3053 and several other breeding lines from the cross of Mame Penda x Yacine were found to be promising and these were included in advanced trials conducted in 2004 and 2005.

In Cameroon the program is re-establishing itself with the return of Boukar Ousmane from Purdue, who completed his Ph.D. in May 2003. By 2005 a large number of breeding lines/populations from UC-Riverside and Cowpea International Trials from IITA had been evaluated and a strong crossing program initiated.

At UC-Riverside**,** advanced blackeye-type cowpea lines UCR-Sh-49 and UCR-Sh-50 have been bred to produce high yields of blackeye grain that is larger than commercially available varieties. Large-scale on-station and grower strip trials, as well as canning evaluations, were conducted in 2005 and will help determine if these varieties will be released. Development of an improved version of standard blackeye cultivar 'CB46' was completed in 2005. Breeders' seed of this new variety, CB46-INR (improved nematode resistance), as well as breeders' seed of UCR-Sh-49 and UCR-Sh-50 are being increased now in the greenhouse.

A set of 70 key cowpea genotypes (the 'CRSP Cowpea Core Collection') has been assembled and screened by the U.S. and HC programs for resistance to pests, diseases and tolerance to drought throughout the WA region. The resulting core collection data base enables cooperators to identify lines with multiples sources of resistance effective across a wide range of environments, and request seed samples from the CRSP cowpea breeding team..

Amplified Fragment Length Polymorphisms (AFLP) studies were conducted on the CRSP Core Set at UC-Riverside to determine primers that yield polymorphisms and allow us to estimate the degree of relatedness among varieties within and among U.S. and West African cowpea breeding programs, including IITA's. This work has resulted in a manuscript that has just been submitted for publication.

In Senegal, 98 lines of the Mouride x Bambey 21 RIL set were tested for Striga resistance under field and screenhouse conditions in order to map and develop markers to this trait. A second RIL population of 150 lines developed from the cross of ISRA-819 and 58-77 was inbred to the F_5 generation. This population is being developed to map genes or QTLs for flower thrips resistance present in 58-77.

Observations and/or Recommendations

This is a well-established, traditional plant breeding program with breeding materials flowing back and forth among the plant breeders. The excellent network of UC-Riverside with three WA countries has resulted in significant progress in identifying and producing enhanced varieties for yield and stress resistance. As noted for the previous activity, plant breeding research requires a long-term commitment. Since the work in this activity is a high priority and is highly productive, plant breeding should continue with collaboration especially in utilizing molecular genetic techniques.

WA4-A2: Assessment of the Nematode Incidence and Speciation in West African Soils, Identification of Genetic Resistance to Nematodes in Cowpeas and the Development of Strategies to Control Nematodes in Cowpea-Based Cropping Systems

Principal Investigators and Institutions:

Phillip Roberts, University of California, U.S.; Ndiaga Cissé, ISRA, Sénégal; Issa Drabo, INERA, Burkina Faso; O. Boukar, IRAD, Cameroon

Collaborators and Institutions:

Mame Birame, CLN, Senegal; A.S. Sawadogo, INERA, Burkina Faso

Total Activity Budget: $249,614

Background and Rationale

A determination of the incidence and species present of root-knot *(Meloidogyne spp.*) and other nematodes including *Scutellonema cavenessi* on cowpeas and in cowpea-based production systems is needed in West Africa. While the presence of some important nematode species has been documented and their suppression of yield potential inferred from field observations, the significance of their impact to cowpea productivity in these countries has not been determined. There is a strong likelihood that nematodes contribute to the low fertility soil regimes in which cowpea production is low. Nematode infection reduces the function of root systems in uptake of water, nutrients and minerals. The specific types of nematodes and their prioritized ranking for importance to cowpea productivity must be determined to target genetic improvement in cowpeas based on incorporating resistance to the most damaging nematode parasites. In California, determination of the prevalence and crop loss impact of two *Meloidogyne* species in cowpea production has led the way to development of resistant cultivars from the breeding programs, and their subsequent implementation into nematode management schemes in commercial cowpea production. A similar approach is being taken in Sénégal and Burkina Faso.

Objectives

- Determine species composition and incidence of nematode parasites through standard survey procedures within each Host Country cowpea-growing region.
- Determine the susceptibility or resistance of common Host Country cowpea genotypes and the UC-Riverside's (UC-R) advanced breeding lines to the most important nematode species on cowpeas.

Progress and Findings

Characterization of nematode populations in Burkina Faso soil has been completed. Initial results show that five or more species of nematodes are present in the region. *Scutellonema* and *Meloidogyne* appear to be the most widespread species. Nematodes in the Sahelian zone (rainfall >600mm/year), the North-Central Sudan Savannah zone (rainfall about 800mm/year) and the meridional Sudan Savannah zone (rainfall between 900mm and 1200 mm/year) yielded 12 nematode types in the 75 field samples. Experiments in Senegal were completed to determine the effect of nematode infestation on yield of native cowpea varieties. Interestingly there was no significant effect of nematode presence on yield. In Burkina Faso, several genotypes of local varieties were found to be resistant to nematodes. These varieties will be further utilized in breeding programs.

Observations and/or Recommendations

This research activity has been successful in surveying soils in Senegal and Burkina Faso for nematodes. More importantly, several varieties of local cowpeas have been found to be resistant to nematodes and are now being used in the breeding program. This is precisely the outcome of such research activity and the team is to be complimented on its progress. The PIs have excellent communication and interaction in this team effort.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
WA4	Samba	Thiaw	Senegal	UCR	Ph.D.	Plant Physiology/ Genetics	1998	2003
WA4	Mame Codou	Gueye	Senegal	UCAD, Dakar	Ph.D.	Plant Biology	2001	Active
WA4	Sayan	Das	India	UC-R	Ph.D.	Plant Science/ Genetics	2003	Active
WA4	Wellington	Muchero	Zimbabwe	UC-R	Ph.D.	Genetics/ Nematology	2003	Active

\a Degree completion status as of reporting year FY05.

WA5-A1: Molecular Genetic Improvement of Cowpeas for Growers and Consumers

Principal Investigators and Institutions:

Larry Murdock and Barry R. Pittendrigh, Purdue University, U.S.; Idah Sithole-Niang, University of Zimbabwe, Zimbabwe

Collaborators and Institutions:

T. J. Higgins, CSIRO, Australia; Matt Jenks, Purdue University, U.S.; George Bruening, UC-Davis, U.S.; Jeff Ehlers, UC-Riverside, U.S.; Ivan Ingelbrecht, IITA, Ibadan; U.S.; Richard E. Shade, Purdue University, U.S.; Christian Fatokun, IITA; William Moar, Auburn University, U.S.

Total Activity Budget: $36,625

Background and Rationale

In sub-Saharan Africa, cowpeas suffer heavily from insect damage both in the field as well as when the grain is stored after harvest. Traditional host plant resistance -- the breeding and deployment of cultivars carrying genes that condition resistance to the insect pests -- has proven to be of limited value. This is because the genome of cowpeas may be devoid of major resistance genes to many insect pests that attack cowpeas. IITA, among other organizations, has carried out extensive screening of cowpea germplasm for resistance to pod borer (*Maruca vitrata*), thrips, pod-sucking bugs, and cowpea weevil. At best, weak sources of resistance were found. Lacking strong insect resistance genes, the breeder's task of introducing insect resistance into the crop is difficult, or even impossible. Attempts to bring insect resistance into cowpeas from another source, wild *Vigna* species, have failed because there are high genetic barriers between these species and cowpeas, *V. unguiculata.*

In recent years, advances in molecular and cellular biology have made it possible to move genes from one species into another species. The transferred gene can impart a needed trait in the recipient plant, and thereby enhance its vigor, health, resistance to biotic or abiotic stresses, productivity, or nutritional value to humans or livestock. Insect resistance genes currently in hand, in particular those encoding *Bt* crystal toxins, alpha-amylase inhibitors and cysteine proteinase inhibitors, can undoubtedly be used to increase cowpea production and storability via genetically-engineering them into the crop. Currently, however, the use of this technology for cowpeas is stymied by the lack of an efficient method for the genetic transformation of cowpeas.

Objectives

- Develop and optimize a reproducible and efficient genetic transformation system for cowpeas.
- Identify optimized genes for control of *Maruca* and cowpea weevil.
- Lay the basis for introducing a consumer-friendly trait into cowpeas through genetic engineering by reducing flatulence causing oligosaccharides.

Progress and Findings

Progress on a transformation system for cowpeas as demonstrated in Dr. Higgins' laboratory in Australia is very encouraging and may prove very useful in the application of biotechnological approaches to improvement of cowpea varieties. Development of methods for tissue culture of cowpeas at Purdue University is a significant contribution and should prove useful in future efforts to transform cowpea.

Although the work done in Dr. Sithole-Niang's lab to use molecular methods to reduce oligosaccharides in cowpeas is scientifically interesting, it is not of high priority for this CRSP. Soybean-based weaning foods are more nutritious and cost effective. Consequently, even if reduced oligosaccharide cowpeas were developed, there is no evidence to suggest that cowpeas would be used in weaning foods. Furthermore, flatulence does not appear to be a significant problem to most consumers of cowpeas. Dr. Sithole-Niang's work should refocus on other characteristics of cowpeas of higher priority.

In Accra, Ghana, NGICA (Network for the Genetic Improvement of Cowpea for Africa) and AATG (African Agriculture Technology Foundation) entered a partnership to facilitate the mobilization of molecular and other technologies to improve cowpea productivity and utilization. The EEP supports the Bean/Cowpea CRSP's activities in the NGICA, and Dr. Murdock and Dr. Sithole-Niang's responsibilities as co-chairs of NGICA.

Observations and/or Recommendations

This project has been modified significantly with the potential development of a transformation system for cowpeas in Dr. Higgins laboratory in Australia. The system must be validated as reproducible and capable of producing stable genotypes. Researchers at Purdue University are encouraged to continue their collaboration with Dr. Higgins, and protocols from Higgins' lab should be tested at Purdue and other collaborating institutions for use in *Bt* transformation.

WA5-A2: Toward a Comprehensive Resistance Management Plan for Bt Transformed Cowpeas to Control Maruca vitrata in West Africa

Principal Investigators and Institutions:

Barry R. Pittendrigh, Purdue University, U.S.; and Mohammad Ishiyaku, Ahmadu Bello University, Nigeria; Madame Clementine Dabire, INERA, Burkina Faso; Ibrahim Baoua, INRAN, Niger

Collaborators and Institutions:

Jean-Baptiste Tignegre, INERA, Burkina Faso; Manu Tamo, IITA, Benin; Bill Moar, Auburn University, U.S.; Larry Murdock, Purdue University, U.S.;

Total Activity Budget: $422,749

Background and Rationale

The CRSP can make a unique contribution to the development and dissemination of *Bt*-cowpeas by carrying out work to lay the basis for a resistance management plan. Such a plan is essential to ensure that the *Bt*-technology introduced into cowpeas is sustainable. Such knowledge is fundamentally important for the development of a viable insect resistance management plan (IRM) for *Bt* cowpeas and to provide enhanced understanding of *Maruca vitrata* populations and migrations in the Nigerian grain shed, the region where *Bt* cowpeas is most likely to be introduced.

Objective

- Distribution, abundance and migrations of *M. Vitrata* adults.

Progress and Findings

The investigators have made significant progress in identifying the distribution of *M. vitrata* in Niger, Burkina Faso and Nigeria. The work at Purdue University to use microsatellite libraries to develop polymorphic markers to assess the populations of *M. vibrata* is cutting edge and should be supported.

Observations and/or Recommendations

Excellent progress has been made in characterizing populations of *M. vibrata* in West Africa. Development of molecular techniques to identify these populations and their subsequent deployment not only in West Africa but elsewhere is an important development in an integrated *Maruca* management system.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
WA5	Ousmane	Boukar	Cameroon	Purdue	Ph.D.	Agronomy	1999	2003
WA5	Claudius	Marondedze	Zimbabwe	UZ	Masters	Biochemistry	2004	Active
WA5	Venu	Margam	India	Purdue	Ph.D.	Entomology	2004	Active
WA5	Eugene	Parsons	Zimbabwe	Purdue	Ph.D.	Horticulture	2005	Active

\a Degree completion status as of reporting year FY05.

