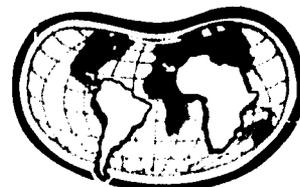


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**THE BEAN/COWPEA
COLLABORATIVE RESEARCH
SUPPORT PROGRAM (CRSP)**

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**REPORT OF
THE EXTERNAL EVALUATION PANEL OF
THE BEAN/COWPEA CRSP FOR FY 90**

December 1990

Funded through A.I.D./BIFAD Grant No. DAN-1310-G-SS-6008-00

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TABLE OF ACRONYMS

A&M	Agricultural and Mechanical	INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias (National Institute of Forestry and Agricultural Investigations)
A.I.D.	Agency for International Development	INTSOMIL	Sorghum/Millet CRSP
AGR	Agriculture	IPRC	Insect Pathology Resource Center
ALS	Angular Leaf Spot	IR	Institutional Representative
AMIX	Additive Main effects and Multiplicative Interaction effects analysis	IRA	Institut de la Recherche Agronomique (Institute of Agronomic Research)
ANTH	Anthraxnose	ISRA	Institut Sénégalais de Recherches Agricoles (Senegalese Institute of Agricultural Research)
ARS	Agriculture Research Station	ITA	Institut de Technologie Alimentaire (Food Technology Institute in Senegal)
ATP	Adenosine Triphosphate	LASPAU	Latin American Scholarship Program for American Universities
BCMV	Bean Common Mosaic Virus	LDC	Less Developed Country
BDMV	Bean Dwarf Mosaic Virus (BDMV-CO, Colombia)	MDR	Multiple Disease Resistance
BGV	Bean Golden Mosaic Virus (BGV-BZ, Brazil; BGV-DR, Dominican Republic; BGV-GA, Guatemala)	ME	Management Entity
BIFAD	Board for International Food and Agricultural Development	MIAC	MidAmerica International Agriculture Consortium
BIFADEC	Board for International Food and Agricultural Development and Economic Cooperation	MNR	Ministry of Natural Resources
BNF	Biological Nitrogen Fixation	MO	Management Office
BOO	Board of Directors	MPN	Most Probable Number
BOSTID	Board on Science and Technology for International Development.	MSU	Michigan State University
BTI	Boyce Thompson Institute	MUCIA	Midwest Universities Consortium for International Activities
C	Carbon	N	Nitrogen
CATIE	Centro Agrónomico Tropical de Investigación y Enseñanza (Tropical Agricultural Center for Investigation and Teaching)	NAS	National Academy of Science
CB	Common Blight	NCRE	National Cereals Research and Extension Project
CESDA	Centro Sur de Desarrollo Agropecuario (South Center for Agricultural Development)	NDBC	Nebraska Dry Bean Commission
CGIAR	Consultative Group on International Agricultural Research	NIFTAL	Nitrogen Fixation by Tropical Agricultural Legumes
CIAT	Centro Internacional de Agricultura Tropical (International Center of Tropical Agriculture)	P	Phosphorus
CILSS	Comité Inter-Etats pour la Lutte contre la Sécheresse dans le Sahel (Permanent Interstate Committee for Drought Control in the Sahel)	PCOMCA	Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios (Central American Cooperative Program for the Improvement of Food Crops)
CNPAF	Centro Nacional de Pesquisa de Arroz e Feijão (National Center of Investigation for Rice and Beans)	PCR	Polymerase Chain Reaction
CNPQ	Brazilian National Science Foundation	PI	Principal Investigator
COSUDE	UN, USAID and Swiss funding program coordinated by CIAT	PR	Puerto Rico
CRSP	Collaborative Research Support Program	PROFRIZOL	Research network of Latin American and Caribbean countries "for beans" funded by COSUDE
CSRS	Cooperative State Research Service	PSTC	Program in Science and Technology Cooperation
DNA	Deoxyribonucleic Acid	RENACO	West and Central Africa cowpea research network
DR	Dominican Republic	RFP	Request for Proposals
EAP	Escuela Agrícola Panamericana (Pan-American Agricultural School)	RFLP	Restriction Fragment Length Polymorphism
ECP	External Evaluation Panel	RNA	Ribonucleic Acid
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria (Brazilian Enterprise for Agricultural Investigations)	S&T	Science and Technology
EP	CIAT Preliminary Yield Trial	SADCC	Southern African Development Coordinating Committee
EPACE	The Ceara State Agricultural Extension Service	SAFGRAD	Semi-arid Food Grain Research and Development Project
FAO	Food and Agricultural Organization of the United Nations	SEA	Secretaría de Estado de Agricultura (Secretary of State for Agriculture)
FTE	Full-Time Equivalent	SODECOTON	Société de Développement du Coton (cotton production cooperative in Cameroon)
FY	Fiscal Year	SUA	Sokoine University of Agriculture
GN	Great Northern	TC	Technical Committee
HB	Halo Blight	UCD	University of California-Davis
HC	Host Country	UCR	University of California-Riverside
IARC	International Agricultural Research Center	UFL	University of Florida
IBPGR	International Board of Plant Genetic Resources	UGA	University of Georgia
IRSNAT	International Benchmark Site Network for Agro-Technology Transfer	UMN	University of Minnesota
IBYAN	International Bean Yield and Adaptation Nursery	UMR	University of Minnesota Rhizobia
ICTA	Instituto de Ciencias y Tecnología Agrícola (Institute of Agricultural Science and Technology)	UNAH	Universidad Nacional Autónoma de Honduras
IFS	International Foundation for Science (Swedish foreign aid program)	UNL	University of Nebraska-Lincoln
IITA	International Institute of Tropical Agriculture	UPR	University of Puerto Rico
INCAP	Instituto de Nutrición de Centroamérica y Panamá (Institute of Nutrition of Central America and Panama)	U.S.	United States
INIAP	Instituto Nacional de Investigaciones Agropecuarias (National Institute of Agricultural Investigations)	USAID	U.S. Agency for International Development
		USDA	U.S. Department of Agriculture
		UMI	University of Wisconsin
		WB	Wet Blight
		WID	Women in Development
		WSU	Washington State University
		Xcp	<i>Xanthomonas campestris</i> pathovar <i>phaseoli</i>
		YSA	Yield System Analysis

