REPORT OF THE EXTERNAL EVALUATION PANEL

QUINQUENNIAL REVIEW FY 1997-2001

BEAN/COWPEA COLLABORATIVE

RESEARCH SUPPORT PROGRAM

March 2001

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THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)

An international community of persons,
institutions, agencies and governments committed
to collectively strengthening health and nutrition in
developing countries by improving the availability
and utilization of beans and cowpeas.

Bean/Cowpea CRSP
200 International Center
Michigan State University
East Lansing, Michigan 48824-1035 U.S.A.
Phone: (517) 355-4693
Fax: (517) 432-1073
E-Mail: defouw@msu.edu

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TABLE OF ACRONYMS

ALS	Angular Leafspot
BCMNV	Bean Common Mosaic Necrosis Virus
BCMV	Bean Common Mosaic Virus
BGMV	Bean Golden Mosaic Virus
BGYMV	Bean Golden Yellow Mosaic Virus
BOD	Board of Directors
CBB	Common Bacterial Blight
CIAT	Centro Internacional de Agricultura Tropical
CRI	Crops Research Institute
CRSP	Collaborative Research Support Program
DLS	Delayed Leaf Senescence
DNA	Deoxyribonucleic Acid
EEP	External Evaluation Panel
FAO	Food and Agriculture Organization
EU	European Union
FY	Fiscal Year
GMO	Genetically Modified Organism
HB	Halo Blight
HC	Host Country
IARC	International Agricultural Research Centers
IITA	International Institute of Tropical Agriculture
IPM	Integrative Pest Management
ISRA	Institut Senegalais de Recherches Agricoles
LAC	Latin America/Caribbean
MO	Management Office
MSU	Michigan State University
N	Nitrogen
NGO	Non-Governmental Organization
NRM	Natural Resource Management
P	Phosphorus
PCR	Polymerase Chain Reaction
PI	Principal Investigator
RAPD	Random Duplicated Polymorphic DNA
SARI	Savanna Agricultural Research Institute
SUA	Sokoine University of Agriculture
TC	Technical Committee
U.S.	United States
UCD	University of California-Davis
UCR	University of California-Riverside
UGA	University of Georgia-Athens
UGL	University of Ghana-Legon
USAID	United States Agency for International Development
USAID/W	United States Agency for International Development/Washington
WB	Web Blight
WID	Women in Development

PREFACE

The Bean/Cowpea Collaborative Research Support Program (CRSP) is an international partnership of United States (U.S.) and developing country research programs designed to (1) increase the production and consumption of beans and cowpeas in developing countries and (2) support agriculture in the U.S. The CRSP is funded by the U.S. Agency for International Development, Global Bureau, Economic Growth Center, Office of Agriculture and Food Security. The Cognizant Technical Officer, currently Dr. Jiryis Oweis, was Dr. Harvey Hortik at the beginning of the period covered by this review.

The Bean/Cowpea CRSP began in September 1980 with an authorization through fiscal year (FY) 1986. Since then, there have been two three-year extensions and two five-year extensions. The most recent extension authorizes the CRSP through April 27, 2002.

Due to the long-term commitment of support by the United States Agency for International Development (USAID) to the Bean/Cowpea CRSP, it was decided early in the life of the program to establish a yearly process of evaluation. These yearly evaluations involve two parallel groups: (1) a Technical Committee (TC), an internal group consisting of Principal Investigators (PI) and two scientists from the International Agricultural Research Centers (IARC) that review the technical research progress and training activities; and (2) an External Evaluation Panel (EEP), that provides an external review of the program. The EEP s evaluations would be based on (1) reviews of the regional projects Annual Research and Training Progress Reports and publications, (2) rotating visits to Host Country (HC) and U.S. institutions, (3) EEP presence at professional meetings where CRSP scientists present papers and, with their peers, deliberate technical issues, and (4) discussions with the CRSP Management Office/Management Entity (MO) and USAID Cognizant Technical Officer.

As mandated by the *Guidelines for Collaborative Research Support Programs under Title XII*, the EEP is to conduct a special evaluation of the CRSP during each grant/extension period which is to be used in USAID s Five-Year Review. This evaluation by the EEP includes a technical review (page 34), and thus the designation of the *Report of the External Evaluation Panel Quinquennial Review FY 1997-2001 Bean/Cowpea Collaborative Research Support Program* given to the present document.

This report by the Bean/Cowpea CRSP External Evaluation Panel is the eighteenth such report evaluating this program. The CRSP has benefitted from the internationally experienced professionals of the EEP who represent a wide range of disciplines relevant to the CRSP objectives, e.g., biotechnology, agronomy, food science, and international agriculture economics. The CRSP Guidelines, which encourage regular turnover in EEP membership, identify the EEP role as judging the overall balance of the CRSP and the relevance of each sub-project to the program s goals. Specifically, the EEP is to review the status, funding, progress, plans and prospects of the total effort.

During the current extension period, the Bean/Cowpea CRSP is committed to a regional structure that seeks to achieve impacts from technologies and knowledge generated by CRSP research activities at the regional level, i.e., beyond the borders of CRSP HCs. This is a

departure from the bilateral project structure that existed prior to 1997. During the period from 1980 to 1996, the program supported eighteen U.S./HC bilateral projects in thirteen African, Central/South American and Caribbean countries. Beginning in 1997, three regional projects were established, including a West Africa Regional Project with a focus on cowpea, and an East Africa and a Latin America/Caribbean Regional Project, each focusing on beans. Ten countries were incorporated into the current regional structure. Over the course of the Bean/Cowpea CRSP, fourteen bilateral projects were terminated either for cause or because their objectives were met, and eight new projects were initiated based on need identified within the participating countries and the wider international community.

As part of the current review, the EEP conducted site visits of all component U.S. and HC CRSP institutions, including the Management Entity, over the period from November 1999 through January 2001. When conducting the site evaluations, the EEP followed a Scope of Work prepared by the MO and filed a Site Evaluation Report for each CRSP institution visited. The Site Evaluation Reports were discussed extensively by the EEP, and jointly with evaluations of the FY 2000 Annual Regional Research and Training Progress Reports, served as a basis for the recommendations presented in this EEP Quinquennial Review.

Thus, the present document not only reports the EEP s evaluation of the Bean/Cowpea CRSP for FY 2000 (October 1, 1999 through September 30, 2000), but also assesses research and training progress in accord with goals established for the current extension period. As such, it covers the third reporting period that this program has utilized the new regional format. The Bean/Cowpea CRSP is proud of the progress that has been made in achieving a more integrated multi-disciplinary program with a regional focus.

Irvin E. Widders, Director

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QUINQUENNIAL FY 1997-2000 EEP REVIEW: THE PROCESS

1. Using USAID *Guidelines for Collaborative Research Support Programs* and input from the TC and BOD, the MO developed, and USAID/Washington (USAID/W) approved, a Scope of Work (see Attachment A). This Scope of Work provided a framework for evaluation of (1) progress, (2) funding, (3) plans and (4) status/prospects for each CRSP Regional Project.

2. EEP members were assigned sections to review, and discussion drafts were prepared and disseminated to other EEP members prior to the January-February 2001 meeting in New Orleans, Louisiana.

3. At the January-February 2001 meeting, EEP members discussed their site visit reports. The EEP visited all U.S. and HC sites over the past two years. Trip reports from these visits and a discussion of them formed a key part of the EEP information base.

4. The overall evaluation of the Bean/Cowpea CRSP is a result of a combination of individual project and activity reviews, site visits, evaluation of written Annual Regional Research and Training Reports, discussions with CRSP officials and scientists, and confidential discussions exclusively among the members of the EEP.

5. Unlike previous EEP annual reports, the EEP decided not to assign numerical ratings in this five-year review. After considering the merits and demerits of attempting to quantify our assessment, members of the EEP decided to rely instead on the narrative to describe what were deemed to be the strengths and weaknesses of individual projects and the CRSP as a whole. The rationale was that numerical ratings would imply more precision than is possible and invite comparisons among projects that may be misinterpreted.

PROGRAM EVALUATION: SUMMARY

For this five-year review, the EEP conducted a detailed review of the past years activities in the three regional projects as well as the fiscal and administrative aspects and relied on previous EEP reports to broaden the scope to include the period since the last five-year review in 1996. One caveat is in order. It was not possible to evaluate regional projects over the five-year period because the regional concept was not implemented until about three years ago. Until that time, projects were bilateral, the typical mode being a project consisting of one U.S. University and one Host Country Institution.

The most striking and most lasting accomplishment of the Bean/Cowpea CRSP over the past five years is the increase in human and institutional capacity in host countries to conduct research and transfer technology to bean and cowpea producers, marketers and consumers. This product of years of investment in human capital development by the Bean/Cowpea CRSP is obvious to the EEP in site visits where most of the scientists hold advanced degrees supported by CRSP funds. Most of the collaborating host country institutions are staffed with scientists who are on a par with their U.S. counterparts, even though the physical facilitates in which they work are sometimes inadequate.

Another significant accomplishment is the increased stock of scientific knowledge that has been built up over the years about bean and cowpea breeding, culture, storage, marketing and consumer satisfaction. A corollary accomplishment is the global network of scientists that has been established which adds value to the scientific advancements. The Bean/Cowpea CRSP can justly point with pride to numerous areas in which the global stock of knowledge has been increased and technology has been developed with support from the CRSP. In the view of the EEP, the Bean/Cowpea CRSP is as important, or more so, as the two International Agricultural Research Centers with a mandate in bean and cowpea research, Centro Internacional de Agricultura Tropical (CIAT) and International Institute of Tropical Agriculture (IITA), in terms of scientific advances and human capacity.

The Latin America and Caribbean (LAC) project stands out as the strongest project in terms of scientific capacity as indicated by publications and the number of scientists who participate in the network. To some extent this is not surprising since the LAC region had a stronger base from which to build, enjoyed a close proximity to U.S. institutions and had a better infrastructure than African counterparts.

The West Africa project, although facing a number of obstacles including an environment favorable to insect pests and diseases, has developed a strong research program and a viable cowpea production and marketing sector. This remarkable success story can be explained in large part by the long-term commitment and persistence of U.S. and Host Country scientists.

The East Africa project, faced with even more formidable challenges has not yet reached the maturity of the other two regional projects, but now appears to be positioned to make significant progress during the next phase. With CRSP research in only two countries, Malawi and Tanzania, the East Africa project has received less funding, has the fewest scientists and consequently has fewer scientific publications, compared to the other projects. On the positive side, there is a small cadre of well trained and highly qualified Host Country scientists who are dedicated to the objectives of the CRSP. In addition, the collaborating U.S. institutions have equally dedicated scientists who are making remarkable scientific progress that has yet to be fully transformed into increased bean productivity in Africa. The EEP is optimistic for the future, despite the handicaps faced in East Africa.

The global network of Bean/Cowpea CRSP scientists working on bean and cowpea production, marketing and consumption is a result of nearly a quarter century of investment by U.S.

universities, Host Countries and USAID. It is surely a remarkable success story of what can be accomplished by sustained efforts over a long period of time.

Despite these successes, the Bean/Cowpea CRSP faces difficult challenges as it moves into the next phase. It will have to deal successfully with a number of second generation problems including how much to invest in the newer tools of biotechnology, how to achieve the proper balance among disciplines and approaches, how to fully utilize the more advanced Host Countries in meeting global objectives and how to complete the shift from bilateral projects to a regional approach.

PROGRAM EVALUATION: FISCAL AND ADMINISTRATIVE

One of the tests of an institution s ability to provide long-term support for the CRSP is surviving the inevitable turnover of key personnel and replacing them with quality faculty and staff. During this evaluation period, October 1, 1999 through September 30, 2000, Michigan State University (MSU) and the Bean/Cowpea CRSP MO deserve special commendation for successfully adjusting to a major transition of key project personnel due to retirements.

During 2000, the MO lost the services of Dr. Pat Barnes-McConnell to retirement after 17 years of distinguished leadership as Director to the Bean/Cowpea CRSP, as well as another person who is key in any USAID project: the Administrative Officer, Sue Bengry, who also retired at the end of 2000. Both positions were replaced with experienced faculty or staff. MSU administrators, who gave the transition the high priority it deserved, provided funds for an overlap period for their replacements. The Deputy Director, Dr. Irvin Widders, was promoted to Director. The Deputy Director position was filled from within MSU by Dr. Mywish Maredia, an agricultural economist who completed her Ph.D. in 1993. She brings significant international experience to this position. The essential post of Administrative Officer was filled by an MSU staff member with experience in international projects, Ms. Christina DeFouw.

Although it may be premature to judge the effectiveness of the new team, the EEP is impressed with the efficiency with which MSU provided replacements, an important period of overlap and with the quality of the personnel now providing the leadership and administrative support for the Bean/Cowpea CRSP. We have every reason to believe that the CRSP will continue to have a MO as strong in the future as it has been in the past.

As if these personnel changes were not enough, the MO had to adjust to a change in the project s Cognizant Technical Officer in USAID/W. During this past summer, Dr. Harvey Hortik retired and was replaced by Dr. Jiryis Oweis. This change was accomplished without any lapse in this key liaison and no noticeable transition difficulty.

One of the more laudable aspects of these transitions is that they have been accomplished so far with little apparent disruption and no gaps in the services that the MO provides. While no transition of this magnitude is entirely seamless, the EEP proposes it as a model that should

be examined when other CRSPs face similar changes. This transition might warrant a modest effort to document the experience and note the lessons learned that might benefit others.

During the transition, the MO was busy with several significant programmatic activities, including a Midcourse 2000 Researchers Meeting, a Technical Committee meeting and solicitations of Expressions of Interest in preparation for the next phase. Over 50 Expressions of Interests were received from interested scientists and institutions, 22 of which were from scientists not currently participating in the Bean/Cowpea CRSP.

Many challenges are ahead for the new MO team as they seek approval for another five- year program grant from USAID. The process laid out by USAID and the Board for International Food and Agricultural Development (BIFAD) is complex, involving a number of sequential steps, a considerable amount of paperwork and likely some hard programmatic questions that require a response. The real test for the new team will be in preparing for and negotiating a new five-year grant.

In contrast to some past years, the MO has not had to deal with a significant budget crisis brought on by a reduction imposed by USAID or because of delays in receiving funding. Indeed, thanks in part to congressional language in the USAID appropriations bill, the past year has been marked by stability and even a modest increase in funds available.

Despite this general complimentary assessment of the MO, the EEP believes there are a few problems that can and should be remedied. These include the following:

1. **Administrative burden:** The EEP encourages the new MO team to give attention to ways of reducing the administrative and reporting burden imposed on subgrant institutions, both in the U.S. and Host Countries. While not unique to the Bean/Cowpea CRSP, but seemingly an inherent characteristic of USAID funded projects, administrative and fiscal procedures seem overly burdensome, especially compared with the small amount of funds associated with any one subgrant. During their site visits, EEP members often heard this complaint from scientists and administrators who say the CRSP grant requires more work than any of their other grants, most of which are many times larger in dollar amount. It is unlikely that the Bean/Cowpea CRSP alone can significantly change USAID requirements, but perhaps acting collectively with the CRSP Council, some reforms might be possible.

2. **Bean/Cowpea CRSP website:** The EEP recommends that the Bean/Cowpea CRSP website be expanded and improved. Unlike most other CRSP websites, the Bean/Cowpea site does not have publications or in-house documents, e.g., Annual Reports and EEP Reports, accessible on the Internet. Since virtually all Bean/Cowpea scientists have access to the Web, greater use of the website would facilitate communications and the rapid dissemination of information.

3. **Governance:** Most of the decision making within the Bean/Cowpea CRSP, such as priority setting and budget allocation, is highly participatory. The TC and regional committees make recommendations to the MO, which nearly always follows that advice.

Although the EEP believes that the committee structure and governance is generally sound, some instances are noted in which the MO should exercise its authority more assertively. For example, the EEP has voiced concerns on several occasions about incomplete reporting of annual results in the Annual Report but these deficiencies persist. The EEP recommends that the MO take whatever action is necessary to rectify these deficiencies and to deal firmly with rare but occasional performance problems.

4. **Advance of funds for Host Countries:** During site visits, the EEP noted that there is apparently no uniform or equitable policy with respect to the advance of funds to Host Country Institutions. Some Host Country Institutions receive an advance and others do not. While some Host Country Institutions have relatively strong economies and can manage their cash flow while awaiting reimbursement; others, such as Bunda College of Agriculture in Malawi which does not receive an advance, have great difficulty doing so. Apparently, this inequity is a result of different policies of the U.S. Institutions that administer the subgrants. The EEP recommends that the MO review the policies and practices of these U.S. Institutions and take action to correct the inequities and hardships that exist.

5. **Five-year progress report:** The Annual Report is highly technical and unlikely to be read by anyone other than insiders and scientists. In addition to the Annual Report, the MO should prepare a report of progress which is understandable to a wide range of readers, describing the major achievements for the past five-year grant period. It should be concise, written in nontechnical language and focus on results and benefits to both U.S. and Host Countries. The primary audience for the report should be USAID officials, university administrators and the Congress. Agricultural interests in the U.S. and the general public might also be audiences to consider.