Table 3. West Africa Regional Project Team

United States PIs		Host Country PIs	
Dr. Jess Lowenberg-DeBoer (RF) Purdue University	Dr. William Payne Texas A&M University	Dr. Ousmane Boukar (Co-Chair) IRAD, Cameroon	Dr. Ndiaga Cisse ISRA, Senegal
Dr. R. Dixon Phillips University of Georgia	Dr. Philip Roberts (Chair) University of California-Riverside	Dr. Issa Drabo INERA, Burkina Faso	Ms. Mbene Faye ISRA, Senegal
Dr. Barry Pittendrigh Purdue University	Dr. Larry Murdock Purdue University	Dr. Mohamadou Gandah INRAN, Niger	Dr. Germaine Ibro INRAN, Niger
Dr. Jeff Ehlers * University of California-Riverside	Dr. Joan Fulton Purdue University	Dr. Saket Kushwaha Abubaker Tafawa Balewu University, Nigeria	Dr. Esther Sakyi-Dawson University of Ghana, Ghana
Dr. Manjeet Chinnan * University of Georgia	Dr. Yen-Con Hung * University of Georgia	Dr. Mohammad Ishiyaku Ahmadu Bello University, Nigeria	Dr. Idah Sithole-Niang University of Zimbabwe, Zimbabwe
Dr. Matthew Jenks * Purdue University	Dr. Bill Moar * Auburn University	Dr. Madame Clementine Dabire INERA, Burkina Faso	Dr. Ibrahim Baoua INRAN, Niger
Dr. Mike Timko * University of Virginia	Dr. Creighton Miller * Texas A&M	Mr. Paul Houssou * PTAA/INRAB, Benin	Dr. Jeremy Ouedraogo * INERA, Burkina Faso
Dr. T. J. Higgins * CSIRO, Australia	Dr. Brent Bean * Texas A&M	Dr. Mame Birame * CLN, Senegal	Dr. A. S. Sawadogo * INERA, Burkina Faso
		Dr. Manu Tamo * IITA, Benin	

* Co-PIs/Collaborators

C. East and Southern Africa Regional Project

Summary of East and Southern Africa Regional Project

The Bean/Cowpea CRSP has had programs in East and Southern Africa (ESA) since 1980. In 2002, the ESA activities were reorganized as a regional program with the expectation that expertise and activities would be shared among collaborating institutions. Collaborators included 11 U.S. PIs from 6 universities and 21Host Country PIs and collaborators from Tanzania, Malawi, Mozambique, and South Africa (Table 4). During the 2002-07 phase, $ 3,149,508 million was obligated for research and training activities for the ESA regional program.

One of the primary and most successful activities of the ESA regional program has been institutional capacity building and the training of graduate students. Since the start of the Bean/Cowpea CRSP in this region, 77 M.S. and Ph.D. students have been trained, 27 since 2002-07 (Table 5). Many of the first graduate trainees now hold senior faculty positions at Bunda College of Agriculture in Malawi and at Sokoine University of Agriculture in Tanzania and are themselves training a second generation of graduate students. The EEP also observed that several recent graduates are beginning professional careers as new faculty members at Bunda. The training model used by the Bean/Cowpea CRSP is an excellent example of how a sustained and collaborative program can have a significant impact in the technical capacity of a region. The graduate training activities of the program have also added to our global scientific knowledge on beans and cowpeas. Over 35 peer-reviewed scientific papers and 20 other publications have been produced with support from the current project.

The impact of the Bean/Cowpea CRSP in ESA in terms of increased bean/cowpea production and productivity through the breeding, release and dissemination of new bean varieties, sustainable crop management and seed production systems has been variable. Over the previous grant phase, the breeding programs in ESA have become more productive. Bunda released three new varieties, BCMV-B2, BCMV-B4 and BC-D/0(19); Sokoine University released two varieties, SUA 90 and Rojo. The breeding programs at both universities are directed by experienced field-based breeders who are making crosses, evaluating segregating populations, and recommending advanced lines for release as varieties. The Host PIs are actively involved in M.S. level graduate student training and much of their research is conducted through their students. Collaboration with SABRN (South African Bean Regional Network), CIAT, and with the National Bean Improvement Programs of Malawi and Tanzania was observed, primarily in the exchange of advanced lines, regional observational and yield trials, and resistance sources.

Among the U.S. PIs, the breeder at Oregon State University and the molecular geneticist ARS/USDA scientist at Prosser, Washington have made significant progress in the use of molecular marker-assisted breeding techniques to develop improved bean germplasm with resistance to multiple disease and insect pests. Markers for resistance to Common Bacterial Blight (SAP6 and SU91), anthracnose (Co-4-2) and rust (Ur-3, Ur-5, Ur-11), BCMNV (bc-3), BCMV (I gene), halo blight (Pse-2, Pse-3), and soon, root rots, are now available. Within the near future, the host country breeders will have access to breeding lines and populations with multiple stress resistance. The ability to use marker-assisted selection in beans is, in itself, a remarkable achievement. There are

very few agricultural commodities outside of the major cereals and grains (with the backing of large, multinational seed producing companies), where marker-assisted breeding is routinely used. The Bean/Cowpea CRSP and its PIs are to be congratulated on this accomplishment.

One of the problems limiting the release and dissemination of new bean varieties to farmers in ESA has been the development of a functioning seed production system. To address this situation, in Malawi, NGOs and donor organizations began to actively promote seed multiplication programs by encouraging smallholder seed associations and entrepreneurs to become more involved in the production and marketing of seed. Farmers in the smallholder seed associations would receive a small portion of seed of new varieties to plant and maintain. Within this project phase, Bunda College has been successful in developing collaborative smallholder seed production partnerships with several NGOs, including Total Land Care, World Vision, Concern Universal and others. Concurrently, low cost irrigation technologies, like the treadle pump, are being promoted to smallholder farmers and farmer associations. Bean/Cowpea CRSP PIs are conducting assessment studies of the seed production methods, consumer and farmer acceptance of new varieties, and other factors. This collaboration has tremendous potential for the breeders as a vehicle to get new varieties tested with farmers. The EEP was very excited and encouraged by this progress of this program in Malawi. That said, Bunda College and U.S. collaborators expressed concern that the NGOs and farmer associations were having problems maintaining seed stocks from one planting season to the next. As a result, Bunda was continuing to maintain large quantities of seed for distribution to the NGOs. Unfortunately, Bunda does not have even basic seed production and storage facilities to take on this responsibility, but with some investment in infrastructure, the college could serve the role of foundation seed producers and receive income from the NGOs for this seed.

In Tanzania, the Seeds Act of 2003 allowed for smallholder farmer seed production of 'Quality Declared Seeds' and for field crop inspection by the Tanzania Official Seed Certification Institute (TOSCI). Unfortunately, during this project phase, Sokoine University has not been able to get their seed production activities organized effectively, to the detriment of their breeding and farmer participatory research programs. Overall, there has been a significant lack of leadership at Sokoine for this project, as well as friction between the host country PIs and with U.S. PIs. Although Sokoine released two promising bean varieties several years ago, these varieties have not been adopted by Tanzanian farmers, primarily due to the lack of seed. The EEP observed that the PIs at Sokoine University do not function as a team and there is an overall lack of leadership at the faculty and university level for this project.

The economic and marketing studies in ESA were initiated during the 2002-2007 phase of the Bean/Cowpea CRSP with the objective of establishing baseline data on a variety of socioeconomic and consumer traits relating to beans and cowpeas. Hedonic analysis of consumer preference traits were conducted in Malawi, Mozambique, Zambia, and other regions of Southern Africa, resulting in a more complete picture of market and consumer dynamics. Although some beans and cowpeas are traded across the region, with South Africa being a major importer, the lack of infrastructure (roads, vehicles, storage facilities, and grain) has limited trading opportunities. With increase production capacity, some countries, such as Mozambique could become exporters of beans to SA.

Beans and cowpeas are nutrient-dense foods and for this reason are extremely important in the daily diets of people in ESA. Nevertheless, protein, mineral and vitamin deficiencies are common in children in certain regions. The Bean/Cowpea CRSP has been developing simple food processing techniques that can be used at the village level to make nutritionally rich snack foods and food supplements, especially for children. Two feeding studies are underway now to look at the health effect of these supplements. This work is being supported through leveraged funds from the Beans for Health Alliance based in the U.S. The Director of the Bean/Cowpea CRSP is a Board member of this Alliance. Unfortunately, the results of a bean food supplement feeding trial at an orphanage in Tanzania were compromised when the local caretaker began giving the children an additional food supplement that had been supplied to the orphanage free of charge. Another study in Botswana, however, continues on track. It appears that there has been a significant improvement in the children's overall health and development when bean-based supplements are added to their daily diets. Other studies looked at bean cooking time and other consumer preference traits. This resulted in the development of a prototype, low cost, rapid screening method to determine bean cooking time at the University of Pretoria in collaboration with Texas A&M University, which will now be tested throughout the region.

The EEP recognizes that ESA will continue to be a critical region for bean and cowpea research and training in the future. Nevertheless, we believe that strategic changes are needed in the areas of responsibility and focus of activities. Our recommendations are based on a review of the 2002-07 programmatic activities in the host countries and U.S. universities, their output and future directions. The next phase of the CRSP should concentrate its efforts primarily in the Southern Africa highland region of Malawi, Mozambique, Zambia, Zimbabwe, and South Africa. Host country partners should include universities, national programs, regional programs, NGOs, foundations, and farmer associations working in these countries. Breeding will continue to be a critical component of any new phase, as well as seed production and distribution, economic and market analysis, health and nutrition, and food security. Training at the M.S. and Ph.D. levels will be critical for maintaining and enhancing institutional capacity.

ESA1-A1: Developing Bean and Cowpea Market Opportunities in Eastern and Southern Africa

Principle Investigators and Institutions:

Jess Lowenberg-DeBoer and Joan Fulton, Purdue University, U.S.; Patrick Kambewa, Chancellor University, Malawi; Anna Temu, Sokoine University of Agriculture, Tanzania

Collaborators and Institutions:

Manuel Duarte-Fillippe, INIA, Mozambique; André Jooste, University of the Free State, South Africa; Fulgence Mishili, SUA, Tanzania

Total Activity Budget: $444,665

Background and Rationale

Much of the bean and cowpea research in ESA has focused on production issues. Little work has been done on bean and cowpea marketing in the region. A greater understanding of bean and cowpea

markets is a prerequisite for CRSP impact in the region. Consumer preference and market information will help target CRSP research by identifying traits and practices that lead to bean and cowpea products having characteristics that facilitate marketing. The benefit of these new products should be felt directly by producers as they sell more of their product at a higher price.

Objectives

- Provide an initial description of the market structure for beans and cowpea grain and processed products in the ESA region.
- Determine supply and demand characteristics for beans in Eastern and Southern Africa.
- Improve understanding of consumer bean and cowpea preferences.

Progress and Findings

Bean and cowpea marketing studies were conducted in ESA. In 2002-04, the surveys of market structure for beans and cowpea grain and processed products focused on Tanzania, Malawi, Mozambique and South Africa. During 2005, Zambia was also added. The marketing data collected included bean types (varieties, seed color, size, shape, as well as the presence of bruchid weevil holes) that were sold in local markets, wholesale and retail prices over time, and the role of intermediaries in the direct marketing of agricultural commodities. Beans and cowpeas are, in general, widely traded throughout East and Southern Africa, although seed type preferences directly affect market prices and consumer acceptance. South Africa is a major importer of beans from around the world. In general, consumers are willing to pay a higher price for large size beans. Beans appear to be traded more than cowpeas.

This is a new activity for ESA and the Purdue team has provided excellent leadership to the project, which is a true regional approach. Graduate students from ESA did much of the research analysis. A better understanding of bean/cowpea market structures within the region was obtained. Baseline data for understanding the value-chain framework for beans and cowpeas in ESA was established, but primary data collection was difficult in some countries. As a result, some analyses were based on secondary data obtained from the National Agricultural Research Systems and other sources.

Observations and/or Recommendations

Until this project was initiated in 2002, very little work had been done in ESA on bean and cowpea market analysis. A fixed number of locations within each country were surveyed during this first project phase. The EEP recommends that these surveys should be extended to other areas within the region to complete the study. This will provide a baseline database from which to evaluate trends, forces and changes in bean/cowpea markets over time. These results will also provide guidelines for breeders and for seed production efforts.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA1	Manuel	Filipe	Mozambique	Purdue	Ph.D.	Agricultural Economics	2002	Active
ESA1	Fulgence	Mishili	Tanzania	Purdue	Ph.D.	Agricultural Economics	2003	Active
ESA1	Juliette	Ziote	Mozambique	UFS	Masters	Agricultural Economics	2003	Active

\a Degree completion status as of reporting year FY05.