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**REPORT OF
THE EXTERNAL EVALUATION PANEL OF
THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM
FOR FY 90**

I. INTRODUCTION

The Bean/Cowpea Collaborative Research Support Program (CRSP) began with funding in September 1980. The original grant came to an end in FY 86. Subsequently, there have been two three-year extensions. The present review covers FY 90 activities, the second year of the second extension.

Evaluations were based on site visits to eight Host Countries (HC), comments of the Technical Committee (TC), project extension documents and annual reports, and discussions with the CRSP Management Office/Management Entity (MO/ME), Principal Investigators (PIs) and the Agency for International Development (A.I.D.) Project Manager.

A. The FY 90 External Evaluation Panel (EEP)

Originally the EEP consisted of seven members, all appointed in 1980-81. During 1986, two members (Drs. Melvin Blase and Luis Camacho) retired from the EEP, reducing the number to five. In 1987, another two of the original seven retired (Drs. Antonio M. Pinchinat and Charlotte E. Roderuck). They were replaced by Drs. Edna McBreen and Kenneth O. Rachis. Two more of the original seven (Drs. Hugh Bunting and Peter E. Hildebrand) retired in 1988. They were replaced by Drs. John S. Robins and Arthur J. Siedler in 1989. The last of the original seven, Dr. Clarence C. Gray, retired in 1990 and has not as yet been replaced. The current members and their affiliations are given in Attachment D.

B. Organization of the Bean/Cowpea CRSP

When it was organized, the Bean/Cowpea CRSP consisted of eighteen projects in thirteen countries of Africa, Central and South America, including the Caribbean area, in collaboration with ten U.S. lead institutions. At the end of FY 90, there were thirteen projects for review (beans—nine and cowpeas—four). These thirteen remaining projects are located in eleven Host Countries (including INCAP, a regional institution located in Guatemala) and involve thirteen U.S. lead institutions.