6. **Distance learning and conferencing:** The EEP recommends that the MO explore the possibility of training through distance education, such as web-based courses, and networking through electronic conferencing. While the LAC region has begun distance education initiatives, all of the U.S. universities involved with the CRSP have such programs which should be drawn upon to keep the CRSP training in line with current educational trends.

7. **Mission buy-ins:** The EEP believes that the MO and PIs should be more aggressive in pursuing buy-ins or add-ons from USAID missions. The Bean/Cowpea CRSP has no USAID mission funding, unlike most other CRSPs, although the amount of funds from USAID missions varies widely among CRSPs. Certainly the Bean/Cowpea CRSP could make use of the extra funds and there is reason to believe that with a modest amount of marketing effort, some missions would support selected Bean/Cowpea CRSP activities in their country of responsibility.

I. EVALUATION OF REGIONAL SPECIFIC RESEARCH PROGRESS DURING FY 1997-2000

WEST AFRICA REGIONAL PROJECT

A. REGIONAL PROGRESS

1. Progress

The project in West Africa continues to show excellent collaboration and cooperation among the African scientists with their U.S. counterparts. Impacts have resulted from increased adoption by farmers of two cowpea varieties developed by the Institut Sénégalais de Recherchés Agricoles (ISRA), Mouride and Mélakh, and their extension in Senegal by seed producers and non-governmental organizations (NGO). Important preliminary research has been conducted on the development of an efficient transformation system for cowpea, since this transformation will allow pest resistance and drought tolerance genes to be introduced into the species, allowing it to survive the harsh conditions of Africa.

Extensive research is ongoing on the utilization of cowpeas in weaning as well as traditional African foods. The food and social scientists are providing valuable data for the breeders and plant scientists to use as they select varieties of cowpea that are more nutritional and desired by the consumers and appropriate for target production areas.

Outreach, the transfer of technical information from research to farmers, extension workers and consumers, has been excellent in West Africa. Ghana has served as a center for these efforts, whether they be the development of farmer field schools or collaboration/cooperation on the compositional analysis of varieties. The NGOs in West Africa have served an important role in partnering with CRSP scientists to aid the transfer of research findings to users.

The training of young scientists has been one of the most important investments by the CRSP. During the past few years, the number of students being trained, both for advanced degrees or for specialized training on methods, has decreased. The CRSP scientists state that this is an important effort because it builds sustainability into the programs. Thus, this area needs special attention in the future if training is to remain a major focus of this regional project.

2. Strengths and Weaknesses

a. Strengths

There is excellent interaction between HC and U.S. scientists across all disciplines.

A sweet cowpea variety was discovered in Cameroon. This finding has significant marketing possibilities.

Ideotypes have been developed to improve time to maturity, grain quality traits, yield potential and nematode and lygus resistance.

Seed dissemination to farmers is going well in most areas, but needs continued strengthening.

Seed storage systems have been developed and tested, but improvements are still needed.

Village and small business initiatives for expanding cowpea utilization have begun.

Socioeconomic assessments on the acceptance of weaning foods, field schools and price-quality characteristics of cowpeas have been initiated.

Partnering with NGOs continues to be a strength in the region, and needs constant nurturing.

Outreach activities within and across countries in the region are very good, and are gaining strength. There is an atmosphere of cooperation evident within the region.

Human capital development continues via degree and non-degree training, but at a slower rate.

b. Weaknesses

Cowpea variety development and evaluation should receive consistent farmer/consumer input.

Seed dissemination systems must be developed and/or strengthened throughout the region.

New foods based on cowpeas must move toward implementation/ commercialization, once independent social-economic studies demonstrate the likelihood of consumer acceptance and commercial success.

The role of neem as a pesticide needs to be substantiated through objective research.

In West Africa, the research infrastructure at specific HC sites is in dire need of support and rebuilding.

3. Issues and Recommendations

Each research activity within this regional project needs to continue to seek additional funding from outside of the CRSP to maintain, and build when possible, the research infrastructure for that project.

The CRSP scientists need to develop and sustain strong partnerships with governmental ministries, NGOs and international research centers to extend limited resources and ensure continued research success.

Scientists must continue their efforts to disseminate production and/or utilization research findings to farmers, extension workers and consumers.

The socioeconomic data now being generated will be important in helping direct and focus research and outreach efforts.

Commendations must go to the Savanna Agricultural Research Institute (SARI), Crops Research Institute (CRI) and University of Ghana-Legon (UGL) for partnering with and assisting other West African cowpea production and utilization programs.

B. CONSTRAINT #1: INSUFFICIENT NATURAL RESOURCE MANAGEMENT (NRM) AND PRODUCTION TECHNIQUES

1. Assessment of Progress

Cowpea breeding and transformation research are extremely important considering the magnitude of cowpea production and utilization in the world. The development of cowpea germplasm with specific adaptation is the most time consuming part of a breeding program and it must be conducted every year to generate a continuous flow of new varieties. The genetic map of cowpea is not yet sufficiently dense to employ effective deoxyribonucleic acid (DNA) marker-assisted selection. Activities to develop cowpea ideotypes for intercropping and the use of the parthenocarpy trait for lygus resistance has been completed. The heat-tolerant cowpea lines developed in California did not perform well in Senegal.

Insect pests are a major constraint to cowpea production in Africa and the U.S. There has been progress with thrips, root-knot nematodes, cowpea weevil and bruchids resistance. However, much more work needs to be done to confirm insect pest resistance in promising cowpea lines. Since limited funds are available for this work, scientists need to prioritize research activities and use funds on the top priority areas.

Furthermore, alternatives to synthetic commercial insecticides are being sought with emphasis being placed on extracts from leaves or seeds of the neem tree, a tree that grows in many parts of West Africa. Sprays with neem extracts can reduce insect populations and increase cowpea grain yields. However, the effects are highly variable and tend to be weaker than those achieved with chemical pesticides. Precise protocols for extracting, formulating and applying neem products need to be developed that are sufficiently and consistently effective and profitable to warrant their extension to farmers.

The issue of seed dissemination can be a constraint to a breeding program. Yet, considerable progress has been made in the dissemination of new cowpea varieties developed in Senegal, Cameroon, Ghana and California.

In recent years, a cowpea line was discovered by the Cameroon/Purdue CRSP project that has a sweeter grain than other cowpeas. This finding might potentially change the marketing of cowpea around the world by opening up new market opportunities and altering price and demand structures for cowpea.

Baseline and adoption data collected for Senegal, Cameroon, Ghana and South Carolina are essential for impact assessment. These studies contributed considerably to better focused research and extension efforts.

2. Research area: Develop improved breeding and transformation methods

a. Background: Few resources have been targeted to cowpea breeding and transformation methods in relation to the crop s importance worldwide. An efficient transformation system would open the possibility of incorporating trans-genes for insect and drought resistance and other useful traits. The genetic map of cowpea is not sufficiently dense to employ effective DNA marker-assisted selection. New mapping technologies can be used to rapidly describe new markers.

b. Evaluation of Research:

(1) Activity #1: Genetic mapping of cowpea using DNA markers. Research on cowpea breeding and transformation are outstanding initiatives considering the importance of cowpea production in the world. The genetic map of cowpea, however, is not sufficiently dense to employ effective DNA marker-assisted selection. Ousmane Boukar s Ph.D. research work should answer many of the questions in this difficult task. In the future, this technology can improve the efficiency of breeding programs and could be applied by cowpea breeders. There was no documented impact reported on this activity. It seems that with the participation of the Centre d etude Regional pour l Amelioration de l Adaptation a la Secheresse (CERAAS) in Senegal, which is screening the cowpea parents to detect DNA polymorphisms, and the work of the Michael Timko laboratory, which has developed suitable amplified fragment length polymorphism (AFLP) procedures and has found a number of markers for *Striga* resistance, the time to complete this activity should be greatly shortened.

(2) Activity #2: Development of an efficient transformation method. Transformation work was suspended during the entire year in favor of characterizing and developing the sweet cowpea trait. The main activity reported was the organization of a Symposium/Workshop on Genetic Improvement of Cowpea, held in Dakar, Senegal on January 8-12, 2001. The outputs of the meeting will be a report on the state-of-the-science in regards to genetic improvement of cowpea, a coordinated workplan, a time frame and a budget for pursuing genetic improvement of cowpea using modern techniques. It was reported that a team of African cowpea breeders attended a subsequent meeting at Purdue to develop a coordinated long-range plan for CRSP cowpea breeding activities within the West Africa Region.

With the need for insect resistance being so great in Africa, the development of a cowpea transformation method that would facilitate the incorporation of insect resistance should be a priority. It is important that transformation studies proceed with an understanding that it will be years before utilizable results are obtained. While that research will be expensive, it is certainly worth the investments of time and resources. Thus, the EEP feels that cowpea transformation is an area of research that should receive continued funding. However, it should be noted that for the second consecutive year, no report was presented on progress related to cowpea transformation.

(**3**) **Activity #3: Development of cowpea germplasm with specific adaptation to the Sahel, the wet and dry Savannah zones of Africa and the United States.** This is the most time consuming part of a breeding program and it must be conducted every year to generate a continuous flow of new varieties. In Senegal, ISRA-819 looks promising as a potential new variety projected for release in the near future. It has the same large red seed as the land race, Ndiaga Aw, which is popular among many consumers in Senegal and may have potential for export to some parts of West Africa. Important advances were also obtained in Senegal on multipurpose cowpea varieties, which could be used in those parts of the Sahel where both hay and grain are valued and where there is enough rain for an 80- to 90-day growing season. The *Striga* resistance work indicated that cowpea varieties could benefit farmers who rotate cowpea with pearl millet or sorghum. Cowpea lines were developed which have early maturity and delayed leaf senescence (DLS). This material is being grown in breeding nurseries to rapidly advance the generations in order to shorten the time required to develop the improved varieties.

University of California-Riverside (UCR) reported progress in breeding cowpea varieties for irrigated production in California. One of the lines, UCR123, had similar grain yields as CB27 and CB46. These lines warrant further testing in that they have DLS which could result in more consistent long-season performance and in much larger grain than either CB27 or CB46, which is desired by the major markets for California blackeyes. UCR completed studies that demonstrated that the DLS and heat-tolerance traits can be effectively combined.

In Ghana, cowpea elite varieties with some level of tolerance to *Striga gesnerioides,* derived from IITA germplasm, were tested at Manga in the Sudan Savanna in an artificially infested field. The level of tolerance appears to be insufficient against the native strain of the parasitic weed in northern Ghana. Two new varieties, Sul 518-3 and IT x P-148-1 are being released to farmers this year.

Promising gains were demonstrated in enhancing insect resistance in cowpea lines and in developing early and medium/late maturing cowpea varieties.

In Cameroon, several trials were established in various locations; however, production data will not be available until early in 2001. It seems that the Senegal cowpea breeding program is working efficiently and effectively, while some temporary personnel problems are occurring both in Ghana, due to the death of K.O. Marfo, and in Cameroon. It is recommended that Dr. Ndiaga Cissé interact with the breeding programs in both those countries. This would result in a tremendous amount of recognition and be a good incentive to the valuable work that is being conducted by Dr. Cissé s cowpea breeding team.

(4) Activity #4: Develop and test ideotypes for intercropping with maize or millet. This activity is now completed. It was stated that Dr. B. B. Singh at IITA is developing improved cowpea cultivars for intercropping with cereals in the Savanna zone of Africa. There appears to be little need to develop cowpea ideotypes for intercropped systems. However, breeding should focus on developing cowpea varieties that perform well in mono-culture systems.

(5) Activity #5: Test a potential mechanism and screening method for flower thrips and lygus bug resistance. This activity is completed at UCR. The parthenocarpy trait that was tested does not appear to confer sufficient resistance to lygus to warrant its inclusion in a breeding program.

(6) Activity #6: Effectiveness of heat tolerance in tropical Africa. Several years of study in California demonstrated that a set of reproductive-stage heat-tolerance genes can enhance grain yield by as much as 900 kg/ha in a hot commercial production setting. These genes can be effectively combined with a DLS gene that enhances long-season production. However, a field study conducted at Bambey showed no difference in grain yield between sets of heat-tolerant and heat-susceptible lines developed by UCR. This confirms earlier studies in which membrane leakage was used for assessment of heat tolerance in cowpea lines in Senegal and Ghana. At UCR, a new method is being tested using electrolyte leakage from leaf disks incubated in aerated solutions. It is expected that heat-tolerant lines have membranes that maintain their integrity at higher temperatures as compared to heat-susceptible lines. Genetic selection experiments have been initiated to determine whether selection for low electrolyte leakage from leaf disks at high temperatures will enable the identification of cowpea genotypes with higher tolerance during reproductive development. This technique would be useful for Africa, if it works. Frequently the screening tests

effective in the U.S. are not effective in Africa due to the presence of multiple abiotic and biotic stresses that obscure the plant responses. This research will contribute to impact if it results in the development of a more efficient method for selecting genotypes with greater tolerance to high temperatures, a major constraint to production in Sub-saharan Africa.

2. **Research area: Screen germplasm and discover/utilize insect resistance in cultivated and wild x cultivated cowpea germplasm and land races.**

   a. **Background:** Insect pests are the primary constraint to increased cowpea production in Africa and other parts of the world. Insect resistant cowpeas would generate a green revolution for this crop with widespread economic and health benefits to farmers and consumers.

   b. **Evaluation of Research:**

      (1) **Activity #1: Develop and evaluate wild x cultivated and cultivated germplasm for resistance to insects.** None of the wild x cultivated lines screened exhibited strong resistance to lygus. It was found that the lygus resistance in the Italian lines was not strong enough. In Senegal, the local variety, Ndiaga Aw, was not affected by a strong attack of hairy caterpillar. Whether this variety has some resistance to hairy caterpillar will be the focus of future investigation as this can be an economically important pest in northern Senegal. In Ghana, there are still problems with screen house facilities, and thus there was no time frame presented for this activity.

      (2) **Activity #2: Determine the genetic relationship of new sources of resistance to root knot nematodes.** The extent to which root knot nematodes are a current or potential problem for cowpeas and associated crops in Africa has not been quantified. It is commendable that studies to quantify root-knot nematode damage in cowpea and associated crops in different parts of Africa are to be initiated. There was no time frame specified for this activity.

      (3) **Activity #3: Evaluate cowpea line for resistance to bruchids, *Callosobruchus maculatus.*** There appears to have been excellent progress in this research activity. There was no evidence that the elevated levels of sucrose present in cowpea line 24-125B have any significant impact on cowpea weevil growth, development and survivorship. None of the cowpea Italian germplasm lines carry any new sources of resistance to the cowpea weevil. An important finding to be used by cowpea breeders was that the line RIISP-001 appears to carry an usually high degree of resistance to cowpea weevil while none of the recombinant inbred lines (RIL) from UCR exhibited significant resistance.

The above findings will be of tremendous value to the cowpea breeders in the future. There was no time frame reported for this activity.

3. Research Area: Complete evaluation and release of advanced lines.

a. Background: Support is needed to allow for final evaluation, release protocols, and seed increases of several varieties developed by CRSP programs. This will ensure timely completion of release details and the availability of adequate supplies of breeder and foundation seed.

b. Evaluation of Research:

(1) Activity #1: Complete evaluation; increase seed and varietal release protocols for advanced lines. The issue of seed dissemination is a critical one as it is in any plant-breeding program. It is important to emphasize the need to make available information on the agronomic requirements of new varieties to seed producers. These activities will accelerate the adoption of new genetic material. The EEP is impressed that through this activity benefits were derived by U.S. farmers and the resource poor farmers in Senegal, Ghana and Cameroon. This should be emphasized more in the report. Research funding continuity is highly dependent on the research data being understood by decision-makers. Questions like, what are the benefit/cost ratios? Which public is benefitting from the released technology? These simple questions are always on the minds of decision-makers, planners and politicians all over the world. The time frame for this activity needs to be determined. It was not indicated if it would be continued during the next phase of the CRSP.

4. Research Area: Development of grain quality traits for value-added products and consumer appeal.

a. Background: The Georgia project has shown that all-white breeding lines developed at UCR are suitable for production of flour for akara using a dry-milling technique. Varieties are needed that combine all-white grain with desirable agronomic characteristics.

b. Evaluation of Research:

(1) Activity #1: Develop all-white, sweet, green, and sweet-green seeded experimental lines of cowpea for the U.S. and Africa. Some progress was made in the selection of all-white grain cowpea that could benefit farmers in the U.S. and in some African countries. Plants derived from the Cameroon based sweet line 24-125B were grown in a greenhouse and UCR observed morphological and developmental differences among the plants indicating significant heterogeneity in the population. The

variability in sucrose content indicated that segregation was occurring. Crosses were made to study the inheritance of high sucrose content. The first results indicate that it is a simply inherited recessive trait. UCR is also breeding cowpeas with the green seed-coat trait. These cowpea varieties, whose seed remains green as it matures and dries, have the potential for use in several value-added food products. While this activity must be supported in the next extension phase, it is expected that the goals to be attained should be better defined. Marketing studies should be conducted to define which research lines to give high priority and on which target markets to focus. It would be wise to report all research advances within the different studied traits. The time frame for this activity was not determined.