ESA2: Increased Food Utilization of Beans and Cowpeas in East and Southern Africa

This component had two sub activities:

ESA2-A1: Value-added, Processing and Qualities of Cowpea- and Bean-Based Foods

Principal Investigators and Institutions:

Ralph Waniska, Texas A&M University; Louis Pelembe, Eduardo Mondlane University, Mozambique; Amanda Minnaar, University of Pretoria, South Africa

Collaborators and Institutions:

Leda Hugo, Eduardo Mondlane University, Mozambique; Ricardo Macia, University of Pretoria, South Africa; Agnes Mwangwela, Ph.D. student at University of Pretoria; Manuel Amane, Instituto Nacional de Investigacao Agraria de Mocambique; Creighton J. C. Miller, Texas A&M University; Jeff Ehlers, University California-Riverside; Luisa Penicela Macoo and Alice Mkanda, University of Pretoria

Total Activity Budget: $413,236

Background and Rationale

The preferences and desires of consumers for beans and cowpea products should be considered in the development of improved germplasm. This information should include food quality attributes preferred by consumers as well as simple methods to rapidly determine these attributes. Selected technologies were used to evaluate the physico-chemical and sensory properties of dry beans as they influence consumer preferences. These include varietal differences, environment effects (location, agronomics, etc.) and changes during storage (hard-to-cook problem). Processing issues, including cost effectiveness, pre-process conditions (e.g., soaking), treatment conditions (thermal, grinding, decortication, etc.), post-process conditions (holding hot, drying (if necessary)), and packaging for a range of whole and milled products should also be considered. Micronization, an infra-red, high temperature, semi-moist processing method, has been shown to reduce cooking time in some legumes while maintaining protein digestibility and nutritional quality. Consumer issues include the need for milled and pre-processed food products, their sensory acceptability (appearance, odor, texture, taste), nutritional properties, and value of products vs. price (cost of manufacturing, packaging, distribution, marketing, etc.).

Objectives

- Utilize consumer preferences for cowpeas- and bean-based foods to develop rapid, food quality, and screening methods for crop improvement.
- Develop and utilize low-cost value processing technologies in foods containing cowpeas or beans.

Progress and Findings

Dry bean varieties from different locations in South Africa were evaluated for cooking time using a Mattson Bean Cooker and a set of sensory descriptors to evaluate the sensory characteristics of

the cooked bean samples. Significant differences in cooking time were found among varieties and locations for some varieties. Interestingly, similar varieties grown in different areas tasted differently.

Low-cost, value processing technologies were evaluated for cowpeas. The effects of hydrothermal treatment (combinations of water soaking and quick heating) by various methods on the structure and physico-chemical characteristics of cowpea varieties in Mozambique were studied. Low final temperature (130˚C) micronization treatments changed the physical structure and chemical properties of the cowpea seed which led to significant reductions in cooking time. Micronization significantly increased the water absorption capacity whereas all the other functional properties were significantly reduced.

This project showed the need for cooking time and sensory evaluation studies to be conducted on new bean varieties prior to their release. This project had good regional team collaboration and the University of Pretoria was very active in the training of students. Slow transfer of funding from Texas A&M to the Host Country PIs was a problem.

Observations and/or Recommendations

Village-level and cottage industry micronization technologies for cowpeas should be developed. Economic feasibility studies should be conducted to see if the micronization technology is appropriate for Mozambique and other cowpea producing countries.

ESA2-A2: Analysis of Cooking and Consumer Preference Traits to Achieve Wider Impact from Bean/Cowpea CRSP-Developed Bean Cultivars

Principle Investigators and Institutions:

Ralph Waniska, Texas A&M University; James Myers, Oregon State University

Collaborators and Institutions:

Amanda Minnaar, University of Pretoria; Agnes Mwangwela, Ph.D. student at University of Pretoria; James Bokosi, Bunda College of Agriculture; Jeff Ehlers, University California-Riverside; Phil Miklas, ARS Prosser, Washington; Creighton J. C. Miller, Texas A&M University; Susan Mchimbi-Msolla, Sokoine University of Agriculture; Theobald Moshi, Sokoine University; Louis Pelembe, Eduardo Mondlane University, Mozambique; Catherine Madata, Tari, Uyoli, Tanzania; Carol Miles, Washington State University; Roland Chirwa, CIAT, Chitedze, Malawi; Sossi Kweka, Seleian Research Center, Tanzania

Total Activity Budget: $67,375

Background and Rationale

In ESA, limited consumer preference studies have been conducted at various times in specific regions. In most of these, the focus has been on dry seed characteristics with less attention paid to cooking time and palatability traits. The emphasis of these studies was on smallholder farmers and

their preferences, both for food security and for beans as a cash crop. More recent studies have focused mainly on markets with the emphasis on urban consumers. These studies have allowed us to understand in general terms what consumers like in the beans that they eat, but we still do not understand in detail what drives consumer demand. In addition, consumer preferences may vary; local/regional preferences may not be the same as for export markets.

In this activity, the research team seeks to integrate the food utilization and plant breeding components of ESA to: a) understand and quantify consumer preferences, and b) improve the efficiency of the breeding program to release bean varieties that will be successful in the marketplace. Steps are also taken to integrate cowpea research in ESA with that of beans. The concepts and technologies developed in this research can be adapted to cowpeas, as well as transferred to other regions.

Objectives

- Determine cooking quality attributes of traditional and improved varieties of beans and cowpeas using a rapid screening method.
- Apply information and technologies developed above to released cultivars and advanced breeding lines.

Progress and Findings

This is a new project that aims to understand and quantify bean/cowpea cooking time and variety sensory characteristics and improve the efficiency of the breeding programs to release bean varieties that would be successful in the marketplace. A prototype, rapid screening method to determine bean and cowpea cooking time was developed. Advanced breeding lines are being evaluated for cooking time using this methodology. Sensory evaluations include splitting of the cooked grain, aroma, character of the sauce, and/or the integrity/dispersion of the grain during cooking.

A new rapid screening method to determine bean and cowpea cooking time was developed that can be easily used in developing countries. It replaces the need for the Mattson cookers, which is more time consuming and requires the purchase of specialized equipment. Collaborative linkages were developed between U.S. universities and with crop improvement programs in the U.S. and ESA. Malawi graduate student Agnes Mwangwela completed her Ph.D. at the University of Pretoria and will return to Bunda College as a faculty member of the Food Science Department. As part of her studies, Ms. Mwangwela developed a manual for the rapid screening method for cooking time technique. Standard methods studies for use of the rapid screening method are underway in Mozambique, South Africa, Tanzania, and Malawi. The University of Pretoria, South Africa served as an effective training institution for students studying food science/nutrition in the region. This collaboration serves as a training model that should be implemented more broadly throughout Africa and Latin America with more advanced institutions.

Observations and/or Recommendations

This is a strategically important area and more work on improvement of bean and cowpea quality attributes is needed using cost-effective technologies, such as the rapid screening method to

determine bean and cowpea cooking time and other seed quality traits important to consumers that can be used by breeders, seed production specialists, and food scientists.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA2	Minah	Phadi	Botswana	UP	Masters	M Inst Agrar Food Processing	2001	2005
ESA2	Ana Eduarda	Macunguel	Mozambique	EMU	B.S.	Food Science	2003	Active
ESA2	Agnes	Mwangwela	Malawi	UP	Ph.D.	Food Science	2003	Active
ESA2	Tayo O.	Adeyemo	South Africa	UP	B.S.	Food Science	2004	2005
ESA2	Brasilino das Virtudes	Salvador	Mozambique	UP	Masters	Food Science	2004	Active
ESA2	Alice V.	Mkanda	Malawi	UP	Masters	Food Science and Technology	2004	Active
ESA2	Virtudes	Salvador	Mozambique	UP	Masters	Food Science	2004	Active
ESA2	Luisa	Penicela	Mozambique	UP	Masters	Food Science	2006	Active
ESA2	Marilena	Yerou	South Africa	UP	B.S.	Nutrition and Food Science	2006	Active

\a Degree completion status as of reporting year FY05.

ESA3-A1: Nutritional and Health Benefits of Beans and Cowpeas in Improving Child Survival

Principal Investigators and Institutions:

Maurice Bennink, Michigan State University; Henry Laswai, Sokoine University, Tanzania

Collaborators and Institutions:

Theobald Mosha, Ph.D. student at MSU from SUA, Tanzania

Total Activity Budget: $388,501

Background and Rationale

Malnutrition is very common in Tanzania. Various forms of nutrient deficiencies, especially protein and micronutrients, are widespread among infants and young children. Research conducted in 2003-04 demonstrated that inexpensive, shelf stable, culturally acceptable foods capable of preventing malnutrition and rehabilitation of malnourished children can be produced from cereals and beans grown in Tanzania. Increasing bean utilization and making more nutritious diets available at affordable cost is pertinent in insuring food and nutrition security to both adults and children. Evidence also suggests that eating beans might help reduce the incidence of colon, breast and prostate cancer.

Objectives

- Identify the most suitable processing methods, optimize the food production conditions, and identify potential collaborators for future large- and medium-scale processing of bean/cowpea-based foods.
- Promote strategies to improve household food security through utilization, storage, marketing and processing beans and bean-based products.
- Determine the relative importance of alcohol soluble bean phyto-chemicals in the prevention of colon cancer.

- Evaluate the efficacy bean-based extruded products formulated from bean-cereal blends to promote growth and rehabilitation of undernourished children.
- Evaluate the efficacy of bean-based snack foods in improving the nutritional status and learning ability of primary school children.

Progress and Findings

The food processing capabilities of the Nutrition and Food Science Department at Sokoine University were enhanced with the purchase of much needed food processing equipment.

The consumption of beans and cowpeas was studied in the Mvomero district of Tanzania. A second study looked at the contribution of cowpeas to legume consumption for households in Mbarali (an area suitable for growing cowpeas, but not beans) and Njombe (an area suitable for bean production). Both studies showed the importance of beans and cowpeas in the daily diet of the people in these areas. Beans, cowpeas and pigeon peas provided the largest amount of protein source consumed in the households. Cowpeas were often eaten as a green leafy vegetable. Legumes were primarily eaten at lunch and dinner, rarely at breakfast. As a result, most children are sent to school having had low intake of protein. Increased cowpea cultivation in the Southern Highlands of Tanzania is warranted to improve household food security, especially in places where beans do not perform well. There should be a deliberate effort to move cowpeas from an intercrop to sole crop production system.

Dr. Bennink's research on the benefits of bean consumption in reducing cancer risks are impressive and the potential payoff could be enormous. A manufacturer has been located in South Africa to supply low cost extruders for making snack and weaning foods and food supplements using beans as a principal ingredient. This project has been very successful in leveraging other funding, especially from the Beans Alliance for Health group, to support the cancer trials and children feeding studies in Africa.

One of the child feeding studies using bean-based foods that was being supported by leveraged funds from the U.S. Beans for Health Alliance was compromised in Tanzania. This was a major study being conducted in Tanzania and Botswana using a bean-sorghum-maize food supplemented with micronutrients and provided to malnourished schoolchildren. Unfortunately for the Tanzania study, the priest in charge of the students also administered another supplement supplied free of charge by a South African company. This confounded the results of the bean-based feeding trials, and consequently the data from this study could not be used. The study in Tanzania will have to be reinitiated.

Observations and/or Recommendations

Understanding the health attributes of beans needs to be increased. This project should be combined with the work on-going in Latin America as a cross-cutting project rather than a regional effort. Investigate the potential use and impact of low cost extruders that can be used in a cottage setting in villages to develop snack, weaning foods and food supplements using beans and cowpeas as principal ingredients. This effort should be extended throughout ESA.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA3	Theobald	Mosha	Tanzania	MSU	Ph.D.	Nutrition/Food Science	2000	2004
ESA3	Elizabeth	Rondini	U.S.	MSU	Ph.D.	Food Science and Human Nutrition	2001	2005
ESA3	Pia Andrew	Urio	Tanzania	SUA	Masters	Nutrition	2004	Active
ESA3	Kathleen	Barrett	U.S.	MSU	Ph.D.	Food Science and Human Nutrition	2006	Active

\a Degree completion status as of reporting year FY05.

ESA4-A1: Edaphic Factors Limiting Production of Beans in Latin America and East and Southern Africa

Principal Investigators and Institutions:

Peter Graham, University of Minnesota; Robert Mabagala, Sokoine University of Agriculture (SUA) , Tanzania

Collaborators and Institutions:

Johnson M.R. Semoka and Susan Nchimbi Msolla, SUA, Tanzania; Ken Giller, Wageningen, Netherlands; Phil Miklas, USDA, U.S.; Roland Chirwa, CIAT, Malawi/Southern Africa; Steve Beebe, CIAT, Colombia; Mariangela Hungria, EMBRAPA, Brazil; Ken Grafton, NDSU, U.S.

Total Activity Budget: $316,597

Background and Rationale

Acid soils, low soil phosphorus, and nitrogen deficiencies are widespread throughout ESA. Although beans use *Rhizobia* to fix atmospheric nitrogen, effective nitrogen fixation will not occur in low P soils. Studies in Brazil and by CIAT have identified bean cultivars with greater levels of tolerance to low soil phosphorus and to acid soils. In addition, rhizobium strains tolerant of acid soils have also been identified. The development of bean lines and *rhizobia* strains with greater tolerance to low soil P and acid soil could enhance the use of this technology in the bean producing regions of Africa.

Objectives

- Select bean cultivars and rhizobium with tolerance to low P and N levels in soil, and able to nodulate and fix nitrogen under these conditions.
- Select bean cultivars and rhizobium with tolerance to acid soil factors and able to nodulate and fix N2 at acid pH.