The Bean/Cowpea CRSP projects are developed and executed by PIs in collaborating U.S. and HC institutions. Oversight and participation in approval of plans and budgets are made by the TC, the MO/ME and the Board of Directors (BOD). Michigan State University (MSU) serves as the MO/ME. As the MO/ME, MSU has overall responsibility for the programs of the Bean/Cowpea CRSP and is accountable for the funds granted by A.I.D. MSU funds CRSP projects through sub-contracts with the lead institutions, which are responsible for their projects and accountable for funds received.

The Bean/Cowpea CRSP is funded through the Office of Agriculture, Bureau for Science and Technology, Agency for International Development (A.I.D./S&T/AGR). The S&T/AGR Project Manager is Dr. Harvey Hortik, Chief, Agricultural Production Division and Senior Horticulturist/Plant Pathologist.

C. FY 90 EEP Review: Sequence of Events

The following are events which comprised the FY 90 EEP review process.

1. A Scope of Work (see Attachment A) was developed by the MO/ME, using BIFAD/A.I.D. CRSP Guidelines and inputs from the TC and BOD. The Scope of Work was distributed to Principal Investigators to be used as a format and guide for preparation of annual reports due by November 1, 1990. The Scope of Work also served as a guide for EEP reviews of individual projects.
2. A schedule of EEP site visits to eight HCs was executed during the August-December 1990 period and usually involved two EEP/MO members/staff.
3. EEP members McBreen, Rachie and Siedler were assigned the four projects not covered by HC site visits and the Women in Development and training programs. Discussion drafts were prepared prior to the annual EEP meeting in Washington, DC, December 1990.
4. Draft reviews of individual projects and special topics were discussed at the Washington meeting. Final project and topic evaluations were made during the discussions.
5. The fiscal and administrative review was based on data/information supplied by the MO. Discussions of CRSP operations and procedures, status of activities and related matters were held with MO officials, with PIs during the site visits and with the A.I.D. Project Manager.
6. The summary, overall evaluation of the Bean/Cowpea CRSP was made on the basis of the results of individual project reviews, discussions of the progress towards amelioration of constraints, estimates of the performances of participating U.S. institutions, evaluation of fiscal and administrative operations, site visits and information acquired through conversations and discussions with PIs and CRSP officials.

II. PROGRAM EVALUATION: SUMMARY AND SPECIAL COMMENTS

SUMMARY:

For the FY 90 review, thirteen projects and the Women in Development (WID) and training components were evaluated with regard to progress, funding/fiscal management, planning, status and prospects. Nine of the projects are devoted to improvement of beans (seven in Central and South America and the Caribbean and two in East Africa). The remaining four are concerned with improvement of cowpeas (one in South America and three in West Africa). WID is separate from the MO and is funded as a half-time position at the ME institution.

Since the Bean/Cowpea CRSP is in the process of petitioning for a five-year extension, it was agreed the EEP should conduct site visits to those HCs where activities are proposed in the extension. Thus, on-site reviews were conducted in eight countries and involved nine proposed projects. Generally, two EEP members/MO staff participated, although in three cases (Cameroon, Dominican Republic and Ecuador) schedules did not permit multiple representation. In all cases, the U.S. and HC PIs participated and HC and USAID Mission officials were consulted extensively. EEP reports for these projects were prepared by those who participated in the site visit. For those projects (HCs) not proposed for inclusion in the extension, and for the WID and training component, review reports were prepared by the EEP member most familiar with the activity.

The EEP finds that the Bean/Cowpea CRSP is being managed and operated in a highly satisfactory manner in full compliance with BIFAD/A.I.D. CRSP Guidelines and the enabling grant document.