5. Research Area: Regional integrated pest management (IPM) development and testing.

a. Background: It is clear that insects are the major constraint to cowpea production in West Africa. With the abundance of neem trees in the region and given the voluminous literature on the efficacy of neem against insect pests, it is logical to move toward programs that incorporate neem and other biologicals into an integrated insect management program.

b. Evaluation of Research:

(1) Activity #1: Develop alternatives to chemical insecticides. Alternatives to chemical insecticides, such as neem, have been available for years. The EEP considers this activity important because insecticide usage not only increases production costs, but may cause human and environmental problems. In most developing countries, the cost of chemical inputs is prohibitive to small holders, which makes the development of this neem technology even more important. Work on neem, as well as other botanicals, however, should include the development of standardized methods for extraction, formulation and application of neem in West Africa.

(2) Activity #2: Identify cowpea germplasm with resistance to insect pests and diseases. It is suggested that this activity be reported in the research area #2 section. The EEP recognizes that germplasm screening is a long-term continuing activity, however, funding periods are finite and activities should be planned with expected timetables for results. The continuation of this work is extremely important due to germplasm exchange among cowpea networks and within regional project researchers.

6. Research Area: Collect baseline data for impact assessment.

a. Background: Baseline and adoption data have been collected for Senegal and Cameroon. For northern Ghana, baseline data has been collected and it is being analyzed. For southern Ghana, the farming systems review and extension agent survey were completed in September 2000. Social, environmental, health and nutritional baseline data are needed.

b. Evaluation of Research:

(1) Activity #1: Baseline measures of family units on social, environmental, human health impacts of IPM adoption in rural Ghana. The EEP is very pleased that there is clear recognition of the importance of impact. Researchers are collecting the needed baseline data so that present situations are realized and intervention strategies can be implemented. More detailed analyses from South Carolina and Ghana data are expected in the next annual report.

C. CONSTRAINT #2: LIMITED STORAGE OPTIONS

1. Assessment of Progress

In the early history of the Bean/Cowpea CRSP, the emphasis in West Africa was on the development of high yielding cowpea cultivars that contained some resistance to drought, insect pests and diseases. Later, inadequate storage technologies and grain quality deterioration from insect damage received more emphasis. Even if farmers are able to produce enough cowpeas to last until the next harvest, the grain would not survive the assault from insect storage pests under traditional storage conditions. The result was an extended hunger period, that period of time after the grain from one harvest is consumed or inedible until the new crop is available.

As a result of the focus of the Bean/Cowpea CRSP on the farm level storage technologies, significant progress has been made toward the development of storage methods that can help subsistence farmers, traders and consumers to overcome this constraint. Studies of the feasibility of simple solar heaters, insecticides, stored metal drums, steaming and sealed plastic bags are suggested options that can reduce or eliminate the terrible "hunger period." Technologies that are appropriate for small farmers have been developed and are in use in Senegal, Ghana and the Cameroon. Good progress has been made on the technical aspects of this constraint. It is critical that the economics and suitability of the technologies in the region be the determinants for adoption.

2. Research Area: Adapt CRSP storage technologies to more users

a. Background: Cowpea merchants have somewhat different storage needs than producers. They often handle larger volumes of cowpea and must be able to handle and transport the containers. They currently use storage insecticides. Ash storage would require too much labor and the quantities of ash would be enormous. Solar heating would require substantial labor. Triple bagging seems to be the CRSP storage technology best adapted to their needs. Bags are needed, however, that can be repeatedly handled and transported.

b. Evaluation of Research:

(1) Activity #1: Determine a method of cowpea storage suitable for traders; a modified triple bagging may be useful. Since traders face different storage problems and because they are an important component in the cowpea marketing system, it is appropriate to evaluate methods to meet their special needs. Triple bagging may be an appropriate technology and research must be designed to answer this question. The description of this research and methodology is too abbreviated to judge the likelihood of success.

The last EEP report, in commenting on a sealed container storage activity, expressed concern about the lack of information provided for this activity. A full explanation and reporting of this activity is needed.

3. Research Area: Technology development for steam treatment of cowpea before storage

a. Background: The efficacy of the steam treatment of cowpeas in preventing infestation of cowpea weevil (*Callosobruchus maculatus*) has been demonstrated. Studies have consistently shown that though the number of eggs laid is not affected by the steam treatment, there was no emergence of adult insects from the steamed cowpeas. Field studies at the farm level and in the markets have shown the effectiveness and interest of farmers and market operators. The economic and technical analyses will allow the technology to be moved closer to the consumer.

Physical modification, steaming and drying, are critical in developing desirable cooking and storage properties of cowpeas. Recent work has demonstrated that the cooking time of physically modified cowpeas may be shorter than that of untreated cowpeas. There is a need to measure heat and mass transfer and to optimize these processes to ensure better application of the technologies. If sufficient funding can be found, these studies should be extended to maize and other grains.

b. Evaluation of Research:

(1) Activity #1: Economic and technical evaluation of hydrothermally treated cowpeas in storage to determine cost and benefits over time. This line of investigation holds promise as a partial answer to the serious problem of insect damage during storage. The activity seems well designed and includes the disciplinary mix that the problem demands.

The last EEP report suggested that this research needed to focus on the economic and sociological aspects of this technology. This activity is addressing these questions and the findings thus far look promising. This work appears to be making good progress and should be continued.

(2) Activity #2: Modeling heat penetration during cooking of seeds and studying the effect on quality of seeds and products prepared from such treatments. This research is designed to increase the understanding of heat penetration during cooking of seeds. It may lead to better information about the effects of boiling, as opposed to steaming, on eating quality, cooking time and storage loss. This is a logical follow-up to modeling work done on steaming treatments.

Summary Comment: The West Africa project is to be commended for using a multidisciplinary approach to finding solutions to the serious losses of cowpeas in storage. In contrast, the East Africa project relies solely on attempts to develop resistance to insect pests through breeding research.

D. CONSTRAINT #3: INSUFFICIENT UTILIZATION RESEARCH

1. Progress

The faculty and staff from the University of Georgia-Athens (UGA) and UGL have done an excellent job in collaborating to develop data on the nutritional composition of a large number of cowpea varieties. The data is invaluable to breeders, farmer-producers and consumers in the U.S. and Africa. Together, these two university groups have made important progress on enhancing the use of cowpeas in the African diet through the development of fermented iron-fortified cowpea-maize weaning foods. They have also made progress on enhancing both the U.S. and African diets by producing a popular food, akara, more conveniently from cowpea flour in-lieu of the traditional product from cooked cowpeas.

A strong suggestion for the scientists preparing next year s annual report would be to condense down the analytical tables to just a few, and describe only significant compositional or functional differences that occur between varieties or products.

2. Research area: Food and nutrition quality testing

a. **Background:** The determination of the nutritional and functional properties of new cowpea varieties provides breeders and agronomists with important information needed for the final decisions on variety performance and potential for making genetic gains in nutritional quality.

b. **Evaluation of Research:**

(1) **Activity #1: Assess chemical and nutritional quality of promising cultivars and cowpea-fortified foods.** Protein analysis, amino acid analysis, cooking times, dehulling efficiency, water absorption, swelling and foaming capacity, texture, and viscosity tests were run on 50 varieties of cowpeas. These tests were run at UGA and at UGL. The researchers found significant variability, >10%, in protein and lysine content across the 50 varieties. The researchers also characterized the cowpeas for other chemical and functional properties important in the nutrition and cooking properties of cowpeas in the diet. As the analyses of nutritional and functional traits are very extensive, they will give excellent guidance to breeders and agronomists working with U.S. or HC farmers on selecting cowpeas best suited for the respective markets.

Collaboration and cooperation across these two distant faculties seem to be excellent.

3. **Research area: Product development**

a. **Background:** The safety of traditional fermented West African weaning and infant foods is dependent on pH, competitive bacteria and water activity; all are important in controlling pathogenic bacteria.

b. **Evaluation of Research**

(1) **Activity #1: Safety, packaging and shelf stability of cowpea-based weaning foods.** Again, faculty and staff from UGL and UGA conducted this research jointly. The tests were run on maize-cowpea (80:20) blends that were fermented, then either solar dried or oven dried and then ground to a powder and packaged for storage in a variety of materials. The intent of this research was to develop a weaning food using processes that could be utilized at the village level, thus the natural fermentation and solar or oven drying. The researchers then compared the chemical, nutrient and functional properties of the weaning food across drying methods (solar vs. oven), packaging material (plastic bottle, metal can, film lined cardboard box, or foil pouch), and storage time (zero to six weeks) to find the optimal conditions and define product cost and quality characteristics. The findings are clear and will aid those small industries in Africa who want to commercialize this weaning food technology.

(2) **Activity #2: Dissemination and evaluation of cowpea-fortified weaning food in communities and health institutions.** This research was done entirely in Ghana by UGL. The product produced in Activity #1 was fed as is or fortified with iron. Weaning foods were introduced into four villages in the Central Region of Ghana. Women in the villages were taught how to prepare the weaning food. UGL faculty and students monitored the feeding of the product to children in the villages. Within three weeks, children who were consuming the iron-fortified fermented maize-cowpea weaning food showed significant improvements in nutritional status, i.e., blood hemoglobin level. At the end of six months, the children on the weaning food continued to show improvements in hemoglobin level, and other measures of body growth and strength.

(3) **Activity #3: Composite flours/fortified traditional foods.** UGA and UGL faculty and staff jointly performed this work. The main goal was to use cowpea flour as an ingredient in a greater variety of traditional African foods to be consumed both in Africa and among African populations in the U.S. The researchers found that cowpea flour can make akara, a traditional African food, of equal quality to that made from the traditional method using soaked cowpeas. Secondly, they found that a white-eyed cowpea flour made an excellent product for both the overseas and domestic markets. This research demonstrates how findings from a HC can be utilized within the U.S. to help the domestic farmer-processor-consumer.

E. CONSTRAINT #4: SOCIOECONOMIC RESEARCH INSUFFICIENTLY INTEGRATED WITH PRODUCTION AND UTILIZATION RESEARCH

1. Assessment of Progress

Impact studies were performed on the acceptance of the cowpea-maize weaning food by mothers, and on the field schools held throughout Ghana. Limited assessment data was available at the time of this review, but data show the infant food and the field schools were both initially well received. Continuing assessment will be needed to see if product acceptance continues, especially once it enters the commercial market and has purchase costs associated with its value.

The assessment of field schools is critical, since Ghana has become a center for offering such schools not only to its farmers and extension workers, but also to colleagues in other African countries. This assessment will allow for the constant improvement of the field schools, ensuring that they are providing the farmers and extension workers with pertinent information and that they provide valuable feedback to the associated research programs.

An extensive study was performed on price, quality and demand characteristics for cowpeas across eight West African countries. Even though the data is still

incomplete, the initial findings give a much better picture to breeders and producers (farmers) as to what cowpea quality characteristics have economic value in the marketplace, what regions in West Africa are the major producers and which are the major consumers of cowpeas, the latter being important in the marketing of the crop.

2. Research area: Economics of cowpea utilization

a. Background: The adoption and use of cowpea utilization technologies should be linked with a clear understanding of the socioeconomic and other critical factors that influence outcome.

b. Evaluation of Research:

(1) Activity #1: Economic analysis of cowpea processing. Faculty and staff from UGL performed this research. The findings of this study showed that from the group of 12 Ghanaians interviewed, only one had used the cowpea-fortified maize previously. In general, the participants responded positively to cowpea fortification, even though the product was relatively new to them. The study is 30% complete and this next year will provide better survey data.

3. Research area: Field school impact evaluations

a. Background: Baseline and follow-up studies have been done on some of the farmer field schools in Ghana to determine their effectiveness. These studies need to continue on existing schools and incorporate new schools in order to determine what are the most effective tools for transferring technical information to farmers in the region.

b. Evaluation of Research:

(1) Activity #1: Ongoing evaluation of field schools. This evaluation involved staff and faculty from CRI, SARI, UGL and Clemson University. These assessments were initiated in 1999. To date, they show that the field schools are having a significant impact on farmers (both men and women), crop yields, the safe use of pesticides, and increased awareness of the benefits of cowpeas in the diet of villagers.

4. Research area: Regional cowpea marketing and demand studies

a. Background: Cowpea price and quality data are being collected in HCs throughout West Africa. This base of data will aid farmers by allowing them to determine the markets and value of their crop based upon its quality.

b. Evaluation of Research:

(1) Activity #1: Study cowpea price and quality relationships in Cameroon, Senegal, Ghana, Nigeria, Mali and Niger. This study involved scientists from the Institut de la Recherche Agronomique le Developpement (IRAD), CRI, SARI, ISRA and Purdue University. This study gathered information at 24 markets within the six African countries on specific cowpea characteristics, e.g., testa color, eye color, insect damage, etc., as related to the market value of the cowpeas. Even though the data set is still incomplete, data from Cameroon and Ghana were complete enough to determine how cowpea quality characteristics affect market value. The socioeconomic data, as well as the food science data, are extremely valuable to cowpea producers in helping them determine the varieties that will give the greatest return in the marketplace.

(2) Activity #2: Study structure of cowpea demand and markets, with priority on Senegal, Mauritania, Mali, Ghana, Burkina Faso, Niger and Nigeria. This joint study effort between Purdue faculty and HC scientists looks at cowpea production and consumption data in each country, and the export or import of cowpeas to meet the needs of the region. Since the import/export data were often times conflicting, future work will seek to refine these data, gather consumption data for Central Africa, and finally develop an economic model that describes the effects of various factors on the direction and volume of cowpea trade.

F. CONSTRAINT #5. INSUFFICIENT CADRE OF TRAINED PERSONNEL

1. Assessment of Progress

Human capital development is essential for building an infrastructure that will result in the success and sustainability of program initiatives funded by the CRSP. The number of students listed as continuing their degrees is down from last year when fourteen were listed as continuing their degrees, MSc. and Ph.D. programs, and four new students were to begin in 1999 with similar degrees as listed above. Have the degree-training programs been reduced in priority? What has happened to the relatively large number of students in the pipeline from last year?

2. Research area: Degree Training

(1) Activity #1: Training to be completed this year. Only one student is scheduled to finish this year. She is from Ghana, guided by L. Beuchat at UGA in food science.

(2) Activity #2: Continuing training. Substantial funding is being provided, $133,559 for five Ph.D. candidates, one to finish in 2001 and the others in 2002. Four are males, one female, two from Ghana, two from Senegal, one from Cameroon, two in agricultural economics, one in entomology, and two in agronomy. Three are at Purdue (two with Lowenberg-DeBoer and one with Ohm), one is with Hall at UC Riverside, and one is at Clemson with Shepard.

3. Research Area: Non-degree training

(1) Activity #1: Workshops for training health personnel and food processors. This is a commendable example of a project developing useful collaborative ties. Working with the Ministry of Agriculture and the Ministry of Health in Ghana, a program was developed to train medical personnel and Extension officers on topics of maternal and infant nutrition, food sources, food nutrient requirements of children, the food science of maize and cowpea and high protein foods, as well as topics on sanitation and food safety in Ghana. A manual was developed and the program is being expanded.

(2) Activity #2: Analysis of sugars and amino acids in the sweet and other cowpeas. Apparently, this was a project for continued training. Dr. Esther Sakyi-Dawson spent three months at UGA working on this project and learning analytical techniques. This project focuses on consumer preferences. Cowpeas purchased most at markets were found to have high sucrose content. Also, it appeared that in spite of the sweet taste due to sucrose, some of the sweet cowpea genotypes were associated with high flatulence. Stachyose was determined to be the cause of this. These analyses are useful for cowpea selections. Complementary information was provided on the amino acid profile, thus including both sensory and nutritional information for continued work.

The focus on consumers and healthful benefits will result in easily measurable impacts. Without relating the high quality research programs of the West African region to food preferences and needs of the people, valuable work will go unrealized. Support for these activities should be sustained.

(3) Activity #3. Two week training at Clemson University. This was not done because of lack of funds.

G. CONSTRAINT #6: INSUFFICIENT EXTENSION SERVICES SUPPORTING COWPEAS IN THE REGION

1. Assessment of Progress:

The West Africa Regional Project has shown commendable attention to extension activities. Sometimes the difficulty in developing effective programs has been an inadequate infrastructure, e.g., facilities, field equipment, vehicles, etc. Without such support, outreach efforts are compromised. However, the Farmer Field Schools are certainly extending the CRSP impacts as training is provided to extension workers throughout Ghana.

2. Research area: Production, distribution of IPM storage technologies

a. Background: The CRSP efforts on storage technologies are being extended by NGOs to eight countries.

b. Evaluation of Research

(1) Activity #1. Continue to disseminate storage technology information/ provide training to region. A report was not received from the HC researchers. However, Purdue is working with L. Kitch of the Food and Agriculture Organization (FAO). They provided him with extension bulletins on storage technologies and the project film for a workshop in Harare, Zimbabwe. There were 28 workshop participants from four countries. This is an effort to extend CRSP impact beyond West Africa and to establish a new partnership with FAO.