Progress and Finding

At Sokoine, screenhouse trials showed that there were differences among bean genotypes for tolerance to low soil P. Bean genotypes that had high P uptake at low P levels appeared to be efficient in P uptake. They also responded to the addition of P in the soil. In these studies, nitrogen was limiting at both low and high P levels. Different sources of P (readily available, rock phosphate)

are also being evaluated as a soil fertilizer by Sokoine University. At Minnesota, a hydroponic procedure was developed to evaluate beans for low P tolerance.

Bean lines been identified with greater P acquisition efficiency were evaluated at Sokoine University. P acquisition efficiency in these lines is being evaluated using molecular techniques.

From discussions with the participating scientists at SUA, it appears that there is a real issue of ownership and relevance concerning this project. The links and collaboration with the crop improvement program are not clear. Work on improved bean nitrogen fixation has been on-going for many years at a number of institutions. Although advances have been made in the identification of more productive *Rhizobia* strains and bean lines with enhanced ability to fix nitrogen, there has been limited benefit to bean production in Africa and Latin America, with the exception of large bean growers in Brazil who are accustomed to using soybean inoculants.

Observations and/or Recommendations

The identification of bean genotypes with tolerance to low soil P should be continued as a cross cutting research activity for both Africa and Latin America. The Bean/Cowpea CRSP project has supported research on nitrogen fixation for over 27 years. The EEP recommends that this work not be continued in the future.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA4	Mourice	Sixbert	Tanzania	SUA	Masters	Soil Microbiology	2003	2005

\a Degree completion status as of reporting year FY05.

ESA5: Seed Multiplication, Dissemination, Marketing and Promotion in East Africa

This component was originally comprised of two activities which were merged into one activity during years four and five of the grant.

ESA5-A1: Development of Cost-Effective and Sustainable Seed Multiplication and Dissemination Systems for Improved Bean Cultivars that Meet the Needs of Limited-Resource Bean Farmers

Principal Investigators and Institutions:

Carol Miles and David Holland, Washington State University; Flavianus Magayane and Dismas Mwaseba – Sokoine Universety of Agriculture, Tanzania; Charles Masangano, Bunda College of Agriculture, Malawi

Collaborators and Institutions:

Susan Nchimbi-Msolla and Emmanuel Rwanbali, Sokoine University of Agriculture, Tanzania; James Bokosi and Henry Mloza-Banda, Bunda College, Malawi; Total Land Care, Malawi; Concern Universal; CARE, Magu; World Vision; Jess Lowenberg-DeBoer; Irente Farm, Lushoto

Total Activity Budget: $342,275

Background and Rationale

The Bean/Cowpea CRSP has over the past two decades conducted research aimed at improving bean production in Malawi and Tanzania. In Malawi, this research has resulted in the release of a number of varieties. However, lack of a seed multiplication system has led to limited adoption of these varieties. The government-led seed multiplication system in Tanzania and Malawi are generally dysfunctional. To address this situation, NGOs and donor organizations began to actively promote seed multiplication schemes by encouraging smallholder seed associations and entrepreneurs to become more involved in the production and marketing of seed. There is however, a major lack of infrastructure and training for foundation and certified seed production to support these seed multiplication projects. An additional issue impacting the performance of these projects is that farmers have not historically purchased bean seed and instead have relied on bean grain for their planting stock. Farmers save beans for replanting and buy bean grain for planting from local markets only when their farm supplies are inadequate. There is a general lack of awareness of the benefits of improved seed for a crop like beans.

To address the limited production and dissemination of improved seeds, the government in Tanzania has revised its seed policy by privatizing the seed industry and introducing a new seed grade referred to as Quality Declared Seed (QDS). It can be produced by smallholder farmers on their farms and does not require a rigorous seed inspection regime. This change in policy in conjunction with the promotion of private extension service providers in Tanzania provides an opportunity for exploring the use of such providers in speeding the adoption of bean varieties produced by the Bean/Cowpea CRSP.

In the U.S., seed companies provide good access to seed, however, the diversity of beans offered is low. In a 2002 study covering bean producers in Washington, small-scale farmers each grew up to 20 varieties of dry beans, and over half of these farmers saved seed from their bean crop and only purchased new seed if they produced insufficient beans on their farm. These farmers reported that a primary constraint to bean production was poor emergence and stand establishment. These problems are likely due to the poor quality of farmer-produced seed.

Objectives

- Investigate the effectiveness of alternative approaches to seed multiplication in terms of their ability to provide adequate amounts of improved seed at affordable prices to rural communities in a sustainable manner.
- Assess the effectiveness of different institutional arrangements and approaches, including extension activities, employed to disseminate and promote adoption of improved seed.
- Test the effectiveness of extension brochures and booklets in promoting adoption of CRSP varieties.

Progress and Findings

Seed multiplication approaches used by different national and international agencies were evaluated in Malawi and Tanzania and farmers were interviewed to determine the pros and cons of the

different approaches. In both countries, bean yields were negatively impacted by the severe drought of 2004-05. In Malawi, the bean variety 'Kalama' was preferred by the majority of farmers for its early maturity, seed quality, marketability, and cooking characteristics, while other, more recent Bunda bean varieties were less acceptable. In Tanzania, CRSP/SUA releases 'Rojo' and 'SUA90' showed higher levels of drought tolerance than the local variety. In Tanzania, field crop inspectors were trained to access seed multiplication plots for the Quality Declared Seed grade. In Malawi, Bunda has been very active in identifying collaborating seed producing NGOs. Bunda provides foundation seed for their multiplication efforts. Total Land Care (TLC) is one of the principal NGOs involved. Total Land Care works not only on seed production, but also on irrigation systems, primarily through the introduction and extension of treadle irrigation pumps. Last year 3,000 new farmers were producing seed in the dry season with the use of treadle pumps. Total Land Control employs 50 staff of which 40 are field based. The use of improved irrigation technology allows TLC to obtain high yields on its seed producing farms.

The seed production work in Malawi is progressing well. The U.S. and Host county PIs collaborate well and they have established excellent collaboration with seed producing NGOs. Seeds of new Bunda bean varieties are being distributed by the NGOs and a brochure describing the new varieties was developed and is being distributed. Other technologies, such as the treadle pumps, are also promoted by local NGOs to increase bean production. Seed production plots are inspected by trained inspectors.

Work at SUA has stalled, with very little impact achieved up to the present. Nor, at this point is there much promise of having anything to show by the end of the current grant period. In part, the problems can be explained by the departure of the SUA PI and the recent assignment of a new seed production faculty member who seems able and willing to make it work. Unexplained delays seem to have occurred though in the formulation of a viable workplan and budget for FY 06/07. The U.S./SUA work also suffers from a troubled history of the relationship between PIs from WSU and SUA, and between U.S. PIs. The SUA breeder needs to work more closely with the new seed production specialist to insure that this work gets off the ground before the end of the project. SUA varieties are not being adopted because little seed is being produced for farmers.

Observations and/or Recommendations

Successful seed production activities are critical to the success of breeding programs. In spite of the drought that impacted the recent harvests, the Malawi seed production project is showing great promise and new breeding lines from Bunda and the Malawi National Bean Program are being increased and distributed to farmers. In contrast the seed production project at SUA has been very weak. Funding for this project at SUA should not be continued during the current grant unless a satisfactory workplan is developed and when a satisfactory relationship is evident with the U.S. PIs. If a new workplan is established, the new SUA faculty member should visit the seed multiplication projects in Tanzania to gain insights from that on-going effort.

ESA5–A2: Development of Methodologies and Approaches to Evaluate Agricultural Technologies in Target On-Farm Environments to Promote their Adoption in East and Southern Africa and the U.S.

Principal Investigators and Institutions:

Carol Miles, Washington State University; Charles Masangano, Bunda College of Agriculture

Collaborators and Institutions:

James Bokosi, Bunda College, Malawi; Ralph Waniska, Texas A&M University, U.S.

Total Activity Budget: $151,235

Background and Rationale

Although, over the last two decades, the Bean/Cowpea CRSP has developed and released several improved bean varieties in Malawi and Tanzania, adoption of these varieties is low. The key to successful rapid adoption of new varieties is the involvement of the farm community in variety selection and a sensitization of farmers and marketers to variety attributes prior to variety release.

In Malawi, smallholder farmers tend to have multiple objectives for growing beans, including a contribution to food security, especially during the lean months of December through March when food reserves are extremely low and bean leaves are consumed and green pods are marketed in order to purchase other staple foods. Preliminary studies conducted in Dedza have demonstrated that farmers grow a diversity of bean varieties and each variety has unique characteristics that fulfill the objectives of the farmers throughout the growing season. New varieties being introduced into bean farming systems must also address some of these objectives if they are to be adopted.

In the U.S., new technologies developed by the Bean/Cowpea CRSP have generally been targeted towards large-scale production systems, and large-scale producers have mainly benefited from these innovations. Small-scale direct market production is common throughout the U.S. and is gaining in popularity and demand. Further variety trials and on-farm testing are required to develop variety and production recommendations for niche market dry bean production. In the U.S. and East Africa, health and nutritional qualities of beans can be promoted to increase bean consumption and demand.

Objectives

- Establish participatory research on-farm trials in Malawi and Washington to evaluate perceptions of variety performance, to improve feedback to breeders, and to promote an effective bean selection and breeding process.
- Survey bean use patterns and preferences of farmers and compare with laboratory cooking evaluations.

Progress and Findings

In Malawi, farmer participatory research trials were conducted using dwarf and climbing bean lines from the Bunda breeding program. Extension workers and farmers were trained in basic concepts

of on-farm research. Yields were variable across sites. Farmers were surprised that some non-preferred bean types actually had good flavor and texture. In Washington, yield trials of breeding lines as potential niche varieties were conducted. The information is posted on a website.

Farmer participation in the evaluation of potential new bean varieties is important for the ultimate selection of successful new varieties for distribution. Extension worker training in Malawi was inadequate as many were unable to complete the evaluation forms. This work should be combined with other projects related to bean breeding and seed production.

Observations and/or Recommendations

Continued use of farmer participatory research trials is important especially in ESA where numerous bean varieties may be grown as a mixture or in different fields. This project was appropriately merged with ESA5-A1 in 2005 and the EEP is supportive of this change.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA5	Baltahazar M.L.	Namwata	Tanzania	SUA	Masters	Extension Education	2002	Active
ESA5	Vincent Mgoli	Mwale	Malawi	Bunda	Masters	Crops and Soils	2003	Active
ESA5	Paul	Fatch	Malawi	Bunda	Masters	Rural Development and Extension	2005	Active

\a Degree completion status as of reporting year FY05.

ESA6: Genetic Improvement of Beans for East and Southern Africa

This component has two activities:

ESA6-A1: Develop Bean Cultivars for East and Southern Africa with Enhanced Resistance to Diseases and Insects

Principal Investigators and Institutions:

James Myers, Oregon State University; Philip Miklas, ARS-USDA, Prosser, Washington; James Bokosi, Bunda College of Agriculture, Malawi; Susan Nchimbi-Msolla, Sokoine University of Agriculture, Tanzania

Collaborators and Institutions:

Charles Masangano, W.A.B. Musuku, G.K.C. Nyirenda and A. Mwanwela, Bunda, Malawi; Roland Chirwa, SABRN/CIAT, Malawi; Catherine Madata, Margaret M. Mkuchu and Betty Gondwe, TARI, Uyole, Tanzania; Robert Misangu, Robert Mabagala, Cornel Rweyemamu, Dismas Mwaseba and Emmanuael Rwambali, Sokoine University of Agriculture, Tanzania; Carol Miles and David Holland, Washington State University; Mligo-Ilonga Research Center; Bob Gilbertson, University of California-Davis; Steve Temple, University of California-Davis; Joseph Mligo, Sosthene Kweka and D. Kabungo, AIR, Uyole, Tanzania; Cesar Cardona, CIAT, Colombia; Diedra Fourie, ARC, Potchefstrom, South Africa

Total Activity Budget: $420,744

Background and Rationale

Bean yields are about 400 to 500 kg/ha in farmers' fields in Africa, but yield potentials up to 1500 to 2500 kg/ha can be achieved when improved varieties and proper agronomic practices are used. Many problems contribute to low bean yields: low yielding varieties, susceptibility to diseases and insects, poor adaptability to soil conditions, and unreliable weather. Because of the differences in biotic and abiotic conditions, bean varieties developed in one country are not necessarily adaptable to conditions in other countries in the region. The development and support of strong bean breeding programs in ESA is critical for the sustainable development of improved varieties that satisfy local market demands and possess desired agronomic traits conferring high yield potential and pest resistances.

Improved lines in a few market classes have been developed by the National Bean Programs and by Bean/Cowpea CRSP supported institutions in Malawi and Tanzania. Although these lines may possess resistance genes, research is needed to identify more durable forms of resistance and to pyramid resistances into elite varieties. An integrated approach, combining the resources of both the U.S. and Host Country institutions to tackle biotic and abiotic constraints, while allowing individual programs to develop locally adapted materials is the most efficient way to make progress. The breeding programs collaborate with CIAT, ECABRN and SABRN within the Eastern and Southern African region.