Overall rating of the Bean Cowpea CRSP: 1—Highly Satisfactory

SPECIAL COMMENTS:

Distribution of RFPs for New Activities and Projects: The Bean/Cowpea CRSP has been praised among the CRSPs for its approach to accessing leading scientific talent from the U.S. university community in determining locations for new CRSP activities. The CRSP has been especially adept in this approach within the confines of the U.S. bean/cowpea research system. Now the EEP urges that the CRSP expand the reach of their search for institutions to take leadership, or participate in developing activities, in such cross-cutting areas as food science and utilization, integrated pest management, and the social sciences. Because excellent expertise in these fields exists in a variety of U.S. institutions, the EEP suggests that a formal process of issuance of requests for proposals for new activities include notification of potential participants through such nationwide dissemination media as BIFADEC and advertisement in *The Chronicle of Higher Education*. Wider notification of CRSP opportunities can only increase the possibilities of accessing the best talent for the CRSP while assuring fairness to all elements of the scientific community.

Socio-Economic Case Studies: In the FY 89 EEP Report, we noted the impact study of cowpea activities in Senegal and reacted positively to this approach to documenting benefits of the CRSPs. We now note that the Bean/Cowpea CRSP Management Entity has been contracted to extend these studies to other Bean/

Cowpea CRSP projects and to projects in other CRSPs. We applaud this development and commend the Management Office and A.I.D./S&T/AGR for their initiative and leadership on behalf of the total CRSP community through these efforts.

CRSP-Related Activities Not Funded by the CRSP: The EEP is interested in maintaining CRSP reporting procedures whereby research activities and results related to but not funded directly by the CRSP are included in annual reports. These procedures reveal a total research program in beans, cowpeas or related areas and better characterize overall progress and constraints. At the same time, we are interested in a clear delineation of CRSP-funded activities for evaluation purposes.

Inter-Project Collaboration in Host Countries: The Panel has observed some instances where CRSP activities in HCs might productively collaborate and/or share resources, including technical expertise, with other A.I.D.-funded projects. We think that such collaboration might sometimes (but clearly not always) prove to be mutually beneficial. We, therefore, encourage PIs, the MO and A.I.D. to be alert for such opportunities and to capitalize on them wherever possible. We especially urge A.I.D., in designing and implementing country projects, to take cognizance of such opportunities and, above all, avoid project designs that mitigate against such cooperation, i.e., geographic or institutional limitations.

Germlasm Conservation: The Panel takes note of the large number and diversity of germplasm in accessions collected and evaluated in this program. We believe that these resources are extremely valuable to researchers in this project and to those in the community-at-large and thus are well worth preserving. We, therefore, urge that special attention to conservation of this resource be assured by placing these documented resources in multiple gene banks, i.e., local, IARC and other international gene banks.

Baseline Data: The Panel observes that there is a wide divergence among the Bean/Cowpea CRSP projects in the attention given to collection of baseline data. While conceding that this activity does compete for funds, we nonetheless think that a reasonable base of information is important in assessing project progress over time. We thus encourage that PIs give this matter attention during the coming year and include in the FY 91 Annual Report, a brief status report on the situation in the project. We further ask the TC to comment on the subject in their FY 91 review of the projects.

Need for Economic Competence: As indicated in the review of the WID program, the Panel is quite positive toward Dr. Ferguson's activities--activities that encompass a social science dimension but are carried under the WID banner. We are concerned, however, that the economic dimension of "socio-economic" concerns does not have continuing attention in the CRSP. We encourage the Technical Committee and Board of Directors to consider this matter as we approach the five-year extension.

English Language Training: The CRSP has made excellent progress in human resource and institutional development to assist Host Country researchers to become a viable part of the international agricultural research community. The successes in this area are clear with counterpart scientists who have received long-term training through, or with assistance from, the CRSP. Other Host Country scientists have also been brought into the international

agricultural research community through their CRSP activities. However, there appears to be a significant group of scientists involved in the CRSP who are essentially excluded from greater involvement in, and even access to, the international scientific community because of their lack of English language skills. English has clearly become the international language of science. If Host Country scientists are to be able to function within that milieu and profit from the advances of the larger scientific community, they must be able to function in English. With the training and institutional development successes of the CRSP to date, it appears that English language capability of larger numbers of Host Country scientists should be a priority concern for their long-term progress and competitiveness in international science.