3. Research Area: Development of IPM training materials

a. Background: Development of relevant training materials is essential for effective training of trainers and farmer field schools. These materials need to be continuously updated over time.

b. Evaluation of Research:

(1) Activity 1: Develop training materials. While the number of IPM training materials has been growing since 1996, more updating and expanding needs to be done on the field guide to cowpea pests. The researchers estimate that this might take two years.

4. Research area: Expand collaboration with rural communities, NGOs and entrepreneurs

a. Background: Not provided in the Regional Project Work Plan.

b. Evaluation of Research:

(1) Activity #1. The team serves as a technical backstop for NGOs etc. for information on cowpea weaning products. Their strongest effort apparently has been with The Hunger Project-Ghana, however, this initiative has stopped.

Apparently, there are substantial activities ongoing with extension officers and farmers that are not reported here. SARI established two Farmer Field Schools and Train-the-Trainer groups in the northern region of Ghana last year. At least 225 farmers and 50 extension officers have been trained thus far in IPM methods since 1996 at SARI and 1998 at CRI. By 2001, these numbers are expected to grow to 500 and 210 respectively. Such attention to technology transfer/outreach is a great strength of the West African region.

EAST AFRICA REGIONAL PROJECT

A. REGIONAL PROGRESS

1. Progress

Malawian and Tanzanian researchers have been somewhat lagging in project performance in previous years compared to the other regions. However, there are unique and overwhelming constraints that must be considered. For example, the Bean/Cowpea CRSP budget for this region is considerably less than the other two regions. Also, the cadre of U.S. scientists and institutions is small, and for some of the regional activities there is no U.S. counterpart. Progress is also impeded because of lack of institutional or governmental infrastructure, overworked faculty members, and the effects of the human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) epidemic.

Sokoine University of Agriculture (SUA) and Bunda administrators attest to the importance of the Bean/Cowpea CRSP. Their scientists have an opportunity to publish and receive professional recognition, their research activities become intertwined with the academic curriculum for its students, they have a vital line to U.S. cutting edge science, and they partner with U.S. mentors who assist them in human capital development for their countries.

Progress has been made in developing bean varieties that have high stable yields, are multiple disease resistant and are fast cooking. They have begun to focus more on seed dissemination, training, and socioeconomic studies. The extension activities are too new to realize substantial impact yet. However, all the scientists recognize the importance of extension activities and more is being learned about

the needs and practices of farmers and consumers as the regional project is taking an expanded sociological focus.

Although the East Africa Regional Project has suffered a few set backs in recent years, the EEP believes the East Africa Program is now positioned to make significant progress.

2. Strengths and Weaknesses

a. Strengths

The U.S. bean industries in California, Oregon and Washington are receiving clear benefits from the stateside initiatives and from the genetics and breeding work performed in the host countries.

Information learned about pathogenic genes of viruses will help develop resistant strains proactively.

The U.S. scientists are extremely well suited for the goals of the CRSP. Not only do they posses high technical competencies, but they also have a genuine concern for, and devotion to, the people of the host countries.

Accomplishments, especially the findings on co-evolution and the development of molecular techniques for making rapid identification of pathogens, are impressive.

The collaborative breeding work is strong with active exchange of germplasm.

The East African team appears more cohesive and productive since the counterproductive personnel issues of last year were addressed.

Women in Development (WID) issues receive a considerable focus and a substantial number of women are contributing scientists for the region.

The region has a cadre of very capable, hard-working, and committed scientists.

A number of CRSP bean cultivars have been released and promising lines are forthcoming.

b. Weaknesses

While it is recognized that the high quality of scientific work produced by the University of California-Davis (UCD) team has excellent payoffs for the California bean industry, the payoff of this work in East Africa is less evident.

The East African team must produce more scholarly works to assist in justifying funding for their much needed efforts, even though they have increased the number of their publications over last year. However, some of their publications were neither listed nor submitted for review in this year s Annual Report.

The polymerase chain reaction (PCR) technical work in Malawi is quite deficient and the self-supporting service initiatives for the PCR lab at SUA are not going as fast as hoped. Marketing PCR to industry probably needs promotional materials and marketing strategies.

Economic components in this region are inadequate. What is missing is analytical work on the bean production and marketing sector cost structure, cost/benefits of production technologies, adoption rates of new varieties and the economic effect of new varieties on the farm households.

The lack of baseline data on CRSP bean usage/hectarage prevents the CRSP from assessing the benefits/impacts of CRSP-developed bean varieties.

3. Issues and Recommendations

Stronger efforts are still needed in developing effective and sustainable mechanisms for the multiplication and dissemination of improved varieties of seed in East Africa.

The East Africa Regional team should develop regional strategies for leveraging funds and expand efforts to partner with NGOs and government agencies.

Strengthened regional coordination and communication are needed. In particular, the annual bean workshop must be continued as it is an excellent means of networking and planning together.

Food scientists should interact more with their counterparts in the other regions as some of their projects are near fruition and thus, they can share technologies and results of initiatives already tested and demonstrated to be effective.

Human capital development must be a higher priority for the East Africa region in order to address the limited number of trained personnel and to address the inevitable turnover of key personnel and replacing them with quality faculty.

B. CONSTRAINT #1: INSUFFICIENT NRM AND PRODUCTION TECHNIQUES

1. Assessment of Progress

Diseases that are the major constraints to bean production in East Africa include common bacterial blight (CBB), halo blight (HB), angular leaf spot (ALS), rust, and bean common mosaic and bean common mosaic necrosis viruses (BCMV and BCMNV). Resistances to rust, viruses, and halo blight are well defined, and in most cases, have been incorporated into improved varieties. Breeding for resistance to CBB and ALS is more difficult and is the current focus of the East Africa activities. PCR laboratories have been established in both Tanzania and Malawi, to be used in training, disease diagnosis, seed certification, and in varietal development. Unfortunately, the PCR lab in Malawi is underutilized. PCR-based research will continue identification and characterization of CBB, HB and ALS pathogens, and facilitate co-evolution studies by determining bean (Mesoamerican and Andean) gene pools and CBB isolates associated with them.

Early generation bean lines were also evaluated for nematode resistance and drought tolerance in field trials. Bean germplasm exchanges have taken place between research institutions in Tanzania, Malawi, South Africa as well as in the LAC and in the U.S.

2. Research area: Pest and disease control through genetic and agronomic means

a. Background: Pathogens are a major constraint to bean production in East Africa. Pathogens of importance are ALS, CBB, BCMV and BCMNV. Nematodes constitute an important, but often-overlooked problem, particularly in the lowland areas. Several breeding lines have been developed at SUA, Malawi and UCD for improved cooking quality, nematode resistance, and BCMV, BCMNV, CBB and ALS resistance. Lines with improved resistance to ALS, BCMV and BCMNV are currently being evaluated in Malawi and at UCD. These activities under this constraint are directed toward development of bean varieties that have high, stable yields, multiple disease resistance, and are fast cooking.

Common bacterial blight caused by *Xanthomonas campestris* pv.*phaseoli* is a major constraint for bean production in Tanzania and Malawi, as well as being a problem in the more humid bean-producing regions worldwide. In addition, the European Union (EU) requires testing for absence of the CBB bacterium before imports are allowed into any of the EU countries. Most of the varieties grown by farmers are susceptible. Information generated from these studies will assist breeders to efficiently deploy resistant genes to the CBB pathogen.

b. Evaluation of Research:

(1) Activity #1: Promote PCR capabilities (develop DNA protocols, screen random duplicated polymorphic DNA (RAPD) primers; identify pathogens, develop diagnostic capabilities). It is quite clear that the SUA PCR laboratory is becoming a reality. Tanzania bean seed growers are interested in using this facility for testing bean seed for CBB and HB at SUA. Today, they mail seed for testing to Europe or South Africa. The SUA PCR lab facilities would reduce mailing costs and the time lag for results. On the other hand, the EEP is quite concerned with underutilization. It is suggested that more effort be put forth in Tanzania to sensitize the seed industry, agriculture research institutions and other decision makers on the aim of developing a fee-based research and diagnostic service. The implementation of a PCR lab in Malawi will benefit the country s bean industry, which ultimately will benefit the whole society. UCD must be congratulated for the development of the virus detection program, which has significantly benefitted the California bean industry.

(2) **Activity #2: Fingerprint Kalima and Bokosi/Temple lines.** Fingerprinting can provide a quantitative tool to measure seed dissemination of improved varieties to farmers and through the market system. The micro satellites will complement RAPDs in the detection of polymorphisms. The EEP expects the extension of the screening to additional African bean lines with a focus on Malawi landraces and improved varieties. However, it is recognized that some laboratory problems must be overcome.

(3) **Activity #3: Finish CBB co-evolution work.** Substantial work has been completed characterizing the distribution of brown-pigmented CBB bacteria and the genotypes of bean being grown. The simple isolation of yellow pigmented bacteria from common bean leaves or seeds on semi-selective medium MXP is not conclusive evidence of the presence of common blight bacteria because of nonpathogenic xanthomonads. Using CBB-specific primers and rep-PCR, CBB isolates were reliably differentiated from nonpathogenic xanthomonads and other yellow bacteria. The co-evolution studies with Malawian *Xcp* and *Xcpf* strains showed that certain *Xcp* strains had greater pathogenicity for Andean, compared with Mesoamerican materials, but *Xcpf* strains were highly pathogenic on both centers of origin. In Malawi, *Xcp* was more commonly isolated from Andean genotypes and *Xcpf* was more commonly isolated from Mesoamerican materials. This suggested that some level of CBB resistance may be present in certain East African Mesoamerican materials which may be important for enhancing genetic resistance in beans. The data also suggested some level of pathogen-host co-evolution, i.e., host plant selection, particularly in regard to the consistent association of *Xcp* and *Xcpf* with Andean and Mesoamerican materials respectively. The EEP looks forward to the release of bean varieties based on these findings, which will be more stable and productive and will improve the life of the small scale farmer.

(4) **Activity #4: Continue advance of Temple/Bokosi materials; incorporate CBB resistance (collaborate with LAC).** Preliminary evaluation to confirm resistance of the Temple materials showed that a number of materials were able to stand the pressure of ALS in Malawi and BCMV in Davis, California. It is hoped that this resistance will hold up in field trials and more importantly that the resistant materials will out yield the susceptible materials. The EEP recognizes the progress in this activity with four potential varieties which have been earmarked for release in 2000, Lyamungu 90, ZPV906, 15P/8 and 2G/2. It is important to note that these materials have a yield potential close to 2000 kg/ha while the average yield for rainfed crops in Malawi is under 400 kg/ha.

(5) **Activity #5: Early Generation (EG) selections/nematodes.** The EEP looks forward to next year s results from this activity. Nematode resistance

usually is set aside in most plant breeding programs in tropical countries. As the most obvious symptoms of damage due to nematodes occur below ground, they usually are not detected by either farmers or scientists. Thus, the extent of the problem is usually underestimated.

(6) **Activity #6: Exchange of advanced lines between Tanzania, Malawi and other institutions.** The EEP realizes that germplasm exchange is an ongoing activity. Other than stating that exchanges are occurring and that a graduate student abandoned his research, no other progress was reported for evaluation.

(7) **Activity #7: Drought breeding materials.** The EEP feels that this activity demonstrates the very essence of a CRSP in that it is truly a collaborative research initiative. Some very encouraging results are shown, especially good yields of drought-tolerant materials under stress conditions. Most of the bean producers in East Africa are small farmers and rainfed bean production systems are mostly used. The release of drought-tolerant varieties will have a great impact on these producers lives by reducing poverty and improving nutrition. There was no impact reported in FY 2000.

C. CONSTRAINT #2: LIMITED STORAGE OPTIONS

1. Assessment of Progress

The East African environment is favorable for insect pests that quickly destroy bean grain intended to furnish a poor household with nourishment until the next harvest. The Bean/Cowpea CRSP response to this constraint was to control insect pests through genetic and agronomic means. Bruchids are the major cause of insect damage during storage for seed for propagation and consumption. Five advanced lines of bean cultivars have been developed with the *arcelin 1*" gene, a protein in the seed coat that confers resistence to certain species of bruchids. One variety with Bruchid resistance should be released this year (2001) and other lines may be suitable for release shortly thereafter. The Bean/Cowpea CRSP is doing some of the basic research which is needed to reduce this constraint through genetic modification, but the payoff is still in the future. In the meantime, some of the storage methods tested in West Africa should be evaluated in the East Africa context.

1. Research Area: Pest and disease control through genetic and agronomic means

a. Background: Two species of bruchid, *Zabrotes subfasciatus* and *Acanthoscelides obtectus*, are found in East Africa. In Tanzania, *Zabrotes* has been more prevalent in the Ruvuma and Tabora regions whereas *A. obtectus* has been more common elsewhere. Resistance in the form of the arcelin seed

protein confers resistance to bruchids. There are at least five arcelin alleles, each of which has different degrees of resistance to the bruchid species.

Bruchids are a major problem for storage of seed for propagation and consumption. There is a need to have resistance to both species of bruchids. About eight advanced lines have been developed with *arcelin 1* that confer resistance to *Zabrotes subfasciatus*. One variety, a ROJO backcross line, is nearing final testing and should be released by SUA in 2000-2001. As such, this research has not yet had documented impact on the smallholder, but is expected to prolong the time that a farmer may keep seed. We need to determine the utility of these lines in on-farm trials. Additional resistance to *Acanthoscelides* is needed because this is the prevalent bruchid species in some parts of the region.

b. Evaluation of Research

(1) Activity #1: Evaluation of bruchid-resistant (Arcelin-containing) lines on-farm and in the laboratory. Bruchids are a serious storage pest in East Africa which often prevent farmers from carrying over seed for planting in the next growing season. This insect is a major cause of hunger because insect-damaged stored beans are no longer edible. Based on studies in 1997 and 1999 that documented the incidence and species of bruchid infesting bean in Tanzania and Malawi, this activity is utilizing on-farm trials with cooperating farmers and laboratory analyses to evaluate several promising advanced lines with arcelin seed protein. The on-farm trials have been hampered in the past by drought and severe insect damage. This is a worthwhile undertaking as part of a long-term effort to develop better bruchid resistance in East African bean varieties. This approach responds to last years EEP report suggesting the use of on-farm trials.

There is no indication that Malawi is participating in this activity. If so, there should be a linkage with Bunda College.

(2) Activity #2: *Acanthoscelides* resistance--continue/initiate crosses between adapted bean lines from Tanzania and Malawi with CIAT lines resistant to *A. obtectus* and between adapted lines and phosphorus (*P). Acutifolius*. This activity continues a long-term effort to develop lines with resistance to bruchid of the *Acanthoscelides obtectus* species, which has proved to be much more difficult than the other common species, *Zabrotes subfasciatus.* Despite the difficulty of the undertaking, the relatively high payoff from success would seem to justify continued research. Positive results are not expected for another three to four years, but the investment of time and budget seems justified.

D. CONSTRAINT #3: INSUFFICIENT RESEARCH FOR IMPROVED NUTRITION AND PROCESSING

1. Assessment of Progress

Significant progress has been made in characterizing the cooking and sensory properties of many dry bean varieties, providing valuable information for breeders as well as farmers. A weaning food, derived from a bean-maize blend, was developed to meet the nutritional needs of infants. Work needs to continue to move the weaning food technology to small business or village level industries.

2. Research area: Bean culinary and nutritional quality issues

a. Background: Beans in Malawi and Tanzania are produced for both cash income and consumption. They are consumed by the farming community, which comprise about 85% of the population. But they are also consumed by urban dwellers. For both groups, firewood is the major fuel used for cooking. Firewood is currently difficult to obtain in the rural areas and it remains a scarce commodity in the urban areas. Therefore, new bean varieties produced by the program should be faster cooking. There is a need to institutionalize screening for fast-cooking within the breeding scheme.

Methodology for cooking trials is well established. Past research has helped identify superior lines with rapid cooking capabilities. For example, SUA 90 is a rapid cooking variety. In Malawi, lines were evaluated for cooking time. Kalima required the shortest time, 92 minutes, to cook with charcoal. The length of time to cook was shortened when firewood and pressure cooking were used. Kalima also had the highest amount of phytic acid.

b. Evaluation of Research:

(1) Activity #1: Evaluate breeding lines and new varieties for cooking time. This activity was a joint effort between scientists in Malawi and Tanzania, and focused on characterizing the cooking, sensory and shelf life characteristics of 39 lines of dry beans. Secondly, select bean lines were used to develop and test 25:75 bean:maize or bean:sorghum based weaning foods.

This is the first time that cooking and sensory quality information have been available for the bean breeders to use in selecting lines for advancement.

The addition of beans to maize or sorghum to create a weaning food did not influence consumer preferences or shelf life for the maize or sorghum-based foods, but did increase the protein content of the grain-based gruels.