Objectives

- Evaluate promising bean lines with disease and pest resistance in on-farm trials and multiply seed.
- Evaluate germplasm and preliminary and advanced lines for resistance to diseases and abiotic stress.
- Incorporate and evaluate arcelin alleles utilizing intra- and inter-specific hybridization to protect beans against bruchids and to release arcelin protected materials.
- Cross MDR lines to pyramid disease resistances and combine with bruchid resistance.

Progress and Findings

Good regional collaboration has been established between the U.S. PIs, SUA, Bunda, CIAT, ECABRN, SABRN within the Eastern and Southern African region, and the national bean improvement programs of Malawi and Tanzania in the exchange of nurseries, breeding lines, regional and national trials. Bunda College has recently released three new varieties (BCMV-B2, BCMV-B4, and BC-D/O) and seed is being produced for on-farm testing and for farmer seed production with NGOs. SUA is projected to release one or more improved bean lines for commercial production in Tanzania prior to the end of the grant. Crosses to incorporate multiple disease and insect resistance into commercial bean types have been made at Bunda and SUA and progeny have been selected.

OSU and WSU/ARS are providing breeding support through the development of lines with multiple disease and insect resistance for ESA. A CRSP-supported Ph.D. graduate student from SUA at OSU is developing interspecific hybrids between a tepary bean, G40199, with a novel arcelin-like seed

storage protein for resistance to the seed weevil, *Acanthoscelides obtectu,* to and *P. vulgaris.* The main contribution of WSU/ARS is in the marker-assisted selection component and Dr. Miklas, ARS serves as a key support person for the breeding program.

Improved bean varieties have been developed and released by Bunda and SUA. Graduate student training at Bunda, SOA, and OSU has been very successful and with three new breeders trained; marker-assisted selection techniques are being used to combine multiple disease resistance genes in local varieties. Good collaboration and exchange of advanced lines and breeding populations exists within the region and with the U.S. PIs and the CIAT regional programs (ECABRN and SABRN). Phil Miklas and ARS make an important contribution to the Bean/Cowpea CRSP by providing the equipment and technical support for the successful use of genetic markers to aid in incorporating disease resistant genes in African bean varities. The support provided by ARS-USDA for the Bean/Cowpea CRSP activities in ESA are deeply appreciated.

Both Drs. James Bokosi and Susan Nchimbi-Msolla have heavy teaching responsibilities at their respective universities. This affects their ability to manage and carryout large breeding programs. As university researchers, however, they are also involved in graduate student training and their graduate students have conducted successful M.S. breeding theses. The seed storage facilities at Bunda are substandard. SUA has adapted an air-conditioned room for seed storage which is well organized and maintained. OSU had problems forwarding funds to Bunda and SUA in a timely manner, which caused delays in the breeding programs and impacted the graduate students at Bunda. Neither Bunda nor SUA have the financial capacity to allow faculty to deficit spend when reimbursements for expenditures are delayed from collaborating U.S. CRSP universities, even though the funds have been obligated to the Host Country institution. The amount of CRSP funding received by the breeders for their programs is at a minimum for a dynamic breeding program. The breeders are forced to seek alternative sources of funding and through breeding projects on other crops. There is also a problem in obtaining phyto-sanitary certificates for breeding materials produced in Oregon. Bacterial wilt is listed as a disease of quarantine concern for seed originating in the western U.S. Although the disease is not present in Corvallis, the Tanzania government won't allow any seed produced in Oregon to enter Tanzania and be received by scientists at SUA. This has resulted in an informal exchange of seed by breeders taking advantage of meetings and other events. Effort is needed to change the phytosanitary certificate restrictions for bean seed produced in Corvallis.

Observations and/or Recommendations

The EEP recognizes the need to continue to support bean breeding activities in Southern Africa. It is also critically important that degree training in plant breeding be continued in the region. Nevertheless, it must be recognized that the ability of these universities to maintain large breeding programs is limited without a significant increase in funding (besides graduate student funding) and with a concomitant reduction in their teaching responsibilities. Support for post docs could be used to strengthen these breeding programs. U.S. PIs should also initiate projects with the national breeding programs in Malawi and Tanzania, as well establish new breeding projects with Mozambique and selected others within SABRN. The EEP recommends that future phases of the Bean/Cowpea CRSP continue to provide graduate student stipends to train new breeders at Bunda and Sokoine Universities.

ESA6-A2: The Use of Marker-Assisted Selection to Improve Selection Efficiency in East and Southern Africa and the U.S. Program

Principal Investigators and Institutions:

James Myers, Oregon State University; Philip Miklas, USDA, Prosser, WSU; James Bokosi, Bunda College of Agriculture, Malawi; Susan Nchimbi-Msolla, Sokoine University of Agriculture, Tanzania

Collaborators and Institutions:

Catherine Madata, Uyole ARI; Deidre Fourie and Meri Liebenberg, ARC-Grain Crops Institute, Potchefstroom, S. Africa; Matthew Blair, CIAT, Colombia; Bert Vandenberg, University of Saskatoon, Canada; Roxanne Mainz, Syngenta, U.S.

Total Activity Budget: $324,673

Background and Rationale

Resistance to Bean Common Mosaic Virus (BCMV), Bean Common Mosaic Necrosis Virus (BCMNV), rust, and in some cases, Halo Blight (HB), has been incorporated into improved breeding lines and released varieties. The Tanzania and Malawi breeding programs possess germplasm and improved breeding lines containing some of these resistance genes. However, for other traits such as resistance to Angular Leaf Spot (ALS), Common Bacterial Blight (CBB), and root rot, there are few sources of resistance. These diseases have a common thread in that resistance is quantitative, making it difficult to achieve rapid progress. For other diseases such as anthracnose, the genetics of resistance have been elucidated, but the best sources of resistance have not been widely used. Resistances that have been previously incorporated into the breeding programs need to be retained, while new resistances to the other important pathogens are added. In the U.S., the bacterial blights are of major concern, and among the fungal diseases, white mold and root rots are a universal problem.

Selection of markers linked with known resistance genes and Quantitative Trait Locus (QTL) can accelerate development of multiple resistant varieties. The research community is only now beginning to understand that certain forms of resistance may be effective against unrelated pathogens. For example, the same genetic locus or gene cluster of related loci is associated with resistance to both BCMV and certain races of HB. Conversely, resistance genes within a cluster may be linked in repulsion, and thus require recombination in order to achieve multiple disease resistance. For example, QTL conferring partial resistance to CBB, ashy stem blight, and White Mold (WM) are linked in repulsion. Such gene clusters need to be identified, characterized for resistance to high priority pathogens, and exploited for broad and durable resistances that are applicable to both U.S. and African varieties.

Objectives

- Make crosses for marker-aided selection of CBB, BCMNV, rust and anthracnose into elite African materials and conduct field trails and selection in the Host Country for first generation MAS-developed lines.

- Cross lines with HB resistance to develop RIL populations for marker identification.
- Screen RIL populations for root rot resistance.

Progress and Findings

Significant progress has been made by Bean/Cowpea CRSP scientists to develop marker assisted breeding methods to increase resistance to a number of important bean diseases and insect pests into commercial cultivars. Markers for single genes for Bean Common Mosaic Virus (BCMV), Bean Common Mosaic Necrosis Virus (BCMNV), rust, anthracnose, and in some cases, Halo Blight resistance are being incorporated into improved breeding lines and local varieties using these techniques. Not all of the available markers are appropriate for races and strains of the diseases in Africa. Efforts are also underway to develop markers for quantitatively inherited resistance for Angular Leafspot, Common Bacterial Blight, and root rots, white mold, and others.

Marker-assisted breeding has made significant advances in bean improvement through the efforts of the Bean/Cowpea CRSP as compared to many other crops. This is truly a major success of this CRSP project. Many of the markers identified of important genes will be a valuable resource for bean breeding programs across the world. New markers are being developed for quantitatively inherited resistance traits. USDA/ARS is a partner of this project. Neither Bunda or SUA have the facilities to undertake marker-assisted selection at this time.

Observations and/or Recommendations

This should be a cross cutting project for the Bean/Cowpea CRSP, not a regional activity. Need to be integrated into SABRN activities and coordinate research with CIAT on both the development and use of MAS within the region.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA6	Sosthenes	Kweka	Tanzania	SUA	Masters	Plant Breeding	2002	2005
ESA6	B.Y.E.	Chataika	Malawi	Bunda	Masters	Plant Breeding	2003	Active
ESA6	Paul	Kusolwa	Tanzania	OSU	Ph.D.	Plant Breeding	2003	Active

\a Degree completion status as of reporting year FY05.

ESA-CC1-A1: Improved Soil and Water Management for Intensified Bean Production in Malawi in the Dry Season, Taking into Account Labor and Capital Constraints of Women and Resource-Poor Farmers

Principal Investigators and Institutions:

Anne Ferguson, Michigan State University, U.S.; Henry Mloza Banda, Bunda College of Agriculture, Malawi; Sieglinde Snapp, Michigan State University, U.S.

Collaborators and Institutions:

Mr. Essau Mwendo–Phiri, World Vision International; Dr. Julius Mangisoni, Bunda College of Agriculture, University of Malawi; Dr. Davis Ng'ong'ola, Bunda College of Agriculture,

University of Malawi; Mr. Darwin Singa, Bunda College of Agriculture, University of Malawi

Total Activity Budget: $204,035

Background and Rationale

This activity with Bunda College was funded for the period 2002-05 and is now being funded in part through a Rockefeller grant. Designed as a "gender" study, this project promotes research and outreach in the low lying areas of the Chingale region of Malawi, called "dambos." It emphasizes seed production and dissemination, water management technologies and gender dimensions. In Malawi, Bunda College social scientists and agronomists, in cooperation with World Vision International, are conducting the studies and outreach activities.

Observations and/or Recommendations

This project should be reconfigured as a bean production activity and considered for possible reincorporation back into the mix of projects for ESA in the future, rather than as a cross cutting project. The studies in the Dambo regions have wide implications for ESA as well as the introduction and dissemination of the treadle pump technology. Some social science studies will be needed to look at the impact of these activities on household labor and division of labor as more work and energy are required for these types of production systems. This project should be restructured and added to the next phase of the Bean/Cowpea CRSP, but not as a WID project.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status \a
ESA-CC1	Davie	Kadyampakeni	Malawi	Bunda	Masters	Agronomy, Soils	2002	Active
ESA-CC1	Abiba	Longwe	Malawi	Bunda	Masters	Rural Development	2002	Active
ESA-CC1	Courtney	Gallaher	U.S.	MSU	Ph.D.	Crop and Soil Science	2005	Active

\a Degree completion status as of reporting year FY05.

Table 4. East and Southern Africa Regional Project Team

United States PIs		Host Country PIs	
Dr. Maurice Bennink (Co-Chair) Michigan State University	Dr. Philip Miklas USDA-ARS Washington State University	Dr. Henry Mloza Banda Bunda College, Malawi	Dr. James Bokosi Bunda College, Malawi
Dr. Anne Ferguson Michigan State University	Dr. Carol Miles Washington State University	Dr. Manuel Fillippe Duarte Purdue University	Dr. Andre Jooste University of the Free State, South Africa
Dr. Peter Graham University of Minnesota	Dr. James Myers (RF) Oregon State University	Dr. Patrick Kambewa Chancellor College, Malawi	Dr. Henry Laswai Sokoine University, Tanzania
Dr. Jess Lowenberg-DeBoer Purdue University	Dr. Ralph Waniska Texas A&M University	Dr. Robert Mabagala Sokoine University, Tanzania	Dr. Dismas Mwaseba Sokoine University, Tanzania
Dr. Joan Fulton * Purdue University	Dr. David Holland * Washington State University	Dr. Charles Masangano Bunda College, Malawi	Dr. Amanda Minnaar University of Pretoria, South Africa
Dr. Sieglinde Snapp * Michigan State University		Dr. Susan Nchimbi-Msolla (Chair) Sokoine University, Tanzania	Dr. Louis Pelembe University of Eduardo Mondlane, Mozambique
		Dr. Anna Temu Sokoine University, Tanzania	Dr. Manuel Amane * IIAM, Mozambique
		Dr. Deidre Fourie * ARC-Grain Crops Institute, South Africa	Dr. Rowland Chirwa * SABRN, Malawi
		Dr. Catherine Madata * ARI, Tanzania	Dr. Theobald Mosha * Sokoine University, Tanzania
		Dr. Johnson Semoka * Sokoine University, Tanzania	Ms. Agnes Mwangwela * Bunda College, Malawi

* Co-PIs/Collaborators

D. Cross-Cutting Activities

CC1-A3: Bean and Cowpea-Based Foods for Micro- and Small-Scale Enterprise Development: Integrating Perspectives from Food Technology, Nutrition and Agricultural Economics

Principle Investigators and Institutions:

Anne Ferguson, Michigan State University, U.S.; Germaine Ibro, IRAN, Niger; Ramatou Seydou, INRAN, Niger; Mbene Faye, ISRA, Senegal; Esther Sakyi-Dawson, University of Ghana-Legon, Ghana; Joan Fulton, Purdue University, U.S.; and Jess Lowenberg-DeBoer, Purdue University, U.S.