Host Country Leadership: The CRSP has done much to help build research capacity in the Host Country through various training activities. However, in most CRSP projects, numbers of HC scientists are at the minimum for the project to function. In more and more cases, personnel turnover threatens to interrupt research progress. Similarly, some Host Countries are experiencing the irony of scientists who are so successful that the demands on their time begin to detract from CRSP activities. It is crucial for the CRSP to begin to examine the depth of human resources in the Host Country—especially of individuals who might serve in a PI or Co-PI role and to insure that there are at least two Host Country scientists with sufficient training and experience to serve in a PI role. The EEP suggests that one approach to developing such a level of expertise is through the use of Co-PIs.

In-Country Transportation: During the Host Country reviews from August through December 1990, EEP reviewers noted some serious problems with transportation in several countries. In two cases, reviewers experienced vehicle breakdowns while on review trips. Many of the projects operate in isolated areas where roads are primitive and/or poorly maintained; thus, rugged and reliable transport is critical.

We now learn that vehicle replacement orders have been seriously delayed in processing in A.I.D.—two having been in place for more than a year. We think this is a potentially serious problem that will inevitably adversely impact progress. We urge early and positive action in A.I.D. to rectify this problem.

Considerations for Utilization Research Projects: Utilization research offers unique synergistic opportunities for maximizing outputs via intra- and inter-CRSP collaboration, particularly in method development, grain legume quality, storage systems, process technology, product development and consumer acceptance. Such projects should be very closely coordinated (linked) with production projects since one of the primary functions of their research is to maintain or enhance quality (cookability, digestibility, nutrient content, safety). We suggest also that locations (HC) be selected for utilization projects that have potential for regional impacts. Active involvement of the private sector would also enhance success for market development.

Malawi Access: The Panel takes note of the observation of the Technical Committee with respect to the problems of access by U.S. scientists and administrators to visit programs in Malawi. We suggest that this problem (and similar ones in other countries) be monitored over the coming months and actions relating thereto taken as circumstances warrant.

III. PROGRAM EVALUATION: TRAINING AND WOMEN IN DEVELOPMENT

TRAINING:

The CRSP has made great progress in collecting and analyzing data related to the results of its efforts in short- and long-term training programs. Hopefully the data collection process used in the FY 90 training reports is now incorporated into the year-to-year efforts of the Management Office so that ongoing information and analysis will be readily available.

During FY 90, the "Bean/Cowpea CRSP Guidelines for Degree Training," which had been developed by the Technical Committee in June of 1987, were apparently redistributed to the PIs (this is not clear from the Training Report although the guidelines are included in the report). The guidelines were the result of the development of CRSP projects as of 1987 to the point that training was no longer an essential priority in most projects. At that time, considerable training had been completed or was in progress and funding cuts from A.I.D. were forcing difficult choices between initiating new long-term training for students or investing potential training funds in research. It is unclear whether or not the guidelines actually limited the amount of training funded under the CRSP. Certainly, prior to 1987, larger numbers of students began degree programs with CRSP sponsorship. However, even with those guidelines, a total of 32 new students, supported fully or partially by CRSP projects that were in existence in 1987, have begun degree programs since 1987. The guidelines appear to be appropriate for many of the projects that have been a part of the CRSP since its inception and for those projects that have not had problems of turnover of Host Country scientists. However, the guidelines do not provide assistance to PIs who are beginning new projects or are working in Host Countries that are new to them and are therefore at a stage of having to help build Host Country research capacity. Similarly, the guidelines do not address the issues of Host Country scientist turnover and the resultant need to re-build Host Country research capacity in ongoing CRSP projects. It is especially appropriate that these issues be addressed at this time as the extension proposal is developed.