E. CONSTRAINT#4: INSUFFICIENT SOCIOECONOMIC/WID RESEARCH TO OPTIMIZE PRODUCTION GAINS

1. Assessment of Progress

Through the assistance of NGOs, the new variety, Kalima, was successfully distributed to farmers throughout Malawi, where it has been well received. A study charting the bean varieties raised and their respective yield data throughout Malawi, will be important as new varieties are introduced and evaluated.

The introduction of the varieties ROJO and SUA90 into Tanzania will additionally help the farmers in determining the markets for these new varieties. A partnership between Tanzanian breeders and farmers to grow and jointly evaluate bean varieties is an excellent step in improving bean production nationwide.

2. Research area: Seed multiplication, dissemination and quality concerns

a. Background: Not provided in the Regional Project Work Plan

b. Evaluation of Research:

(1) Activity #1: Follow-up Ministry of Agriculture Seed Package program (Adoption of Kalima in Malawi). A CRSP improved variety (Kalima) was distributed to farmers throughout Malawi via NGOs, including Concern International. Many farmers have grown the variety for two seasons, and 92% indicate they would like to continue growing it. It is grown mostly by women and appears to be important for the family diet.

(2) Activity #2: Continue ROJO and SUA90 impact study. In Tanzania, studies were conducted to evaluate farmer willingness to grow ROJO and SUA 90 beans, both new varieties. The new varieties were marketed as part of the survey process in Tanzania. Because of the questions asked by farmers concerning the new varieties, efforts will continue to help farmers find and build markets for these new varieties.

(3) Activity #3: Follow up of participatory research and selected early generation materials. The CRSP scientists partnered with farmers in Tanzania to grow and select early generation bean varieties. The data from the first year of this study is now being analyzed, but is intended to educate farmers early on about new varieties coming onto the market, get their input on desired qualities, and see how varieties perform under actual farm conditions. This study will be repeated in 2001.

(4) Activity #4: Compile and analyze production trends. Data was compiled in Malawi concerning bean yields throughout the country. The data will

serve as a baseline to assess performance of new bean varieties released in the country. The study will be completed in early 2001.

(5) **Activity #5: Facilitate collaboration among countries and programs.** This is an administrative activity that is to facilitate interchange between CRSP scientists in Malawi and Tanzania. These scientists are also asking for more interaction with bean scientists in the LAC Regional Project.

F. CONSTRAINT #5: INSUFFICIENT CADRE OF TRAINED PERSONNEL

1. Assessment of progress

Compared to the other regional projects, the human capital development is very limited for the East Africa region. Realizing funding is limited, it is very encouraging that a Tanzanian food scientist is at MSU to continue his training. The other very commendable aspect is that Dr. Susan Nchimbi-Msolla leverages funding so she can come to Oregon to retool and keep the research balanced between traditional breeding and related biotechnological techniques.

2. Research area: Degree Training

(1) **Activity #1: Training to be completed this year.** Lillian Chiumia finished her training, acquired her M.S. degree and returned to her duty station at Bunda College. Her training was at Bunda at a cost of $2,000 to the CRSP budget. Another student trained at Bunda, but did not complete his M.S. program. While the data he collected was incomplete, some of it will be quite useful.

(2) **Activity #2: Continuing training.** A thorough description of the research project of a female Ph.D. student from the University of Arizona was provided. This student has performed an extremely commendable sociological/economic study that has clear implications for further study to promote small-scale processing, development of marketing channels and improvement of village transportation. Future research should also address shortages of pesticide, fertilizer and improved seed. Unfortunately, extension efforts were totally absent in the area of Tanzania where this student conducted her study and the farmers knew nothing of SUA bean varieties.

(3) **Activity #3: New Training.** Two students are listed who started their training in the summer of 2000. One will train at Bunda College in the area of Rural Development and Extension. T.C. Mosha, from SUA, began a Ph.D. program at MSU in Community Nutrition in September 2000. Limited funding prevented the on-schedule training of Mr. Mosha which was to begin in 1999. The M.S. training of an entomologist is now being delayed because funds for this training were transferred to finance Mr. Mosha s studies. Mosha will focus on weaning foods based on maize, sorghum and CRSP bean varieties.

3. Research Area: Non-degree training

(1) Activity#1: Non-degree training. In April, a SUA PI offered a one day course to seed growers on techniques for testing seed-borne bacterial pathogens.

G. CONSTRAINT #6: INSUFFICIENT ACCESS TO IMPROVED SEED, ESPECIALLY PREFERRED VARIETIES

1. Research area: Seed Multiplication, dissemination and quality concerns

a. Background: The Malawi CRSP project sells Kalima seed to NGOs which is the major means of seed dissemination in Malawi. In 1997-98, the project sold four tons of seed and increased that to ten tons the next year. By having the government include the CRSP seed in Starter Packets, it was hoped that seed of improved varieties could be provided to about two million farmers. Conversely, SUA does not have land to grow large amounts of seed and the Tanzanian government, not NGOs, has been active in disseminating the seed. Only recently have NGOs made attempts to multiply and distribute bean seed. SUA is currently working with ten farmers to successfully produce ROJO and SUA 90 seed.

b. Evaluation of Research:

(1) Activity #1: Proposed research area work plan. Because of limited funds the Starter Package did not create the demand for Kalima that was expected, so seed production at Bunda was scaled back to meet the needs of NGOs. Nasaka seed was multiplied and provided as requested by ActionAid. Money from the sale of seed is being returned to the project at Bunda to reduce the dependence on external funding. One of the most critical needs in East Africa is to develop an efficient and sustainable seed dissemination system. All efforts in this regard are important.

(2) Activity #2. Multiply SUA 90, ROJO and Bruchid resistant lines. SUA intends to provide support to smallholder seed producers. Seed inspections and technical advice have been provided by CRSP researchers and TOSCA. Concerted efforts to training farmers in several villages have been made and the villagers have been given ROJO and SUA 90 to plant. The plantings differ among villages. Female farmers play an important role in the Chitego village. Promotional activities are also included. Not only are seed production activities explained, but samples are cooked and tasted. ROJO received favorable reviews and continuation of the promotional activities are expected to reach as many as 15,000 farmers within two years. During these promotional activities, it was found that farmers are not aware of improved bean varieties and are not able to differentiate between seed beans and dry

beans. In all villages visited, farmers showed interest in growing SUA 90 and ROJO. Note: The Ministry of Agriculture in Zanzibar requested ROJO seed for its farmers.

It is frequently revealed that farmers know too little about CRSP varieties which were released several years ago. The extension efforts are addressing this, but obviously much still needs to be done. This is a critical area if impact is to be achieved by the breeding programs in East Africa.

H. CONSTRAINT #7: INSUFFICIENT EXTENSION SERVICES SUPPORTING BEANS IN THE REGION

1. Assessment of Progress

Significant progress has been made in extending research findings on pest and disease management to extension staff in Malawi and Tanzania. A significant effort was made to inform extension personnel and farmers about two new bean varieties which show promise for the region. Continued collection of yield data will determine how successful these new varieties will be in the region.

2. Research area: Seed multiplication, dissemination and quality concerns

a. Background: In both Malawi and Tanzania, one of the greatest constraints to increased bean production and consumption has been the lack of means to get seed of improved varieties into the hands of farmers. Over the last three years, Bunda College of Agriculture has stepped up efforts to multiply foundation seed of Kalima, a CRSP variety, and to sell it to the NGOs involved in the smallholder seed production schemes which are proliferating in Malawi. NGOs now represent the major means of disseminating seed of improved bean varieties and other legumes in the country.

At Sokoine University, smaller amounts of ROJO and SUA 90, CRSP varieties, have been grown and disseminated in villages. The bean seed distribution system in Tanzania is significantly different from that of Malawi. Until recently bean seed was produced exclusively on government farms with little seed being produced or reaching the farmer. Very few NGOs were involved in seed production. As the shortcomings of the official Ministry of Agriculture multiplication and dissemination stations become apparent and as market liberalization has proceeded, more decentralized seed production systems are developing, and NGOs are becoming active in this area.

b. Evaluation of Research:

(1) Activity #1: Training the trainers on diseases and insects for farmer field schools. Most of the training of extension staff in Malawi will begin during the growing season which started in December 2000. The training focuses on training extension personnel on the diseases and pests found in bean crops. A booklet has been developed as a tool for trainers and farmers.

(2) Activity #2: Bean stem maggot workshop. Bean stem maggot is the most prominent pest in Malawi and Tanzania. Sixty-two extension staff were trained to recognize the pest, its damage and control. Results of this effort seem disappointing to the HC scientists.

(3) Activity #3: Print pamphlets on ROJO and SUA 90. Three thousand pamphlets in English and Swahili describing SUA 90 and ROJO varieties of beans were developed and distributed to extension agents, researchers and farmers with the hope of expanding the cultivation of these two new bean varieties. Placards were also developed to identify farmer fields where these two varieties were grown, again to advertise the two varieties.

LATIN AMERICA/CARIBBEAN REGIONAL PROJECT

A. REGIONAL PROGRESS

1. Progress

The LAC regional project develops technologies such as disease resistance, abiotic stress tolerance, enhanced biological nitrogen fixation and integrated disease and pest management practices that permit bean producers in the LAC region and in the U.S. to increase yields and reduce production costs. The ultimate goal of the project is to increase smallholder farm income and to reduce hunger and malnutrition in the LAC region by increasing yield, the availability of beans in the marketplace, and improving the nutrition of beans, while not damaging the environment.

The LAC project has developed and released bean cultivars that are having a major beneficial impact throughout the region and the U.S. Good examples of improved varieties include Tio Canela 75 which was released in Honduras, El Salvador, and Nicaragua, and is being tested in Haiti; and Pinto Villa the most widely planted pinto bean in the semiarid regions of Mexico. It is important to point out that the impact of Pinto Villa has extended from the fields of Chihuahua and Durango to the supermarkets in the most populous state of Mexico, where it is the cheapest

alternative for the bean consumer. A recent release, Weihing, was grown commercially in Nebraska for the first time in 2000.

Several biotechnologies have been utilized by LAC researchers, including sequence characterized amplified region (SCAR) and RAPD markers. They are being used to increase breeding efficiency and to provide more effective strategies for the deployment of genes. Seven geminiviruses from the LAC region were molecularly characterized and PCR specific primers were developed for bean-infecting geminiviruses.

Studies on the ecology of pathogens involved in the root rot complex and on integrated systems of root rot control have been very successful. In Minnesota and North Dakota, seed-applied biocontrol treatments are widely accepted by farmers.

Bean seed inoculated with *Rhizobium* has shown significant yield responses. This finding could have a tremendous impact in the LAC region where the majority of bean producers do not use nitrogen fertilization.

Bean/Cowpea researchers have been actively involved in several activities such as field days, demonstration plots, farmer testing plots, fertilization trials, watershed and integrated crop management trials, validation plots, inoculation trials and also in seed production in the low and highlands of the LAC region.

Extensive efforts between scientists in the U.S. and HC have been utilized to characterize the physical-chemical properties of beans, yielding important data for breeding programs as well as for the development of infant and adult foods from beans and bean flour. To commercialize these efforts, scientists should now partner with private sector industries.

A program to help farmers with record keeping has been developed. The data collected is being used to determine the profitability of bean production as well as to encourage bean producers to increase production in the LAC region.

The LAC project researchers produced a considerable amount of scientific and technical articles and have made substantial contributions at scientific meetings, seminars and workshops.

2. Strengths & Weakness

a. Strengths

The LAC research team is well qualified with a high level of training.

There is an excellent level of interaction between U.S. and LAC research institutions.

A large number of coauthored scientific publications have been produced.

There are a high number of training opportunities for young scientists.

Several well-adapted bean cultivars have been released in various countries and a significant number of promising lines are in the pipeline.
There are unique opportunities for HC scientists to be involved in cutting-edge research and to interact with a broad community of scientists.
Excellent progress has been made on developing new bean value-added products, which has a potential to benefit HC consumers.
Intensive extension activities which target small-scale farmers in minority communities, e.g., Indian, mestizo and black, are commendable.
A collaborative regional bean research network focusing on important constraints for bean production is functioning effectively.

b. Weakness

Impact assessment studies are important and should continue to be given higher priority.
Systems research on beans is given inadequate attention compared to breeding activities.
Research activities in LAC are fragmented. They need to be more focused and integrated.
Even though strong partnerships have been established between researchers and the private sector, these partnerships need to be expanded.
The level of interaction among Bean/Cowpea researchers and international organizations is less than optimum.
There is a need for more informative publications addressed to different constituencies other than the scientific community.

3. Issues and Recommendations

The LAC research team has significantly contributed to bean production in the LAC region. For the next phase, it will be necessary to establish new research priorities focused on the most critical constraints as well as reorient or terminate selected activities.
The challenging task of working regionally is important and efforts to extend CRSP technologies at a regional level must be expanded. New initiatives in this direction are to be commended. Developing countries with advanced research capacity, e.g., Mexico, Costa Rica and Brazil, must be stimulated to address key research issues in other Host Countries. Exchanging of experiences and expertise among graduate and Host Countries must also be encouraged.
The LAC bean breeders should work within a larger systems approach and socioeconomic impact studies should be emphasized more. Bean breeders should give higher priority to bean research programs in less developed Host Countries, e.g., scientists from the Dominican Republic providing technical support to scientists in Haiti.
Attention must be given to the promotion of new value-added bean products and their use by private industries, i.e., fortified weaning food, in the region.

The LAC project should continue to prioritize bean cultivar development with multiple resistance to biotic constraints. However, this needs to be balanced with other issues such as drought. Most LAC bean producers use upland farming systems, therefore climatic and edaphic issues must be taken into account.

The LAC research team should continue to work on bean transformation, however, such technologies should be used to overcome only serious bean production constraints. Biosafety and other regulatory issues must be considered.

It is well recognized that the main focus of the LAC project is research. However, researchers must assume responsibility for linking with extension activities in order to better understand problems in the overall bean production system. This would substantially enhance research quality and impact.

B. CONSTRAINT #1: INSUFFICIENT NRM AND PRODUCTION TECHNIQUES FOR LOWLAND AND HIGHLAND AGRICULTURE

1. Assessment of Progress

Biotic and abiotic factors are major constraints to sustainable bean production and increased yield of beans in the LAC region. High yielding, well-adapted small red lines with multiple disease resistance, tolerant to heat and low soil fertility and commercially acceptable seed types have been released. It is commendable that the LAC project focuses on cultivar development for small-scale hillside bean producers who have to deal with many biotic (pests and diseases) and abiotic (heat, drought and low soil fertility) constraints.

Substantial progress has been accomplished in the development of specific PCR primers and DNA probes for the major bean and tomato-infecting geminivirus.

Drought, due to insufficient or unpredictable rainfall, is a bean production problem exceeded in magnitude only by bean diseases. The identification and introduction of genes for increased drought tolerance have resulted in significant progress toward overcoming this constraint. Genetic studies using marker assistance selection and germplasm evaluation have been carried out in HCs and institutions of the LAC and in the U.S.

Bean transformation research has been an ongoing effort in the LAC project. However, there still exists methodological obstacles and several genetically modified organism (GMO) uncertainty issues that must be resolved if GMOs are to be grown within the LAC region.

Considerable progress has been achieved in the development of disease management strategies and soil and water conservation practices as a complement to disease and abiotic stress tolerance of recently released bean varieties. Studies

were completed on the development of bean breeding lines with enhanced ability to fix nitrogen.

Bean/Cowpea researchers have been actively involved in several activities such as field days, demonstration plots, farmer testing plots, fertilization trials, watershed and integrated crop management trials, validation plots, inoculation trials as well as in seed production in the low and highlands of the LAC region.

2. Research area: Variety release and sustainable seed production for lowlands/biotech

a. Background: Biotic and abiotic factors are major constraints to sustainable bean production and to increased yields of beans in the LAC region. Less dependence on pesticides would reduce production costs and benefit the environment. Terminal drought and high temperatures are important abiotic constraints in the lowlands of the LAC region.

Much has already been accomplished through classic breeding methods. Bean gold mosaic virus (BGMV) resistant small red, pink and white bean varieties have been released, e.g., Tio Canela, Morales and Rosada Nativa. The black bean variety Arroyo Loro Negro has high yield potential and resistance to web blight (WB). The red mottled varieties JB178, CIAS 95 and Saladin 97 have enhanced levels of rust resistance. Chase is the first pinto bean and GN Weihing is the first great northern variety with resistance to CBB, bacterial brown spot and rust. BGMV resistant red mottled and light red kidney bean breeding lines have been developed. Biotechnology can be used to generate information on variability of the pathogens, to assist in breeding (marker-assisted selection) or to transfer genes into beans via transformation methods.