Background, Objectives and Progress

A study was conducted during years four and five to identify problems that women entrepreneurs face when selling kosia/akara and to develop potential solutions that will enable these entrepreneurs to be even more successful. This builds upon earlier research by the West Africa CRSP socio-economics team which revealed that kosai/akara preparation and street marketing are an important income generating activity for women in countries such as Niger and Ghana.

Observations and Recommendations

This study integrates economic with food science research and draws upon regional expertise to better understand the challenges and opportunities facing women entrepreneurs who prepare cowpea flour for kosai/akara preparation. The insights gained in this study on costs for production should contribute to increased profitability and sustainability of these micro-enterprises as well as give direction to food science research on cowpeas in the future.

CC2-A1-4: Impact Assessment of CRSP Technologies

Principal Investigators and Institutions:

Richard Bernsten, Michigan State University, U.S.; Jess Lowenberg-DeBoer, Purdue University, U.S.

Total Activity Budget: $216,456

Background, Objectives and Progress

The EEP is pleased that the Bean/Cowpea CRSP has made a serious effort to measure the impact of research and training. Although it is too early to measure the full impact, indicators of impact can already be observed. Senior economists participating in the Bean/Cowpea CRSP are actively working to identify and measure progress. Preliminary results of the training impact studies are promising and should be a significant contribution to the impact literature on CRSP impact. We encourage these studies to continue.

Training Accomplishments

Component	Given Name(s)	Last Name	Citizenship	Training location	Degree	Department	Start year	End year or Status year \a
CC2	Cathy	Ragasa	Philippines	MSU	Ph.D.	Agricultural Economics	2002	Active
CC2	Sika	Gbegbelegbe Donfonsou	Benin	Purdue	Ph.D.	Agricultural Economics	2004	Active
CC2	Tomokazu	Nagai	Japan	MSU	Masters	Agricultural Economics	2006	Active

\a Degree completion status as of reporting year FY05.

VII. Review and Evaluation of the Training Program

Degree training is an integral part of the Bean/Cowpea CRSP and is unique to the CRSPs among international institutional capacity building and agricultural research support programs. Much of the research that takes place is conducted by graduate students as an integral part of the education they receive through the program and many long-term collaborative relationships are initiated during the training process. Since 1980 over 600 people have obtained degrees with support from the CRSP. About 45% were women; two-thirds were from CRSP host countries; 70% were for post-graduate degrees with over 70% of those awarded by U.S. institutions. An estimated $7 million of CRSP resources have been used to support this educational effort.

A retrospective study of those who completed graduate training in the U.S. found that approximately 81% of developing country trainees who responded to the survey had returned home or to another developing country after completing their graduate studies, many to the same institution in which they were employed before their training. Over 60% continued to work in bean or cowpea research even after up to 20 years and more than half continued to collaborate with their U.S. university graduate training supervisor. Over 90% reported that their training was necessary for their professional development and highly relevant in their current job. On average, those who received Ph.D.s under the program were earning 75% higher salaries than colleagues who received Ph.D.s from local universities.

Between 2002 and 2005, 60 individuals completed degree training programs through the Bean/Cowpea CRSP. Currently another 63 are actively pursuing university degrees. Of those, 30 are women. Each regional project has about 20 trainees and another two are part of the cross-cutting activities. Roughly half the trainees are studying for their Master's degree, one-third for a Ph.D. and the remaining for a B.S., the latter at host country universities. Because the costs of training are sometimes covered in part by the research projects, the exact total costs of training are impossible to track. However, the Management Office estimates that the CRSP contributes approximately $10,000 per year toward the training of each individual. This is a fraction of the actual cost, with the balance coming from other sources including the respective U.S. university and other research projects. Thus, training through the CRSP is an exceedingly good investment of USAID funds.

Table 5. Number of persons completed training and actively being trained

	Female				Male				Grand Total
Project	B.S.	M.S.	Ph.D.	Total	B.S.	M.S.	Ph.D.	Total	
Completed 2002-2005									
CC									0
ESA	0	1	0	1	1	3	1	5	6
LAC	3	8	3	14	7	13	3	23	37
WA	3	1	3	7	2	2	6	10	17
Grand Total	6	10	6	22	10	18	10	38	60
Active trainees in 2006 and planned in 2007									
CC			2	2				0	2
ESA	2	4	2	8	0	7	3	10	18
LAC	0	6	6	12	2	6	3	11	23
WA	1	5	2	8	0	6	6	12	20
Grand Total	3	15	10	30	2	19	12	33	63

Food science and human nutrition are well represented among the current trainees with 38, as are the social sciences and extension with 28. The plant and natural sciences have a strong representation with 45 trainees, but this area does not dominate the training agenda as it did in the past.

In the current grant, the Bean/Cowpea CRSP has used "advanced" host country institutions for all the Bachelors level training and half the Masters degree training. This helps achieve economies and takes advantage of training that might more suitably prepare students for the academic and agro-industry contexts to which they will return.

CRSP training is extremely cost-effective. It has a low cost per student, most students return to their home countries, and most continue active research in a related field after they return.

VIII. Review of Management and Administrative Functions

The EEP's Five-Year Technical Review of the Bean/Cowpea CRSP not only addresses technical issues but also how the CRSP is managed and supported administratively and how funds available to it are distributed and accounted for. These issues influence program productivity and quality.

Our comments and recommendations presented here are based on written material provided to the EEP, discussions with the MO staff, numerous interactions with PIs (both U.S. and HC), and interaction with the USAID CTO. Comments and recommendations are organized around four major areas of responsibility: (1) providing administrative support, (2) exercising program leadership, (3) governance, organization and structure and (4) fulfilling obligations to USAID.

Michigan State University (MSU) was awarded the planning grant in 1978 which led to the design of the CRSP. MSU has been given responsibility for the Management Office since the CRSP grant was awarded in 1980. MSU has given the Bean/Cowpea CRSP strong support for all those years and has a long tradition of supporting international activities more generally. This institutional support has been an important factor in the success of the MO. MSU has provided experienced and tenured faculty as the CRSP Director and the university administrators have strongly supported the program by allowing numerous faculty members to work on CRSP projects as well as in other important but less obvious ways.

The MO is staffed with very competent and dedicated personnel and receives adequate attention, support and oversight from responsible administrators at all levels of MSU. The office is operated on a USAID budget which has remained just under the maximum level of 20 percent of the total Bean/Cowpea CRSP obligation from USAID. In addition to the CRSP, the director manages a related project called the "Beans for Health Alliance" (BHA) which has both USAID and private support. The BHA provides some salary and administrative support for the MO. In addition, the MO was asked in September 2004 to take on responsibility for a pilot degree training project called the "USAID Initiative for Long-term Training and Institutional Capacity Building (UILTCB)" which focuses on Ghana and Zambia. In addition to being complementary to ongoing CRSP training activities, it also allows for cost share of MO staff salaries.

The CRSP Council is still another activity that has taken a considerable amount of time away from the director. Dr. Widders chaired the CRSP Council for three years and continues to play an important leadership role for this key organization. The additional financial support from some of these non-CRSP activities enables the MO to meet the required "20% or less" rule. It also means the staff does not devote full time to the Bean/Cowpea CRSP. This is not intended as a criticism because the EEP view them as quite complimentary to the CRSP.

The MO office provides oversight for the Bean/Cowpea CRSP training which cuts across all three regional projects. The MO staff is to be commended for documenting and analyzing the training provided by region, discipline and gender. This will be useful for future selection of trainees and explaining the benefits of this important component of the CRSP.

The CRSP director has developed a strong relationship with the U.S. dry bean industry which has in turn reorganized to work with and support the CRSP more effectively. The U.S. Dry Bean

Council, recently established to replace the three former organizations, invited Dr. Widders to serve on its Board.

Overall, we believe the MO has provided exceptional leadership to the Bean/Cowpea CRSP. This conclusion is supported by our observations and feedback during our site visits from HC and U.S. participants and other evidence. The MO is respected by U.S. and HC PIs as well as the IR as evidenced by their unanimous support for MSU's request to be awarded another five-year grant without competition.

Providing Administrative Support

An important function of the MO is to provide administrative support to all elements of the CRSP, including financial and accounting oversight. This is a huge challenge given the number of U.S. and Host Country institutions involved and the USAID record keeping and reporting requirements. The challenge was further complicated during the first year of the new grant by (1) the unexpected need to relocate the MO office on the Michigan State University campus and (2) an unplanned delay in USAID funding. It is significant that both circumstances were beyond the control of the MO.

These two unanticipated events created an enormous administrative workload, coming on top of the heavy workload associated with closing out one grant and starting up the new program. The EEP commends the MO for successfully completing the transition in spite of these handicaps. This accomplishment is a tribute to the dedication and commitment of the MO staff to the CRSP.

Funding delays by USAID and the necessity of additional paperwork also imposed an added burden on all CRSP participants, especially principal investigators, collaborators and their staff. Significantly, however, none that we interacted with blamed the MO for their frustrations and delays. Although there is no way to measure the costs of the funding delays by USAID, the impact on the program was certainly significant. When it became apparent that USAID would not be able to fund the new grant as planned, funds were allocated under the old grant for a two month extension (August 1 to September 29, 2003) after which the new grant was funded. This created a paperwork nightmare all up and down the CRSP organization! The EEP suggests that USAID review procedures for grant funding to find ways to minimize the transaction costs associated with transitions between grants.

The increased number of subgrants and Memorandums of Understanding (MOU) in the new grant imposed an added paperwork burden on all participating institutions. The lack of timely completion of paperwork by some institutions also contributed to start up delays and some U.S. institutions continue to have difficulty in moving money to HC institutions in a timely fashion. The EEP recommends that in the next grant period that the MO consider establishing and managing directly all subagreements to HC institutions.

The MO has made a special effort to minimize transaction costs in administering the current grant as encouraged by USAID. The EEP applauds this effort but must point out that ironically, a large fraction of total transaction costs incurred by the CRSP are necessary to comply with USAID requirements and adjust to funding uncertainties.

Exercising Program Leadership

Providing leadership for the Bean/Cowpea CRSP is perhaps the most essential function performed by the MO, not withstanding the important role played by the TC. At the end of the day, it is the MO that must account for any failure to lead the program to successful completion.

The MO is to be commended for exercising strong program leadership, especially in the first difficult year of the grant. The MO staff appears to be very well informed about the personnel working on the projects and the progress on the projects and they make good use of the technical expertise represented on the TC. The MO is also to be commended for their commitment to institutional capacity building as evidenced in part by the special effort to strengthen weak institutions in Africa.

The MO emphasizes a "collaborative leadership style" in exercising program leadership, relying heavily on the TC and PIs for technical guidance. The EEP believes that this is appropriate but we also recognize that there are circumstances in which decisive action by the MO is called for. We encourage the MO to make tough unilateral decisions when needed. The EEP expects the MO to exercise their authority to make shifts in funds between projects, when appropriate, as an exception to the normal decision-making process.

An essential element of program leadership is a clear vision of the program objectives and how they are to be achieved. The EEP is convinced that the MO leadership has such a vision for the Bean/Cowpea CRSP and has articulated that vision clearly to all participants and clientele.

Assessing Program Structure and Organization

The Bean/Cowpea CRSP, organized around three regional projects, thematic areas and research activities, is rather complex. The MO is assisted in governance by a Board of Directors, composed of Institutional Representatives, and a Technical Committee (TC) made up of PIs from each region plus a representative from CIAT and IITA.

With 11 U.S. universities, 22 Host Country institutions and 32 research activities, a hierarchical organizational structure is necessary. Organizing around three regional projects, while not perfect, is working quite well. An unintended consequence is that there is little interaction or coordination across regions on activities associated with each thematic area. For example, training needs in LAC as compared to needs in Africa are not routinely evaluated or vetted. The EEP recommends that the MO and TC give more attention to this deficiency but it is too late in this grant period to make any changes in organizational structure.

We strongly believe that the next phase of this CRSP make provision for the evaluation function to continue, although we leave it to USAID and the MO to decide how it is to be implemented.

Fulfilling Responsibilities to USAID

The ME/MO has special responsibilities to USAID as the major source of funds for the Bean/Cowpea CRSP. Not only is USAID a donor but it is also a partner in a larger international

development effort. The 11 participating U.S. universities contribute a significant portion of the costs of the CRSP and they also lend much needed political support for international development. Thus, not only does the Bean/Cowpea CRSP have special responsibilities to USAID that go with any grant, there are shared responsibilities as partners to further international agricultural development.