Past efforts have molecularly characterized four bean-infecting geminiviruses in the Western Hemisphere. BGMV is the major virus in Brazil (BGMV type I); bean golden yellow mosaic virus (BGYMV, previously designated BGMV type II) is found in Central America and the Caribbean Islands; bean calico mosaic virus (BCMoV) is in northern Mexico; and bean dwarf mosaic virus (BDMV) was collected in Colombia. Several antiviral strategies have been explored. The coat protein-mediated resistance, which has been very successful with RNA viruses, was evaluated in transgenic beans. The first transgenic beans were developed in collaboration with Agracetus, Inc., by application of the particle gun technology, but unfortunately, these transgenic beans did not accumulate the viral coated protein and were susceptible to BGYMV. Most research efforts have been devoted to the evaluation of another antiviral strategy, trans-dominance interference. Another antiviral strategy has been investigated with Brazilian colleagues, who have engineered beans with particle gun technology with antisense genes of BGMV (not BGYMV) and these plants showed attenuated and delayed symptoms.

b. Evaluation of Research:

(1) Activity #1: Develop Andean and Middle American bean varieties with enhanced levels of disease resistance. There has been progress in the genetic improvement of small reds for the LAC region. High yielding, well-adapted lines with multiple disease resistance, tolerance to heat and low soil fertility, and commercially acceptable seed types have been released. It is also clear that the LAC project is focusing in cultivar development for small-scale bean producers on the hillsides who usually deal with many biotic and abiotic constraints. It is recommended that future research efforts continue to be devoted to the improvement of black beans, one of the more important bean classes in the LAC region. The researchers are continuing with both conventional and molecular genetics to develop bean cultivars and breeding lines that incorporate enhanced levels of disease resistance and heat tolerance for the low-input farming systems of the LAC region. The EEP is highly impressed with the documented impact reported under this activity.

(2) Activity #2: Develop Middle American and Andean bean varieties for the lowland tropics with enhanced biological nitrogen activity or tolerance to terminal drought, heat or low soil fertility. The EEP considers the development of improved bean varieties for the LAC region to be an important goal. Small farmers are a dominant group in the LAC region and any improved bean variety with greater tolerance to abiotic stress, mainly heat, drought and low soil fertility, would benefit them tremendously. Although breeding for abiotic stress tolerance is slower than breeding for disease resistance, the EEP recognizes significant research progress in this activity. Thus, this activity deserves continued support during the next phase.

(3) Activity #3: Develop BGMV and white mold resistant transgenic plants. It will not be economically feasible to produce genetically modified organisms until a relatively cheap and reliable transformation system is developed. Progress has been slow, but techniques are improving. It seems that a particle gun technique, developed by Brazilian scientists, can help solve the methodological gap. The EEP recognizes that bean golden mosaic virus remains a serious constraint to bean production in the region and transgenic beans with resistance to these geminiviruses will definitively make bean production a more sustainable agricultural activity in the LAC region.

3. **Research area: Effective disease management strategies for the lowlands**

a. **Background:** Before management strategies can be implemented, it is necessary to determine the cause of disease and the source of economically important viruses. Recently, a geminivirus, which is not BGYMV, was detected in beans in the western part of Costa Rica. It is important to characterize this new geminivirus and determine its distribution. Past research has shown that bean-infecting geminiviruses are usually not associated with weeds in the Dominican Republic and Jamaica. However, such relationships have not been studied in Honduras and Puerto Rico. The host range of other vegetable-infecting geminiviruses is not known and this is important to know in designing cropping systems approaches to sustainable production and yield increases for beans. To develop disease management strategies, the causal agent and its epidemiology must be understood, especially in determining the sustainable deployment of new resistant varieties.

b. **Evaluation of Research:**

(1) **Activity #1: Identify and study variability of fungal (*Uromyces appendiculatus* and *Rhizoctonia solani*), bacterial and viral pathogens.** There has been limited progress in this activity. The mobile rust nurseries in Honduras should be used more. Studies on the web bligth (WB) pathogen, on developing differentials for CBB, and on detecting probes for the actual genes for resistance to CBB will require two more years to complete.

(2) **Activity #2: Detailed epidemiology of geminiviruses based on the presence of viruliferous white flies in the fields.** Substantial progress has been observed in this activity. The development of the specific PCR primers and DNA probes for the major bean and tomato-infecting geminivirus have been outstanding achievements of the LAC regional project. This activity will be terminated in 2001 with the publication of these methods. Dr. Maxwell and collaborators are to be commended for their excellent research achievements which have been conducted by implementing a team approach, a principal objective of the Bean/Cowpea CRSP.

4. **Research Area: Improved cropping systems for the lowlands**

a. **Background:** Improved natural resource management and production technologies are needed to promote bean production in the LAC region. Relay intercropping of maize and beans using little input is the major cropping system in Central America. Results from on-farm trials show that intercropping maize and beans during the first growing season increases grain production, helps to reduce soil erosion and facilitates the management of

weeds. Researchers in Africa have found that certain foliar diseases of beans are less severe when beans and maize are intercropped. Recommended soil and water conservation practices include the use of stone or live (vetiver and other grasses) contour barriers, the use of plant residue incorporated or as ground cover, inoculation with Rhizobia, incorporation of organic matter such as cow and chicken manure, and the use of leguminous green manure or cover crops. Results from on-farm trials also demonstrated that a significant increase in bean yields (mean = 45%) could be obtained using the improved variety Tio Canela 75 with a moderate level of fertilization [130 kg/ha of granular fertilizer (18-46-0) at planting and 32.5 kg/ha of urea (46-0-0) 25 days after planting]. Seed treatment with fungicide, a common and inexpensive practice used by U.S. bean growers, might help improve germination and reduce seed rates.

b. Evaluation of Research:

(1) Activity #1: Develop cropping systems for beans in the lowland tropics that integrate disease management practices and cultural practices that sustain productivity and preserve soil and water resources. The EEP is pleased with the amount of work reported under this important activity. Bean/Cowpea researchers were actively involved in several activities, such as field days, demonstration plots, farmer testing plots, fertilization trials, watershed and integrated crop management trials, validation plots, inoculation trials and in seed production activities. The LAC project team must be congratulated for this.

5. Research Area: Variety release and drought tolerance for the highlands

a. Background: Drought, due to insufficient or unpredictable rainfall, has been identified worldwide as a bean production problem exceeded in magnitude only by bean diseases. The majority of bean production in the world takes place under rainfed conditions. Mexico is the second largest bean producing and consuming nation, where 90% of the beans are produced under sporadic rainfall (200-400 mm) resulting in a low average yield of 450 kg/ha. Even those low yields vary greatly from year to year depending on the cycle of the weather in any particular season. Drought and disease limitations, endemic to Mexico, are similar to production experienced elsewhere. Mexico is an ideal site to study drought because of the network of well-trained scientists in that country. Although the literature contains numerous studies that have been conducted on individual physiological parameters in other crops, there is a need to examine these parameters in bean genotypes to determine their importance in drought resistance. Likewise, there is a need to develop technologies that permit the examination and selection of a large number of genotypes typical of the numbers tested in a breeding program. The development of indirect selection criteria using molecular markers linked to key traits is a major focus of this drought research. The variable nature of

drought stress (either alone or combined with high temperature) and type of drought (intermittent or terminal) will require different strategies for control.

b. Evaluation of Research:

(1) Activity #1: Develop germplasm with enhanced drought adaptation for the lowlands and highlands. A substantial number of trials, that are well under way, are attempting to select more drought resistant cultivars. The identification of superior gene donor lines for drought prone areas is a must in this activity.

6. Research Area: Improved symbiotic nitrogen fixation of bean cultivars under low resource condition

a. Background: Nitrogen deficiency is a problem throughout the Latin American region with 50-75% of soils deficient in nitrogen (N). Fertilization is desirable, but often either outside the financial reach of subsistence farmers, or else impractical because weather conditions are likely to limit fertilizer uptake and efficient use. Nitrogen (N_2) fixation in beans is a desirable alternative, but the crop is often perceived as weak in this trait. Earlier studies within Ecuador sought: (1) to identify and pyramid genes contributing to enhanced N_2 fixation in this crop; (2) to select bean varieties in Ecuador which were active in this trait and well adapted to Ecuadorian production conditions; (3) to improve both the availability and the use of inoculant quality rhizobia for beans; and (4) to research changing needs and methods of legume inoculation.

b. Evaluation of Research:

(1) Activity #1: Development and release of bean varieties or breeding lines having superior nitrogen-fixing ability. The activities with Mesoamerican lines are completed, but dependent on the willingness of breeders to include high biological nitrogen fixation (BNF) lines in their crossing blocks, and to evaluate their progeny in soils low in N. On the other hand, studies on the potential for N_2 fixation in Andean bean lines are somewhat behind that with Mesoamerican germplasm. Two Andean lines, ANT22 and E295, were identified as active in N_2 fixation at low P. Further studies to identify the genetic basis for high nitrogen fixation at low P in these lines and for continued screening of *Rhizobium*-inoculated Ecuadorian breeding nurseries at low soil N are recommended.

(2) Activity #2: Improvement in available bean inoculant rhizobia, bean inoculant availability and inoculation methodologies. In Ecuador, a small inoculant facility was inaugurated. This lab has the capacity to supply a full range of legume inoculants. Staff is being trained in inoculant production and control. The EEP recognizes these initiatives as vital to increase inoculant technology use by poor farmers in Ecuador. More

detailed studies to characterize host and rhizobia interactions are needed in the U.S.

(3) **Activity #3: Biodiversity in the rhizobia nodulating *Phaseolus vulgaris*.** Interesting research, which might answer several questions regarding the poor nodulation and N_2 fixation of beans in the Midwest region of the U.S. and other regions of the LAC. An initiative to sample bean rhizobia from Midwest America, Africa and Brazil is justified and should be supported by the Bean/Cowpea CRSP in the next phase.

7. Research Area: Disease resistance and management in the highlands

a. Background: Disease constraints, particularly rust, anthracnose and root rots present major problems for bean production in the highland regions of Mexico and Andean South America. If yields are to be advanced, and benefits from N_2 fixation realized, it will have to be through genetic improvement and through development of integrated management practices for disease control in this crop. Prior to CRSP activities, there were essentially no improved varieties in Ecuador. Much remains to be done; though fortunately, many of the constraints important in Ecuador find similar expression in Minnesota, minimizing overlap. Initiatives previously undertaken in this area include: (1) evaluation and use of appropriate and adapted breeding lines from the CIAT bean program under field conditions in Ecuador; and (2) with CIAT activities in the region reduced, the initiation of breeding activities at Santa Catalina that emphasize rust and anthracnose resistance, and high altitude adaptation.

b. Evaluation of Research:

(1) **Activity #1: Development of disease resistant lines and management practices for bean production in the highlands.** A substantial amount of research work has been conducted under this activity. The improved bean varieties developed using germplasm from CIAT or originating in the Instituto Nacional Autonomo de Investigaciones Agropecuárias (INIAP) breeding program are now beginning to come on line. These new lines all have resistance to rust and often anthracnosis, and have the maturity characteristics and market class preferred in Ecuador. A search for new sources of root rot resistance for the semiarid highlands of Ecuador is in progress. The EEP appreciates the strong interaction among various institutions and also with farmers in identifying preferred materials with disease resistance.

(2) **Activity #2: Integration of biological, chemical and management practices in the control of root pathogens in beans.** Work was done to combine the use of root biocontrol organisms and rhizobia. The result has been widespread acceptance by farmers and the promotion by the bean industry of seed-applied biocontrol treatments in the U.S. The EEP

feels that this technology should also be promoted in Ecuador because soil conditions are conducive to root disease.

(3) **Activity #3: Identify soil conservation, management and fertilization strategies leading to reduce soil erosion and degradation of soil, and improved water conservation in the highland areas of the region.** No results reported under this activity.

C. CONSTRAINT #2: LIMITED STORAGE OPTIONS

No activity was reported in the Annual Report. Apparently the LAC regional project committee does not consider limited storage options to be a serious enough constraint to warrant use of scarce CRSP funds. If so, their reasoning should be included in the work plan and the report.

D . CONSTRAINT #3: INSUFFICIENT RESEARCH FOR IMPROVED NUTRITION AND PRODUCT DEVELOPMENT

1. Assessment of Progress

Extensive efforts between LAC scientists in the U.S. and HC have characterized the physical-chemical properties of beans, yielding important data for breeding programs as well as the development of infant and adult foods from beans and bean flour. With bean consumption dropping in Costa Rica, a study was performed to determine the causes and segments of the population affected. Community nutritionists are developing programs to help adults and youth understand the nutritional importance of beans in the diet.

The development of new food products using bean flours will also aid the effort to reestablish beans as an important component of the diet. Product development, as well as the commercial production of bean flours and bean-maize weaning foods, should now be moved to the private sector for commercialization throughout the region.

2. Research area: Improved nutrition and product development

a. **Background:** Total dietary fiber, indigestible starch and protein, galactosyl sugars, prolonged cooking time and cooking methods are factors that limit the full nutritional potential of dry beans. Indigestible starch produces more intestinal gas per gram of bean flour than do the oligosaccharides; the genotype and processing method affect the digestibility of dry beans; beans processed in tin cans have lower amounts of indigestible starch than beans cooked with a pressure cooker or boiled in a pot on the stove; the higher indigestible starch associated with pressure cooking and stove top cooking may be the result of the longer cooking time at lower temperature associated

with these cooking methods compared to canning the beans; cooking beans induced cell wall crystallization and decreased starch bioavailability.

A dehydrated iron-fortified bean-based food product was developed. Acceptability studies indicated that the food was acceptable as a weaning food. The next step is to see if the bean-based weaning foods can be produced economically on a commercial scale using industrial technology.

Work is being done to develop a bean-corn weaning food suitable for consumption in countries where corn is a staple in the diet. Strategies are being developed to educate consumers on the health benefits of eating beans in order to increase bean consumption in both the U.S. and LAC countries where beans were once major components in consumer diets.

b. Evaluation of Research:

(1) Activity #1: Identify highland bean lines with superior seed quality traits and the inheritance of seed quality traits. Joint research between Mexico and MSU characterized the chemical and physical properties of bean lines from Malawi, the U.S., Central America, Puerto Rico and Mexico. Lines that showed low yields, poor water absorption and long cooking times were eliminated. This research is still ongoing.

(2) Activity #2: Continued research to identify and quantify bean seed physico-chemical factors amenable to change by food processing and/or genetics. Joint research between MSU, Purdue and the University of Costa Rica examined the effect of salts on phytates and tannins in black beans, with the hope of increasing iron bioavailability. This study is still underway.

(3) Activity #3: Continued research to develop processing technologies that will yield new bean-based products. Improved bean products were investigated using: (1) pectinase and amylase treatment of black and red beans to improve digestibility; (2) bean fermentation and blending with rice to produce weaning foods; and (3) anthocyanin leaching and water uptake of select black bean varieties.

(4) Activity #4: Continue to develop and implement strategies for use of beans and bean products. The University of Costa Rica has mounted an educational campaign to determine why bean consumption is falling for all sectors of the Costa Rican populace. They are partnering with industry to promote beans in the diet of school age children and their parents. The educational campaign to increase bean consumption in Costa Rica has been successful at creating an awareness of the importance of beans in the diet, and at garnering help from private sector business and public agencies to support this effort.

(5) **Activity #5: Continue to develop methodology for use by breeders to screen for starch digestibility.** This research has been focused on developing a rapid and accurate assay for starch digestibility in beans, a tool needed by the breeders. This activity has been ongoing since 1997 and is expected to continue into 2002.

(6) **Activity #6: Carry out studies to assess the consumer acceptability and economical feasibility of manufacturing the developed bean-based product.** This is a joint effort between Purdue and University of Costa Rica. The commercialization of bean-based weaning foods has been slow, but it is now hoped that a processor who processes other cereal products can also produce the bean products. Since the Costa Rican governmental agencies are not able to support the production and distribution of weaning foods, it is critical for the private sector to try to do so. Purdue has successfully tested a bean:corn weaning food, both fermented and unfermented, in Honduras and Costa Rica.

E. CONSTRAINT #4: SOCIOECONOMIC RESEARCH INSUFFICIENTLY INTEGRATED WITH PRODUCTION AND UTILIZATION RESEARCH

1. Assessment of Progress

In an effort to encourage increased bean production in Central America and the Caribbean, a program was established to assist farmers with record keeping. The data collected by the farmers could be used to determine the profitability of bean production. The introduction of new bean varieties into specific HCs was expedited by partnering with NGOs and private sector bean dealers, who helped distribute the seed to farmers. When the seed distribution programs followed-up with the farmers to jointly evaluate the new varieties, the resulting data was valuable in determining varietal performance in different agro-ecological zones.

In Guatemala, work was initiated to assess the market potential of value-added bean-based food products and the opportunities and restrictions on the further development of the bean processing industry.

2. Research area: Adoption and impact studies

a. Background: Due to a lack of reliable data, studies were needed to assess the profitability of new bean technologies that have been adopted by farmers in Central America. In FY 1998 and FY 1999, cost of production studies were carried out in the Dominican Republic, Honduras, Nicaragua, and Mexico.