The EEP believes that MSU has faithfully fulfilled its responsibility as a grantee to USAID and could serve as a model for future university/USAID partnerships.

IX. Recommendations for the Design of the Next Program

The EEP, recognizing that the next phase of the Bean/Cowpea CRSP will be implemented in a different environment, recommends that the following issues be considered in defining and responding to the Request for Applications (RFA).

1. **Focus on Africa**: The next phase of the Bean/Cowpea CRSP should focus primarily on Sub-Saharan Africa. Support to the LAC region should focus on plant breeding and networking to facilitate exchange within LAC and participation in the global bean network, enabling breeders to collaborate with colleagues in Africa. In Africa, support to multidisciplinary teams should focus on barriers to increased production, consumption and trade. The selection of participating institutions in Africa should be based on institutional needs for increased capacity, demonstrated commitment to the CRSP objectives, and capability to achieve results. African institutions considered should include not only universities but also National Agriculture Research Programs (NARPs), regional organizations (i.e., SABRN), and NGOs. Collaborative research relationships with U.S. scientists, a proven and cost effective approach to institutional strengthening, should be emphasized.

2. **Simplify and downsize management structure:** The organizational structure for assisting and advising the Management Entity should be simple and low cost. We believe that one advisory body would be sufficient to provide the ME with both technical and administrative advice. A Management and Technical Committee (MTC) could replace the functions previously performed by the Technical Committee (TC), Board of Directors and the External Evaluation Panel (EEP). The MTC might be comprised of both PIs from the CRSP as well as external experts representing IARCs, private sector groups, international development organizations, etc. The EEP believes that well-designed research meetings should continue but that the Regional Facilitators and formal Regional Project teams are not necessary. Savings from a reduced organizational structure should enable the ME to support occasional disciplinary, regional or global conferences or workshops to enable researchers to interact, coordinate collaborative activities and exchange information.

3. **Regularize interactions with USAID Missions: The Management Entity (ME) should take the lead in establishing contacts with the country missions** and facilitate links by research leaders in each participating country with USAID Missions to keep them informed and elicit their input and support. Although the CRSP global program will not necessarily coincide with field mission strategic objectives, common areas of interest may emerge which present opportunities for associate awards to the CRSP. U.S. Principal Investigators should consider liaisons with missions as a part of their responsibility.

4. **Product development:** Food Science and Nutrition are two disciplines that should contribute to our knowledge base of functional physical and chemical (including biochemical and physiological) characteristics of cowpeas and beans. Sociology and economics are two disciplines that are required to generate knowledge to complement the biological sciences. Studies on populations, value chain economics, food availability, market basket surveys, and culture (in relation to food and diet) will be required so that food products utilizing cowpeas and/or beans can find their appropriate niche in the food chain. Converting the properties of

cowpeas and beans into commercial products should more appropriately be left to the commercial private sector since that sector is most likely to develop products that are successful in the market place and respond to the needs of consumers. However, some activity should be supported to evaluate appropriate technologies for entrepreneurial development of cottage industries in developing countries to produce consumer ready food products.

5. **Long-Term Support for Cropping Systems, Plant Breeding and Seed Production:** Once cultivars have been developed and proposed for further extensive in-field testing and to sustain existing cultivars in the production system, it is essential to investigate sustainable cropping systems applicable to micro-regions. Such field research requires several years of replication within the region so that the effects of climate and cultural factors (e.g., pest pressure) can be taken into account. Such activity consequently requires funding over several years and the CRSP can be an important major source for such support.

   Similarly, breeding research requires the same kind of long-term investment to assess advance lines for adaptation to and productivity in diverse agro-ecologies and production systems. Such studies generally have difficulty generating support, and programs such as the CRSP are essential to get new cultivars into production systems.

   For breeding efforts to be successful, sustainable seed production systems are required. In Africa and Latin America, planting seeds of beans and cowpeas are generally not produced by a formal seed production industry. Farmers must rely on their own stocks or obtain seeds through the market. In some countries, informal farmer-managed seed production systems, supported by NGOs and farmer associations, have been developed. Future CRSP activities should continue to support and enhance this activity especially in Africa where the impact of improved varieties has been significantly restricted because of limited seed availability.

6. **Focus on "market failures:"** More generally, in selecting research activities along the "value-chain," priority should be given to those functions in which "market failure" has occurred in the country or where the private sector has insufficient incentive to perform that function. This implies that any research activity supported by the CRSP should demonstrate the lack of private sector incentive to attract private sector investments. In other words, CRSP research should not engage in activities in which there are adequate incentives and opportunity for the private sector to perform those functions.

7. **Concentrate on research and training:** Building on more than a quarter of a century of success, the future Bean/Cowpea (or Pulse) CRSP should concentrate effort on collaborative research, training and institution building. These activities are clearly where U.S. universities have a comparative advantage in agricultural development. With the continued emergence of new cutting-edge research technologies (i.e., molecular genetic tools, analytical technologies, remote sensing, etc.) and the adverse impacts of HIV/AIDS and political strife on agriculture research institutions in certain countries, institutional capacity building requires a sustained commitment of investment by USAID through the CRSPs.

APPENDIX A

Bean/Cowpea Collaborative Research Support Program (CRSP)

SCOPE OF WORK FOR INSTITUTIONAL SITE VISITS
By External Evaluation Panel

Five-Year Technical Review (2002-2007)

A. Composition of the Bean/Cowpea CRSP External Evaluation Panel (EEP)

- Dr. John Stovall, Agriculture Economist, Independent Consultant (EEP Chair)
- Dr. Julia Kornegay, Plant Genetics and Biotechnology, North Carolina State University
- Dr. Daryl Lund, Food Science, Nutrition and Research Administration, University of Wisconsin
- Dr. Robert Herdt, Agriculture Economics and International Agriculture Development, Cornell University
- Dr. Mamadou Ouattara, Agronomy and Research Administration by NARS, SAFGRAD, African Union

B. Background and Objectives of Five-Year Technical Review

The External Evaluation Panel (EEP) is responsible for "completing an intensive technical review of the Bean/Cowpea Collaborative Research Support Program (CRSP) once every five years prior to an extension" (page 29, Operations and Policy Manual).

Since the current USAID-Washington grant to Michigan State University, the Management Entity (ME) for the Bean/Cowpea CRSP, provides funding for the period September 29, 2002 through September 28, 2007, it seems appropriate that the EEP complete the intensive review by October 30, 2006, one year prior to the end of this new grant. The Management Office believes that this will allow sufficient time to respond to the EEP's recommendations as it plans and prepares a proposal for a five-year extension grant. The Five-Year Technical Review will also be valuable to the Office of Agriculture, EGAT/USAID Washington for its long-term planning regarding investments in the CRSPs.

The objectives to be achieved through the Five-Year Technical Review by the EEP include:

- Assess programmatic focus of regional projects and individual components within the Bean/Cowpea CRSP.
- Evaluate scientific quality and technical progress of research activities relative to achievement of research objectives.
- Assess outputs as an indicator of productivity of research activities relative to achievement of developmental goals.
- Gauge effective balance between research and training activities for development of Host Country institutional research capability.
- Determine the complementarity and coordination of domestic and Host Country research within a Regional Project in terms of effectiveness in overcoming constraints to development of the bean and cowpea value chains within the respective countries and regions.

- Assess collaboration in technology development and alignment of research and training activities with Host Country USAID Missions.
- Assess the Bean/Cowpea CRSP's relationship with U.S. private industry and its role in contributing to the growth and vitality of U.S. agriculture.
- Evaluate the collaboration, coordination and complimentarily of Bean/Cowpea CRSP research and training activities on beans and cowpeas with the International Agriculture Research Centers.
- Formulate recommendations to the Management Entity and USAID based on lessons learned and for refinement of Bean/Cowpea CRSP programming in the future.

C. Conduct of the Five-Year Technical Review

According to the Guidelines for Collaborative Research Support Programs (CRSPs), 2004 Revised edition (page 24), it is recommended that the EEP conduct site visits to U.S. and Host Country universities/institutions participating in a CRSP, during the third and fourth years of a five year award. The proposed schedule of EEP site visits for the Bean/Cowpea CRSP is therefore consistent with these recommended practices for the external evaluation of the technical quality of the program.

The Management Office (MO) will be providing copies of previous annual workplans and progress reports for each of the components and regional projects within the Bean/Cowpea CRSP to EEP members prior to site visits. These documents will enable the EEP to effectively assess progress toward intended objectives and developmental goals as outline in workplans and productivity in terms of outputs.

During each university/institutional site visit, meetings will be scheduled with Principal Investigators (PIs), collaborating scientists, Institutional administrators (i.e., Director Generals, Scientific Directors, Research Center Heads, Deans, Department Chairs, etc.), financial officers, and Economic Growth/Agriculture Development Officers in the respective Host Country USAID Missions. During meetings with these individuals, the EEP members are encouraged to use the list of questions for discussion provided in Section E of this Scope of Work to ensure that relevant issues are addressed.

In order for the EEP to be most effective in its "external evaluation" of the Bean/Cowpea CRSP, the MO has invited the EEP members to attend and participate in all activities associated with the All-Researchers Meeting scheduled on September 12–16, 2005 in Dakar, Senegal. As recommended in the "Guidelines" (page 24), the EEP members will be able to interact with PIs and other CRSP personnel at a meeting where technical reports are made and program planning discussions occur. This will be important for assessment of the coherency and coordination of both the regional projects and the global Bean/Cowpea CRSP program.

D. Outputs from the Five-Year Technical Review

EEP members who participate in a site visit are asked to prepare a written report. This report should include the identity of institutions visited and individuals interviewed, observations regarding the implementation of the CRSP project, responses to questions, assessments of research and training activities, and preliminary recommendations. This will be an internal document for use by the EEP only but will be accessible to the ME and the USAID Cognizant Technical Officer (CTO) for the Bean/Cowpea CRSP, Dr. Jiryis Oweis.

These reports of institutional site visits along with reviews of annual workplans and technical progress reports and dialog with the Director and Deputy Director of the Bean/Cowpea CRSP, Dr. Irvin Widders and Mywish Maredia, respectively, will be the basis for discussions and the drafting of a Five-Year Technical Review Report by the EEP.

To facilitate the final evaluative discussions and the drafting of the EEP's Five-Year Technical Review, the Management Office will schedule a meeting of all the EEP members in September or October 2006.

Tentative plans are to schedule a Bean/Cowpea CRSP Board of Directors meeting immediately following this EEP meeting in order to receive an oral preliminary report of the EEP's Five-Year Technical Review.

The MO will provide assistance to the EEP for the formatting and the ultimate publishing of the Five-Year Technical Report document for the Bean/Cowpea CRSP.

E. Suggested Questions to Facilitate Assessment during Institutional Site Visits

1. For Discussions with Principal Investigators and Collaborators:

Regarding Justification

a. How will outputs of the component's research and training activities contribute to the Global Mission of the Bean/Cowpea CRSP (1) of building the human and institutional capacity of agricultural universities and national research systems, and (2) of enhancing bean and cowpea consumption, utilization, and food security in Africa, Latin America and the U.S.?

b. Will achievement of the research objectives contribute to growth of bean or cowpea "value-chains' in developing countries and the U.S.? Explain?

c. What constraint in the bean/cowpea value chain is being addressed through the component's research and training activities? Describe the importance of this constrain from an economic, social, environmental and/or health and nutrition perspective.

d. How will research by this component benefit other groups such as the urban poor, malnourished children, etc.?

Regarding Implementation

e. How closely do the research and training activities being conducted follow those proposed in the current year's approved workplan?

f. Identify changes which have been made in this team's research and training workplan during the current grant period and the reasons for these changes. Were these changes justified and successful? Were counter-productive efforts identified and terminated? Were new efforts and spin-offs initiated based on prior results?

g. How would you rate the overall technical quality of this research? How is collaboration between U.S. and Host Country scientists contributing in a sustainable manner to the enhancement of research capacity and the quality of research undertaken at agriculture research institutions in the Host Countries?

h. To what extent are Women in Development issues addressed in research, training and outreach? Will a WID perspective be reflected in new technologies to be generated? Is the WID perspective documented in the impact assessments?

i. What is the current level of collaboration (e.g., coordination of research; level of communication; exchange of information and technologies such as advanced breeding lines, etc.) within this component? Within the regional project team?

j. What is the level of participation by women, either as scientists or as stakeholders, in this research program?

k. Will the research and training goals be completed by the end of the current Bean/Cowpea CRSP grant on September 30, 2007? What will be the specific outputs by this component?

l. How effectively have the U.S. and HC PIs involved in this component coordinated their activities with other components in the regional project and sought to work as a multidisciplinary team with common regional goals?

m. How effective has this component been in regionalizing it's research and training activities and to contributing to the goals and objectives of the regional project?

n. Is the component's research and training activities "cost effective" to the program?

o. How effectively are leveraged funds used to support the component's activities?

p. What linkages does this component have with other agencies, NGOs and private sector groups (i.e., farmers associations, food industry groups, etc.) in the Host Country? In the region? In the U.S.?

q. To what extent have the PIs within this component informed Host Country USAID Missions of CRSP activities or sought to be more responsive the Mission Strategic Objectives within the Host Country?

<u>Regarding Impact</u>

r. Will research activities result in scientific findings, technological developments, or information that will benefit stakeholders within the bean/cowpea value chains in the U.S. and the Host Countries? Describe.

s. How will outputs from the research activities be extended to ensure adoption and ultimate benefit to stakeholders in the bean and cowpea value chains?

t. What impact is projected from the outputs of the collaborative research activities? Who will be the beneficiaries? What measures are being taken to maximize the potential for impact?

u. What efforts are being made to ensure regional impact of technologies and information which result from this component?

v. How will U.S. consumers and bean and cowpea industries be impacted by the research activities of this component?

w. How effectively will the short- and long-term training supported by this component contribute to the building up of capacity in strategic disciplinary areas in institutions within the Host Country, region and the U.S.?

x. What non-CRSP entities have partnered and contributed to the achievement of regional impacts by the component or the regional project?

2. For Discussion with University/Institutional Administrators and Institutional Representatives:

a. To what extent does the home institution support the CRSP PI's research program and objectives?

b. To what extent is the CRSP program an integral part of the home institution's academic, research and outreach programs?

c. What is the current level of match? Is the level of match increasing or decreasing? Why? For the U.S. institution, is it at or above the required rate of 25 percent of U.S. expenditures?

d. What administrative/management contributions to the CRSP have been made above the support provided by indirect costs and what is counted as match?

3. For Discussion with Institutional Financial Officers:

a. What is the current level of match? Is it at or above the required rate of 25 percent of U.S. expenditures? Is the level of match increasing or decreasing? Why?

b. What administrative/management contributions to the CRSP have been made by the institution in addition to that which has been committed and reported as institutional match?

c. What is the current state of the U.S./Host Country fiscal relationship? Has this financial relationship influenced the implementation of research and training activities. How effective is the mechanism for transfer of funds?

4. For Discussion with USAID Mission Personnel:

a. What is the level of the Mission's understanding of the Bean/Cowpea CRSP and its institutional partnerships and research and training activities within the respective Host Country?
b. How are Bean/Cowpea CRSP research and training objectives aligned with USAID Mission Strategic Objectives?

c. Does the Mission provide any financial, logistical or programmatic support to the Bean/Cowpea CRSP?

e. How might the Bean/Cowpea CRSP more effectively partner with the USAID Mission and be more supporting of its agricultural development and economic growth objectives for the Host Country?

5. General Issues for Discussion:

a. What has been the CRSP component's or regional project team's response to previous EEP evaluations and recommendations?

b. What challenges or opportunities have been encountered in working regionally?

c. Is there adequate interaction between Host Countries in the region? Is there adequate interaction between Host Countries and non-Host Countries in the region? Has there been impact of CRSP activities in non-Host Countries?

d. How successful has the team under review been in its efforts to regionalize in the face of financial constraints and national disasters?

e. Is a focus on regional impact being maintained? Is impact being adequately documented?

f. What is your recommendation regarding future research and training priorities if an extension is awarded by USAID?

g. How might the Bean/Cowpea CRSP be more responsive to USAID's Mission Strategic Objectives and partner to achieve their economic growth and agriculture development goals?

h. How might the Bean/Cowpea CRSP cultivate stronger partnering relationships with private industry both in developing countries and the U.S.?

i. How might the Bean/Cowpea CRSP's research and training agenda evolve from a primary focus on supply side/production issues to being a more comprehensive program responsive to global driving forces (i.e., urbanization, changes in food supply chains, the HIV/AIDS pandemic, etc.)?

APPENDIX B

EEP INSTITUTIONAL SITE VISITS

Institution Visited	Dates	EEP Member(s)
Purdue	May 11-15, 2005	Lund and Kornegay
University of Ghana-Legon	September 5-7, 2005	Stovall and Lund
INERA, Burkina Faso	September 6-7, 2005	Kornegay and Ouatarra
INRAN, Niger	September 8-9, 2005	Kornegay and Ouatarra
ISRA, Senegal	September 12-16, 2005	Stovall, Lund and Kornegay
Zamorano, Honduras	December 5-8, 2005	Herdt
Pennsylvania State University	February 14-16, 2006	Lund
Texas A&M University	38776	Herdt
INIAP, Ecuador	March 15-21, 2006	Kornegay
University of California-Riverside	April 11-12, 2006	Herdt
Michigan State University	April 25-25, 2006	Stovall and Herdt
University of Pretoria	May 11-18, 2006	Lund
University of Eduardo Mondlane, Mozambique	May 22-23, 2006	Lund
Bunda College, Malawi	May 22-23, 2006	Ouattara and Kornegay
Sokoine University, Tanzania	May 25-27, 2006	Kornegay, Stovall, Ouattara and Lund
Washington State University	38895	Stovall
Oregon State University	38897	Kornegay and Stovall

APPENDIX C

June 14, 2006

Ambassador Randall L. Tobias
Director of U.S. Foreign Assistance and Administrator
USAID
RRB 6.09A
Washington, D.C. 20523-6800

Dear Administrator Tobias:

It's my understanding that as of September 2007, the U.S. Agency for International Development has decided to prematurely terminate the Bean/Cowpea Collaborative Research Support (CRSP) and the grant to Michigan State University for the administration of the important program. The US Dry Bean Council opposes such action because of the benefit our industry receives from the research programs supported by the Bean/Cowpea CRSP at many of the land-grant universities in bean and cowpea (blackeye) producing states. We recommend that the Bean/Cowpea CRSP be extended for an additional five years in accord with its 10-year authorization.

It's also my understanding that EGAT/USAID Washington has based its decision on a desire to establish a new CRSP program that encompasses Dry Grain Pulses and to have U.S. universities bid for the management of this program. We do not see the need to terminate a highly successful program and replace it with a program that doesn't have clearly defined research priorities and that would include research on additional pulse commodities such as peas and lentils.

The dry bean industry is concerned about the potential adverse impact of establishing a new program on existing on-going research programs at land-grant universities that are currently supported by the Bean/Cowpea CRSP. The dry bean industry has strong ties with the bean breeding, food science, crop management, and health/nutrition research programs at the land-grant universities in our respective states. Because dry beans are such a minor crop, we have very limited financial support for research from either public or private funding sources. Through research at our state universities, the Bean/Cowpea CRSP program has served the needs of our domestic industry as well as the small-scale resource-poor farmer and processor in developing countries. The lack of financial support will disrupt critical programs even in the course of one or two years. Personnel will change and research will focus away from dry beans.

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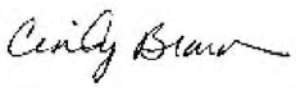
APPENDIX C (Continued)

By allowing the Bean/Cowpea CRSP program to extend another five years, greater continuity could be achieved which would allow the completion of long term goals such as developing improved varieties as well as gaining a better understanding of the health attributes of beans. Time is of the essence. Delaying research will compromise the industry's global competitiveness and limit its ability to take advantage of potential new market opportunities.

The U.S. Dry Bean Council is pleased with Michigan State University's management of the Bean/Cowpea CRSP. Just prior to the establishment of the new grant for the Bean/Cowpea CRSP in 2001, Michigan State University appointed Dr. Irvin Widders as the new Director. He has provided strong leadership to this program and been highly responsive to dry bean industry research and training needs. Examples of an improved relationship between the U.S. dry bean industry and the Bean/Cowpea CRSP include Dr. Widders' assistance in obtaining funding for the Beans for Health Alliance (a GDA funded by USAID), the appointment of an industry representative on the CRSP Technical Committee, and his current service on the Health and Promotions Committee of the U.S. Dry Bean Council. In particular we acknowledge Dr. Widders visionary leadership which has enabled the industry to refocus and make "improving health and nutrition by eating beans" a research and promotion priority. Because of the critical role that the Bean/Cowpea CRSP research plays to the future of the dry bean industry both domestically and globally, we would strongly oppose the awarding of the management of this program to another university which is not in a major bean/cowpea producing state and which does not seek to understand and be responsive to our research needs.

As a benefactor and a stakeholder of the Bean/Cowpea CRSP, the US Dry Bean Council wants to inform you of our full support for a five-year extension of the Bean/Cowpea CRSP and the continuation of Michigan State University as the Management Entity for this program until September 30, 2012.

Respectfully,



Cindy Brown
US Dry Bean Council President

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APPENDIX D History of Funding

Bean/Cowpea CRSP Budget from USAID, 1980-2007

CRSP fiscal year	Annual budget Nominal $	PPI 2006=100	Annual Budget in US $2006
1980-81	$ 2,770,479	54.31	$ 5,100,819
1981-82	$ 2,770,479	59.27	$ 4,673,999
1982-83	$ 2,770,479	60.47	$ 4,581,860
1983-84	$ 2,770,479	61.23	$ 4,524,913
1984-85	$ 2,770,479	62.69	$ 4,419,549
1985-86	$ 2,770,479	62.39	$ 4,440,897
1986-87	$ 2,833,462	60.58	$ 4,677,130
1987-88	$ 2,801,538	62.18	$ 4,505,606
1988-89	$ 2,600,000	64.68	$ 4,019,864
1989-90	$ 2,486,250	67.88	$ 3,662,485
1990-91	$ 2,888,750	70.30	$ 4,108,975
1991-92	$ 3,198,000	70.46	$ 4,538,764
1992-93	$ 2,900,000	70.88	$ 4,091,537
1993-94	$ 2,750,000	71.92	$ 3,823,892
1994-95	$ 2,300,000	72.85	$ 3,157,228
1995-96	$ 2,355,000	75.45	$ 3,121,092
1996-97	$ 2,600,000	77.22	$ 3,366,855
1997-98	$ 2,736,000	77.17	$ 3,545,282
1998-99	$ 2,500,000	75.26	$ 3,321,916
1999-00	$ 2,500,000	75.89	$ 3,294,336
2000-01	$ 2,700,000	80.27	$ 3,363,537
2001-02	$ 2,900,000	81.16	$ 3,573,204
2002-03	$ 2,900,000	79.30	$ 3,657,003
2003-04	$ 2,900,000	83.54	$ 3,471,435
2004-05	$ 2,900,000	88.70	$ 3,269,460
2005-06	$ 2,900,000	94.18	$ 3,079,167
2006-07	$ 2,772,000	100.00	$ 2,772,000

Acknowledgement

Objective assessment of research projects and expert advice on technical matters are essential inputs to program administrators for the management of successful research and training programs. Such programs not only maintain high standards of scientific excellence and achieve international development goals, but they continue to evolve by responding to evaluations and technical counsel with new initiatives and administrative approaches that contribute to improved effectiveness and efficiency. The quality of the evaluations and technical advice are a function of the expertise and professional experiences of the individuals consulted.

The Bean/Cowpea CRSP was blessed by having an External Evaluation Panel (EEP) during the current grant which has extensive experience in research program administration, professional involvement in international agriculture development via employment at NARS, IARCs, NGOs and universities, diverse scientific disciplinary expertise, and knowledge of the various subsectors associated with bean/cowpea value-chains. It is impossible to envision a more qualified EEP than the current members, John Stovall (Chair), Julia Kornegay, Daryl Lund, Robert Herdt, and Mamadou Ouattara to conduct the Five-Year Technical Review of the Bean/Cowpea CRSP.

The Management Office (MO) is genuinely grateful to all the EEP members for their commitment to serve on the External Evaluation Panel, for the countless hours that they spent reading workplans and annual reports to better understand the individual CRSP components, for their willingness to set aside time from their busy schedules to visit the U.S. and Host Country universities and institutions which participate in the CRSP, and for sharing insights and providing guidance that will enable the Bean/Cowpea CRSP to become a stronger and effectual USAID-supported program in the future.

The MO wishes to especially acknowledge and thank John Stovall for his leadership of the EEP throughout the entire process of evaluating the components, establishing a framework for the report, and coordinating the discussions and preparation of the Five-Year Technical Report. His positive and encouraging demeanor was largely responsible for the strong team dynamic among the EEP members and ensured that the report was completed in a timely manner.

Finally, the MO acknowledges that the existence of the numerous collaborative research and training projects in Latin America and West and East/Southern Africa of the Bean/Cowpea CRSP as well as the EEP's activities would not have been possible without the financial support from EGAT/USAID Washington. Dr. Jiryis Oweis, Cognitive Technical Officer for the Bean/Cowpea CRSP, also played an important and valued oversight role in the appointment of the EEP, the development of the Scope of Work for the EEP's Five Year Technical Review, and in the management of the program throughout the current 2002-07 grant.

Irvin Widders
Director