Due to limited access to improved bean seed, resource poor farmers in Honduras continue to plant traditional and older improved varieties. At a seed workshop held at Zamorano in August 1998, participants identified the need to develop and implement a more efficient approach to artisan seed production and

distribution, which would involve Zamorano, the Ministry of Agriculture, and NGOs (including Peace Corps) managing rural development projects. Following Hurricane Mitch, the seed constraint became even more critical as many small farmers lost their bean crop.

As a result of hurricane Georges in Fall 1998, bean seed stocks in Haiti were severely depleted. In early 1999, Bean/Cowpea CRSP scientists in the Dominican Republic procured 20 mt. of a CRSP-improved black-seeded bean variety (Arroyo Loro Negro) for CIPSDA, a Haitian parastatal. During 1999, CIPSDA sold 15 mt. to Agrotech (a private company) which then increased and sold the seed. CIPSDA distributed 5 mt. of the seed to limited-resource farmer-groups in 20 to 30 hillside villages.

As countries in Central America develop, household incomes will increase. As a result, per capita demand for bean (as grain) will likely decline and the demand for processed/value-added bean products will grow. In addition, value-added products are potentially an exportable product for countries in the region with relatively low costs of production. Currently, only a few firms-- primarily located in Honduras, Costa Rica, and Guatemala--process beans. A previous study of bean processing in Honduras found that a new variety developed at Zamorano, in collaboration with the CRSP, was highly preferred due to superior processing qualities. A similar study carried out in Costa Rica in FY 1999, provided insights about bean processing in a second Central American country.

Beans are currently grown primarily in the cooler valleys and adjacent hillsides in Central America. However, several promising heat-tolerant lines are now being tested which scientists anticipate will perform well in the heat prone (high day and night temperatures combined with high humidity) regions of Honduras, El Salvador and Nicaragua.

b. Evaluation of Research:

(1) Activity #1: Implement farm record keeping studies, involving approximately 20 farmers in the Dominican Republic, Guatemala, Honduras, Mexico, Nicaragua and Puerto Rico designed to collect and analyze data required to assess the profitability of bean production under commercial/semi-commercial management. Record keeping data from farmers in Honduras, Guatemala and Puerto Rico gave research information on the adoption of improved bean varieties, the cost of inputs vs. income from crop harvested, and the use of crop management practices on the overall profit/loss incurred from bean production. These studies have yielded important data on the value of the new varieties and improved production practices as related to the economics of bean production in these countries. These studies will continue into 2001.

(2) Activity #2: A seed production and distribution study in Honduras, designed to multiply and distribute improved seed to limited resource

farmers, assess the performance of the seed distribution, initiative, and evaluate the scheme s impact on farmers yields. Joint work between staff from MSU and Honduras allowed for the distribution of the new bean variety Milenio to over 300 farmers in Honduras via partnerships with twelve NGOs in the region. More than 2000 farmers received the variety Tio Canela-75. A second benefit from the seed distribution activity was that select farmer s fields were used as field training sites for variety evaluation, as well as the assessment of the effects of farming practices on crop yield and quality. Following hurricane Mitch, these seed distribution efforts were expanded.

(3) **Activity #3: Implement a seed distribution study in Haiti, designed to distribute improved seed to limited resource farmers, assess the performance of the seed distribution initiative, and evaluate the scheme s impact on farmers yields.** This study in Haiti involved the distribution of a new variety, Arroyo Loro Negro (ALN), throughout the country via private dealers. The data indicates that there was a strong demand for the new variety. The private dealers were an effective and efficient way to distribute seed to the farmers, who were very willing to pay for quality seed.

(4) **Activity #4: Implement a bean processing industry study designed to document the status of the industry in Guatemala, identify the potential for bean-based value-added products, and identify factors that limit further expansion.** This study looks at the potential of producing value-added bean products in Guatemala, hopefully opening up new opportunities for enhancing bean consumption and industry development in the country. Even though bean production is down, bean consumption has remained steady in Guatemala. Since the international market for canned beans is growing, there is a need to expand bean production in the country.

(5) **Activity #5: Implement on-farm varietal demonstration plots in Mexico to demonstrate the performance of several newly released varieties.** This project is ending because of the lack of future funding within the CRSP. The on-farm demonstrations helped to promote new varieties that were developed for the region as well as for other regions of Mexico and Central America. Important feedback was received from the farmers as to the applicability of the varieties for their growing and handling conditions.

(6) **Activity #6: Implement a study to analyze the impact of free trade on Mexican agriculture, with an emphasis on beans.** This study is underway and is focusing on the impact of bean research, new varieties, production areas and governmental policies on farming in the semiarid areas of Mexico. This research addresses an important question facing

the bean sector in Mexico and should be completed as soon as possible and disseminated widely.

(7) **Activity #7: The potential impact of heat tolerant varieties on bean production.** This study in Honduras will evaluate bean populations for heat tolerance. In addition, the researcher will identify those areas in Honduras which are best adapted for bean production. This data, to be completed soon, will help lowland farmers increase bean yields.

F. CONSTRAINT #5: INSUFFICIENT CADRE OF TRAINED PERSONNEL

1. Assessment of Progress:

The LAC region is obviously committed to human capital development. Among the group of students in training, there is a good mix of disciplines and gender represented to meet regional needs. Throughout the years, the degree training component has been a priority and many of the collaborating HC scientists are alumni of U.S. CRSP training programs. These alumni indicate that the personal relationships they have developed with their U.S. mentors is of high value to them, giving them a sense of family and a comfort level that makes it easy to continue partnering in research with the U.S. scientists. It has also been noted that when host country students study in the U.S., they contribute to the advancement of U.S. agriculture since they engage in thesis projects that address problems and develop technologies that will directly benefit U.S. industry.

2. Research area: Degree Training

(1) **Activity #1: Training to be completed this year.** Nineteen students were listed as receiving training through the LAC Regional CRSP project during FY 2000. Five were listed as having completed their degrees in 1999 and four in 2000. Eleven of the students are females, and eight are males, seven are from the United States, two from Brazil, one from Columbia, three from Ecuador, one from Mexico, one from Canada, two from Bolivia, one from Peru, and one from Paraguay. Ten were working on or have received their doctorates, five were/are master degree students, and the rest are undergraduate students, working on B.S. degrees in Honduras. The disciplines under study were: Plant Breeding and Genetics, Plant Physiology, Plant Pathology, Agricultural Economics, Agronomy and Soil Microbiology. The major professors were: Kelly, Foster, Beaver, Rivera, Percich and Meronuck, Bernsten, Rosas, Coyne, and Graham. The student thesis research areas included: resistance to anthracnose, white mold, BGMV, root rot and leaf hopper; economic impact; drought and heat tolerance; and nitrogen fixation. A significant number of the graduate students are at MSU, but one is at the University of Nebraska, three at the University of Puerto Rico, and three at the University of Minnesota. The range of funding for the

students from the CRSP is $0 - $18,000, eight received CRSP funding, and the total amount in all was $58,000.

(2) **Activity #2: Continuing training.** Ten of the above students were listed as continuing in training. Additionally, three students are listed as undertaking thesis research as undergraduates at Santa Catalina.

(3) **Activity #3: Proposed new training.** A Columbian student at the University of Puerto Rico will be receiving $12,000 to pursue graduate studies in Plant Breeding and Genetics.

3. **Research area: Non-degree training**

(1) **Activity #1. Service and upgrade of the Rhizobium website and a monitoring of its impact.** An Internet site was established in English and Spanish, with a Portugese version in development, to provide information on practices and environmental constraints relative to rhizobium inoculation and N_2 fixation. There have been 16,441 hits between 4/1/99 and 8/15/00 from countries that include Mexico, Venezuela, Yugoslavia and England. The site is presently being upgraded. Commendable effort.

(2) **Activity #2. Preparation of a special issue of *Field Crops Research* dedicated to Practical Aspects of Nitrogen Fixation.** This article was published in March 2000 and is considered as the first in a series of review papers. The intent is to update the information to help scientists remain current in their field. They are also developing a professional master s degree in Agronomy and Soil Science that could be part of a distance education program for HCs. One foundation course has already been developed and is available as a web-based course. Because training personnel is so important, yet very expensive, attention to distance education programs has great merit.

(3) **Activity #3. Technical scientists generally lack the knowledge to perform impact studies.** A workshop, organized by Bernsten, Rosas and Viana focused on the methodologies for carrying out economic analysis of agricultural research with emphasis on collecting/analyzing farm record keeping data, and assessing the economic impact of research. Participants felt they understand more about impact studies after the workshop. More information should be provided to the MO about the impact of this workshop so the other regions could possibly benefit. The annual regional research and training progress reports still do an inadequate job in reporting impact.

II. ACTIVITIES DURING THE YEAR FROM CRSP SUPPLEMENTAL FUNDS NOT INCLUDED IN THE WORK PLAN

A. WEST AFRICA REGIONAL PROJECT

The West Africa region reports seven activities undertaken in FY 2000 that were supplemental to the work plan. The first four activities allowed six CRSP researchers and graduate students to attend the World Cowpea Conference, in Ibadan, Nigeria, in September 2000. They presented eight papers at the Conference. Activity #5 will fund a group of African scientists and a U.S. scientist to develop a strategic plan for cowpea breeding for West Africa to better coordinate cowpea breeding activities within the region. It is, of course, an important contribution to the cowpea research. This is the first time that cowpea breeders from both CRSP and non-CRSP countries will develop a comprehensive and coordinated plan for genetic improvement of cowpea. However, as a future guideline for cowpea research it will be missing an important opinion, the clients opinions, i.e., farmers, consumers, exporters, and government officials. In most research initiatives, the scientists views prevail but considering just the scientists perspective is only a part of the entire issue.

Activity #6: Study of sweet cowpea trait, is progressing as expected.

Activity #7: Evaluation and development of the sweet cowpea. It seems that if merit is confirmed, the sweet cowpea trait would cause a tremendous impact on cowpea production in both Africa and the U.S. Preliminary studies at UCR made available Cameroon 24-125-B as four purified homogeneous sublines. These sublines clearly have markedly elevated levels of sucrose, two or three times higher than other varieties of cowpea. The sweet cowpea trait is genetically recessive, and may be conditioned by one gene. A simple chemical assay, potentially useful to breeders, has been developed and should prove useful in future development of the trait, including its incorporation into other cultivars of cowpea, both in the U.S. as well as in Africa. Market evaluation and assessment of cooking and canning properties remains to be completed.

B. EAST AFRICA REGIONAL PROJECT

The East Africa Regional project briefly reported two activities both trying to increase communication among East Africa CRSP researchers. Activity #1: Develop a website for the East Africa component where CRSP activities, research results and other information are available to interested parties worldwide. This is also an excellent idea for the other regional projects. Activity #2: East Africa Regional Bean Workshop. Such a CRSP-sponsored regional workshop has not been held since 1997. Researchers have strongly felt the need for a new venue for dissemination of research information, as well as the coordination of research activities. The workshop at this time is particularly important to strengthen linkages with scientists in the East Africa region and to provide an opportunity for researchers to plan for the next granting cycle. Funding for the above activities was a very wise decision. Communication among CRSP researchers will be more and more important in the next phase,

since increased communications can increase project efficiency, research capacity and stretch financial resources.

C. LATIN AMERICA/CARIBBEAN REGIONAL PROJECT

The LAC region describes only one activity under this section. This activity was to provide training for a student from Costa Rica in research and extension on beans in the Dominican Republic through observation, farm visits, and participation in all aspects of CRSP activities in the HC.

III. EVALUATION OF FUNDING/FISCAL MANAGEMENT

A. CONSTRAINTS RELATED TO LEVEL OF, DELAY IN RECEIVING, OR REPORTING OF CRSP FUNDS IN FY 2000

In the West Africa Regional Project, there have been no difficulties related to receiving or reporting funds, except Ghana/UGA that experienced some delays in receiving the second part of FY 2000 funds, which is beyond the control of the Management Entity. It is a general complaint that funds are not sufficient.

In the East Africa Regional Project, a delay in receiving the second allocation for FY 2000 created some problems due to Washington State University s policies. It is suggested that some changes in wording the amendments from the CRSP would eliminate this problem in the future. The EEP will discuss the issue with the MO.

In the LAC Regional Project, a PI reported that the extension of project activities to non-Bean/Cowpea CRSP countries within Central America and the Caribbean region was limited by budget constraints. There was some confusion over the funds available to a researcher in Honduras who was collaborating with the University of Wisconsin-Madison PI. Fortunately, this situation was resolved at the April all-CRSP meeting at MSU. It was the general consensus among PIs in all regions that there is an inadequate level of funding. The EEP agrees, but points out that FY 2002 might provide an opportunity to redirect, or even eliminate some activities, in order to give support to certain top research priorities.

B. Leveraged Funds

All three projects have made efforts to leverage funds. However, the EEP recognizes that a commendable job has been done by the LAC project researchers on this issue. LAC scientists reported that $240,000 of leveraged funds were obtained from several sources.

C. Other Funds

In the West Africa Regional Project, UCR received $15,500 direct cost funding from the California Dry Bean Advisory Board. None was reported for the East Africa Regional Project.

As a result of CRSP achievements, a Project for Agriculture Development (PRODAS) was initiated at *Centro de Investigatión Agrícola del Suroeste (CIAS)*, San Juan, Dominican Republic. This project is funded up to $2 million for five years. The objectives are to develop technologies to assist farmers to improve their production capabilities for all major crops in the San Juan Valley. The EEP wants to congratulate Dr. Graham and his group, and Dr. Maxwell and his group, for their success in obtaining extramural funding in FY 2000. Dr. Graham reported $2.956 million for a biocomplexity project including support for studies on the diversity and co-evolution of beans and rhizobia. This project will be funded by the National Science Foundation, 2001-2005. Dr. Maxwell reported $1.5 million (1998-2003) in grant funding to develop virus-index methods for propagated crops in the Middle East. It is funded by the Middle East Regional Cooperation Program (MERC)/USAID and involves scientists from Israel, Tunisia, Egypt, Lebanon, Jordan, and the Palestinian Authority.

IV. PUBLICATIONS, PRESENTATIONS AND AWARDS IN FY 2000

A. WEST AFRICA REGIONAL PROJECT

1. Assessment of Progress

Scholarly output is again commendable for the West Africa Regional Project even though it is not as strong as last year. It is obvious that the scientists recognize the importance of sharing the knowledge gained with constituents and the scientific community. The socioeconomic impacts are still not sufficiently documented in the literature and while extension brochures/manuals are being produced or upgraded, these were not listed nor provided for review by the EEP. Awards and recognitions received were quite impressive.

2. Refereed Publications

In 2000, the following refereed journals published articles relating to West African CRSP research: *Agricultural Systems (1); Crop Science (4); HortScience (1); Cereal Chemistry (1); American Chemist (Abstract); Journal of Theoretical Biology (1); and a book chapter*. Publications for both 1999 and 2000 were listed in the Annual Report. Total: Nine.

3. Non-refereed publications

Sixteen non-refereed publications were listed, six of which were CNRA reports (Bambey), one was a cultivar release notice, four were California Dry Bean Advisory Board Reports, one was a thesis, two were abstracts, and one was a Clemson University Vegetable Report.

4. Presentations

Thirty presentations were made at conferences in the U.S., Nigeria, Mali, and Rome.

5. Awards and Recognitions

Anthony E. Hall received the Board for International Food and Agricultural Development Chair s Award for Scientific Excellence. Manjett S. Chinnan was recognized with the 2000 D.W. Brooks Award for Excellence in International Agriculture by the University of Georgia College of Agricultural and Environmental Sciences. Best poster award at the South Carolina Entomological Society Meeting in Myrtle Beach, SC was won by Abudulai Mumuni, coauthored with B. Merle Shepard. Third Prize in the American Agricultural Economics Association (AAEA) Annual Meeting Poster Competition was received by Francisco Diaz-Hermelo and Jess Lowenberg-DeBoer. B.J. Vander Mey was promoted to full professor, Department of Sociology, Clemson University; and nominated by Clemson University for the Ernest A. Lynton Award given by the American Association for Higher Education for distinguished outreach and service.

B. EAST AFRICA REGIONAL PROJECT

1. Assessment of Progress

The number of refereed publications by the East Africa Regional Project scientists has greatly increased, however, the EEP received only two copies for review and most of the articles listed were either in press or were published in 1999. The MO must receive copies of all project related publications. It is possible that the 1999 articles were published later than the submission of the FY 1999 Annual Report. The EEP looks forward to the publishing of the Malawi Journal of Science and Technology articles. It was noted in last year s report, that under the leadership of Dr. Mloza-Banda, conference papers would be forthcoming by this report. Possibly the publishing process has just been slow because six articles are listed as in press in this journal. It seems obvious that the East Africa Regional Project is committed to increasing scholarly outputs.

Fourteen of the nineteen non-refereed publications were from the Entrepreneurship Workshop held in Lilongwe, Malawi on August 4-6, 1999. It is commendable that this information sharing has been committed to record. This year, as was the case for last year, only two presentations were listed. Dr. Myers award is quite laudable and the promotions of the two Tanzanian scientists are quite deserving.

2. Refereed Publications

Of the 21 refereed publications listed, 11 are in press, and therefore will be listed in the next report. Four were published in 1999. The remaining articles were

published in the following journals*: Phytopathology (1); Molecular Plant-Microbe Interactions (1); Journal of Plant Pathology(1); Tanzania Journal of Agricultural Sciences (1); Plant Foods for Human Nutrition (1); African Crop Science Journal (1); Malawi Journal of Science and Technology (1),* and Workshop Proceedings.

3. Non-refereed Publications

Nineteen non-refereed publications were listed. These publications predominately included workshop proceedings; while three were annual reports for the Bean Improvement Cooperative. Not listed, but found elsewhere in the report, was that a published booklet based on information gathered in Malawi concerning farmers knowledge studies of pests and diseases. Also, brochures in Swahili providing varietal descriptions, agronomic requirements, and consumption qualities of SUA 90 and ROJO have been printed.

4. Presentations

Mabagala and Myers have each made two presentations.

5. Awards and Recognition

Robert Mabagala was promoted to Associate Professor and Theobald Mosha to Senior Lecturer at Sokoine University of Agriculture. Alex Mkandawire was nominated to serve on the Crop Science Journal (India) editorial board and Jim Myers received the 1999 Bean Improvement Cooperative Distinguished Achievement Award.

C. LATIN AMERICA/CARIBBEAN REGIONAL PROJECT

1. Assessment of Progress

The LAC Regional Project has again excelled in the areas of scholarship, recognition for excellence and utilization of non-refereed publications and presentations to extend the knowledge generated to appropriate users.

2. Referred Publications

The following is a summary of refereed publications: *Journal of the American Society of Hort. Science (3); Crop Science (10); HortScience (2); Proceedings of the International Am. Soc. Of Trop. Hort. (1); Archeological Virology (1); Field Crops Research (2); Manejo Integrado de Plagas (1); Advances in Agronomy (1); Agronomia Mesoamericanian (3); Euphytica (2); Rev. Fitotecnia Mex. (1); Plant Disease (1); Trop. Ag. (1); Canadian J. of Micro. (1); Agronomy Journal (1); REVITECA (1);* book contributions (5); in press (5). Note: Four 1999 articles were listed and one 1998 article was listed. This is evidence of extremely productive scientists and many of the articles were coauthored with HC and U.S. PIs. Several

of the articles were characterizing new CRSP bean varieties. Only one of the many articles published related to economic impact and that was published in a Cooperative Extension publication on the Chase variety of pinto bean. Nonetheless, it is very impressive that the LAC Regional Project continually demonstrates such a strong performance in scholarly output.

3. Non-refereed Publications

Sixty-four non-refereed publications were listed, 26 of which were annual reports to bean cooperatives demonstrating a commitment to maintaining the support and partnership with constituents. While not listed, a number of excellent extension-type publications were provided at the EEP site visit to the Dominican Republic, all written in Spanish. Three theses were completed by graduate students, five articles for *HortScience,* two in *Phytopathology,* six in *The Bean Bag,* and four in *Crop Watch.* There are abstracts in Proceedings, one article in a CIAT publication and thirteen other general non-refereed publications. A patent was acquired and a University of Nebraska Cooperative Extension article was published on beans.

4. Presentations

At least 17 oral presentations have been given by the LAC scientists at conferences in the U.S., Mexico, the Dominican Republic, Puerto Rico, Quebec and Honduras. There were ten poster presentations listed, three seminars on the geminivirus, videos for training and on WID in the Dominican Republic, and radio and TV spots on beans there as well.

5. Awards and Recognition

James Beaver received a Meritorious Service Award from the Bean Improvement Cooperative. Dermot Coyne and Peter Graham hold positions of honor and leadership in their profession and/or on professional journals. J.A. Castro received a best presentation award in the Legume Crops Section during the XLVI Annual Meeting of the Central American Cooperative Program for Improvement of Plants and Animals. D.P. Maxwell received the Spitz Land Grant Award from the College of Agricultural and Life Sciences, University of Wisconsin-Madison. Lisa Sutton, Dermot Coyne s technician, received the Nebraska Chapter Sigma Xi In Support of Research Award. Graduate students either received travel fellowships, research awards or were inducted into honor societies.

V. PROGRAM EVALUATION: CHALLENGES FOR THE FUTURE

The Bean and Cowpea CRSP has reached maturity in many respects: it has developed a strong research capacity, has well established linkages with National Agricultural Research and Extension Service (NARES), IARCs and NGOs and it is now into the second generation of U.S.

and H.C. scientists. This maturity brings with it new challenges for the program. Not unlike any experienced organization, the Bean/Cowpea CRSP must resist the natural inclination to become too comfortable with past successes, familiar approaches and the usual way of doing business. The landscape is littered with failing and failed organizations that fell victim of this age related affliction.

The Bean/Cowpea CRSP need not suffer any ill effects from its years of extensive experience. Indeed, it can be stronger if it builds on past successes and adapts to the ever changing political and economic environment, shifting needs of clientele and rapidly advancing science.

The EEP has identified some of the more important issues that the Bean/Cowpea CRSP should address as it adapts to these changes. There are no quick fixes or easy formulas for dealing with these challenges. Each will require the intellectual investment of some of the best thinkers, both within and outside the Bean/Cowpea CRSP. Some may best be addressed by an inter-CRSP task force and insights to others may be found in non-CRSP research fora.

The EEP suggests the following challenges be added to the agenda of the MO, BOD and the TC:

1. **Balance among disciplines and approaches:** The current mix of disciplines and approaches has evolved over time, in part the result of deliberate reevaluations and in part we suspect, the result of resistance to change. Despite previous efforts to do so, the EEP believes there should be more focus within each region, concentrating limited resources on the most critical constraints that have reasonable odds for success.

2. **Refining the regional approach:** Regional projects were organized about three years ago replacing bilateral projects, a U.S. institution and a HC institution, which had been the mode of organizing research since the beginning of the Bean/Cowpea CRSP. Although this was a wise decision, the change has not been easy and the transformation is not yet complete. There is still a tendency to focus on one collaborative relationship rather than on the broader region of which the HC is a part. The TC and especially all PIs need to give more attention to ways that research can have more impact on the region in addition to a country.

3. **Investing in biotech (especially transformation): Too much or too little?:** Biotechnology has made tremendous contributions to agriculture and the potential benefits in the future is surely enormous. A breakthrough in bean and cowpea transformation would open up possibilities for cultivars that are resistant to insect pests and diseases that would greatly benefit small farmers in developing countries. The Bean/Cowpea CRSP is already investing an estimated 13 percent of available funds in biotechnology and there is disagreement among competent scientists as to whether that is too much or too little. The EEP is not in a position to say what the optimum amount should be, but does believe the question deserves careful consideration.

4. **Making full use of more advanced developing countries:** A number of HCs participating in the Bean/Cowpea CRSP, after twenty years of collaboration with U.S. institutions, have a strong and experienced team of researchers, many of whom have advanced degrees supported by the CRSP. These relatively strong HC bean and cowpea research teams, mostly in LAC, could play a greater role in the regional project, contributing to the strengthening of weaker research teams. A challenge for the Bean/Cowpea CRSP is to define a new role for country teams with advanced research capacity so that they can contribute more to the regional or global objectives of the CRSP.

5. **Strengthening linkages with international research centers and other international organizations:** The increasing maturity of the Bean/Cowpea CRSP makes it an important player in the global agricultural research system. No longer need its role be considered simply as a bilateral USAID project. Rather, it is on a par with such international agricultural research centers such as CIAT and IITA, in terms of importance and capacity in bean and cowpea research. In the view of the EEP, it is time to redefine the relationship and linkages with other international centers with a mandate for bean or cowpea research. For example, the Bean/Cowpea CRSP might take the initiative to join with interested centers and institutes to develop a coordinated global research strategy for addressing the major constraints to bean and cowpea production in Africa and LAC.

VI. RECOMMENDATIONS FOR THE NEXT PHASE FY 2002-2007

Last year, the EEP made recommendations for priorities during the next phase, FY 2002-2007, for three funding level scenarios: (1) funding increases, (2) funding remains level and (3) funding decreases. The EEP has reviewed those recommendations, updated them and made modest changes in them.

1. **If funding increases:** With an increase in USAID funding for this CRSP project, existing areas should be maintained and the following areas should be enhanced.

    a. The degree-training program, which has suffered from reduced budgets, to the point where it has become a concern for all CRSP scientists.

    b. The rebuilding of the infrastructure for research and outreach education programs serving rural Africa.

    c. The addition of staff and scientists to the CRSP that would be involved in technology development and transfer, including early feasibility studies.

    d. The development and implementation of systems for the production and distribution of seed varieties to farmers in all areas served by the CRSP.

    e. The adding of additional HCs (e.g., Nigeria, Rwanda, Haiti, Nicaragua, Mozambique, Brazil) to the project.

f. Investments in new technologies, e.g., transgenics.

g. Partnerships with the private sector, especially input suppliers.

h. Expanded outreach education and technology transfer efforts to farmers and consumers in both HCs and the U.S. Partnering with non-CRSP institutions is a must for all locations.

2. If funding remains level: Even if funding does not increase, the following areas should be considered for strengthening.

a. Consider low-cost means to rebuild the infrastructure for research and outreach education programs serving rural Africa. If possible, finding leveraged funds from other donors.

b. Expand outreach education and technology transfer efforts to farmers and consumers in both HCs and the U.S. Partnering with NGOs, ministries/agencies and institutions is a must.

c. Development and implementation of systems for the reproduction and distribution of seed varieties to farmers in all areas served by the CRSP.

d. Research on nutritional and functional properties of beans and cowpeas must remain a high priority area for the CRSP. New product development must now move to commercialization in the private sector.

C. If funding decreases: If the USAID funding for the next CRSP project extension drops below the current level, the following options should be considered.

a. Eliminate breeding programs that are not focused on the most critical needs.

b. Downsize the Management Office.

c. Focus the CRSP by more aggressively terminating unsuccessful projects.

d. Combine bean/cowpea utilization research across all regions.

e. Focus efforts on the highest priority constraints within each regional project and discontinue those activities with low potential for impact.

f. Eliminate all Regional Facilitators and their associated budgets.

Bean/Cowpea CRSP
FY 00 EXTERNAL EVALUATION PANEL SCOPE OF WORK
(October 1, 1999-September 30, 2000)

Use the outline below to write your report. Discuss <u>every</u> item based on information presented in the corresponding section of the project's Annual Report and any additional documents and site visits. This report is to be an <u>evaluation</u>. Thus, please do not transfer verbatim the information provided in the Annual Report. When a judgement of adequacies/inadequacies is requested, the EEP's opinion (distinct from the PI's assertion) is what is needed. Please present a discussion of your evaluation of each item rather than a yes/no-type response. If an item does not apply, please do not omit it but rather indicate "Not Applicable." A copy of the Annual Report format is included as part of this Scope of Work. Italicized items are instructions only, not to be included in the finished document.

I. EVALUATION OF REGIONAL SPECIFIC RESEARCH PROGRESS DURING FY 99

A. Constraint #1: *List as in Annual Report.*

1. Research area: *List as in Annual Report.*
- *Are the activities under this research area adequate for the purpose intended?*
- *Are the activities completed consistent with those in the approved workplan?*
- *How would you evaluate the overall level of research progress during this year?*
- *What is the likelihood the anticipated impact will be realized? Is the time frame for impact appropriate? Will the impact be of sufficient importance to justify further support?*
- *Were there major changes in the workplan? If so, were they justified/appropriate?*
- *What, if anything, seems to be missing?*

2. Research area: ***REPEAT FOR EACH RESEARCH AREA UNDER THIS CONSTRAINT.***

B. Constraint #2: *Repeat format of Constraint #1 above.*

C. Constraint #3: *Repeat format of Constraint #1 above.*

D. Constraint #4: *Repeat format of Constraint #1 above.*

E. Constraint #5: Insufficient Cadre of Trained Personnel

1. Research area: Degree training
- *Is the training, underway or proposed, in appropriate disciplines?*
- *Are training funds being used efficiently?*
- *Is sufficient degree training being done?*
- *What, if anything, seems to be missing?*

2. Research area: Non-degree training
- *Is the training which was done appropriate?*
- *Are non-degree training funds being used efficiently?*
- *Is sufficient non-degree training being done?*
- *What, if anything, seems to be missing?*

F. Constraint #6: *Repeat format of Constraint #1 above.*

G. Constraint #7: *Repeat format of Constraint #1 above.*

II. ACTIVITIES DURING YEAR FROM CRSP SUPPLEMENTAL FUNDS NOT INCLUDED IN WORKPLAN

- *Would or should these activities have been supported under the core budget?*
- *Do these activities further the CRSP-supported research?*
- *Will they contribute to the achievement of one or more of the impacts identified in the wordplay?*
- *Was adequate progress made during this year?*
- *Was the supplement justified and should it be continued if possible?*

III. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 99

A. Constraints Related to Level of, Delay in Receiving, or Reporting of CRSP Funds:

- *Did the constraints identified seriously impede research progress?*
- *Can anything be done to eliminate this problem in the future?*
- *How did the institution respond to this problem?*
- *How did the researchers respond to this problem?*

B. Leveraged Funds:

- *How available are outside funds for related work?*
- *Has the team been sufficiently aggressive in attracting such funds?*
- *How successful has the team been in generating leveraged funds?*

C. Other Funds:

- *Were funds generated by this team for work not directly related to their CRSP work?*
- *If not, should there have been?*

IV. PUBLICATIONS, PRESENTATIONS AND AWARDS IN FY 2000

A. Refereed Publications:

- *Is the quantity and quality of these publications appropriate?*
- *Was there adequate U.S./HC collaboration on generating these publications?*
- *Are there jointly authored publications?*
- *Were copies made available as requested?*

B. Non-Refereed Publications:

- *Is the quantity and quality of these publications appropriate?*
- *Was there adequate U.S./HC collaboration on generating these publications?*
- *Are there jointly authored publications?*
- *Were copies made available as requested?*

C. Presentations:

- *Is the quantity and quality of the presentations appropriate?*
- *Was there adequate U.S./HC collaboration on the presentations?*
- *Were there sufficient opportunities identified for both U.S. and HC researchers to make presentations?*

D. Awards and Recognitions:

- *What are the implications of HC awards and recognitions during the year?*

- *What are the implications of U.S. awards and recognitions during the year?*

V. IDEAS FOR STRENGTHENING PROJECT

- *Are the ideas presented for strengthening the project realistic?*
- *Discuss the appropriateness of the ideas.*

VI. OTHER ISSUES

A. Socioeconomic:

- *Is a regional focus on impact being maintained?*
- *Is impact being adequately documented?*
- *Are socioeconomic data disaggregated by gender so possible gender-related issues can be identified?*
- *Is a WID perspective reflected in new technologies which have been/will be generated?*
- *Is a concern for gender reflected in the training participants?*
- *Is the WID perspective documented in the impact assessments?*

B. Extent of Regionalization:

- *Is there adequate interaction between Host Countries in the region?*
- *Is there adequate interaction between Host Countries and non-Host Countries in the region?*

VII. OVERALL RATING:

A. General Strengths: *Based on the current year*

B. General Weaknesses: *Based on the current year*

C. Recommendations: *Based on the current year*

VIII. INCLUSION IN NEXT EXTENSION (2002-2007)

- *Are there major project strengths which should be further exploited in the next five years?*
- *Are there major project weakness which need to be addressed before an extension is considered?*
- *Identify individual components of this project which should be expanded in the next extension, reduced in size, or eliminated entirely. Please explain.*
- *Has this project or some of its components reached the stated goals and, as such, should not be included in the next extension? If so, does this completion point to any next steps that should be the focus for the next extension?*

IX. GENERAL COMMENTS

- *Ideas for evaluation of the CRSP as a whole gleaned from this project.*
- *Other comments.*

BEAN/COWPEA CRSP FY 2000 EXTERNAL EVALUATION PANEL

Dr. John G. Stovall (Chair)
National Center for Food and Agricultural Policy
1616 P Street, NW
Washington, DC 20036
Phone: (202) 328-5081
Fax: (202) 328-5133
E-Mail: stovall@ncfap.org

Dr. Carolyn B. Brooks
School of Agricultural and Natural Sciences
University of Maryland Eastern Shore
Early Childhood Research Center
Room 1120
Princess Anne, MD 21853
Phone: (410) 651-6344
Fax: (410) 651-7657
E-Mail: cbrooks@mail.umes.edu

Dr. Carlos Magno Campos da Rocha
EMBRAPA Cerrados
P. O. Box 08.223
CEP 73301-970
Planaltina, DF
Brazil
Phone: 55 61 388-9971 or 388-9898
Fax: 55 61 388-9879
E-Mail: cmagno@cpac.embrapa.br

Dr. Lowell D. Satterlee
Oklahoma State University
Oklahoma Food and Agricultural Products Research and Technology Center
Office of the Director
Room 148A
Stillwater, OK 74078-6055
Phone: (405) 744-6071
Fax: (405) 744-6313
E-Mail: slowell@okway.okstate.edu