The Management Office initiated several studies related to training during FY 90. Each of these brings additional insight to the returns of training efforts to the CRSP as well as to Host Countries and their research capacity. Work by Dr. James Oehmke, Michigan State University agricultural economist, includes: "Impact Study of the Bean/Cowpea CRSP in Senegal" (completed), "Returns to Education: The Impacts of MSU Training of West African Scientists" (in draft), and a study of the impact of CRSP training in Malawi and Tanzania" (in process). The Management Office also completed a follow-up study of CRSP graduates. It is hoped that the results of all of these studies will find their way into policy guidelines for training in the CRSP as well as overall and specific project training plans.

WOMEN IN DEVELOPMENT:

The Women in Development program of the Bean/Cowpea CRSP has essentially served as the CRSP's social conscience and tie to many of the ultimate users and consumers of the technology developed through the CRSP. Additionally, the WID program has been a center for research related to women producers and other small-scale farmers.

I. PROGRESS DURING FY 90**A. Review of Extension Proposals and Annual Reports**

In support of the Technical Committee, Dr. Anne Ferguson, the CRSP WID Specialist, has been actively involved in the development of the extension proposal. Of special importance to the future of the CRSP are the plans included in the WID extension proposal which will include the following new activities:

1. Socio-Economic Impact Evaluation Model: The development of a model for socio-economic impact evaluation to provide researchers with ways to monitor the effects of their research and the accompanying technology development process in the Host Countries.
2. Participatory Research Strategies: The development of participatory research strategies to be used by CRSP PIs to provide ways for women and other farmers and consumers to have input into the early stages of research and technology development.

Dr. Ferguson also reviewed all of the project extension proposals with the Technical Committee. This process allowed her to play an important role in encouraging researchers to incorporate WID and other social science elements into their plans for the extension period.

Similarly, the WID Specialist participated in the Technical Committee's review of the FY 90 project annual reports.

Table 1 traces the reported incorporation of WID issues and concerns in each of the projects in the CRSP with a goal of showing the level of progress attained in each project and overall.

B. Direct Support to PIs

It is in Dr. Ferguson's direct work with the project PIs that the resultant infusion of WID and other social science concerns becomes especially apparent. The following reflect her direct project involvement during FY 90.

1. Ecuador/University of Minnesota/Graham: In support of this project which focuses on biological nitrogen fixation, the WID Specialist provided research reports on bean production and farming systems from the previous Ecuador/Cornell University project. Dr. Ferguson has also (a) consulted with two graduate students at the University of Minnesota who are working with the project and gathering information on soils and farming practices in Ecuador and (b) been

involved in efforts to identify resource people in Ecuador to work with the project.

2. Nigeria/University of Georgia/McWatters: This project, which focuses on food technology, is in the process of reorganization, a search for a new Host Country, and ultimately the establishment of a new research agenda. Dr. Ferguson has worked with the U.S. PIs in drafting their extension proposal to include the identification of key constraints to cowpea processing and use. It is anticipated that Dr. Ferguson will continue to work with the project with a special focus on institutionalizing WID and social science perspectives when a new Host Country and research topics are identified.
3. Senegal/University of California-Riverside/Hall: Dr. Ferguson has been working with the researchers on this project to initiate an examination of the impact of project technologies in Senegal. Considerable progress has been made toward this goal with an ISRA researcher, Dr. Seynabou Tall, having conducted a survey to examine the adoption of the cowpea Mini-Kits. The survey is currently being analyzed, and it is anticipated that the socio-economics of improved cowpea storage methods and of fresh pod production (in relation to both class and gender issues) will be a part of Dr. Tall's work.
4. Tanzania/Washington State University/Silbernagel: In the transition of replacing the previous U.S. Co-PI, Dr. Jean Due, with Dr. Lorna Butler, the WID Specialist has been actively involved in sharing documentation of past project activities. Additionally, Drs. Ferguson and Butler worked together in developing and presenting a participatory research workshop for agricultural scientists from Tanzania and Malawi at the close of the joint Bean/Cowpea CRSP-Sokoine University, CIAT/SADCC Bean Workshop, September 24-25, 1990.
5. Cameroon/Purdue University/Murdock: Dr. Ferguson has continued to work with the Cameroon/Purdue University researchers who are conducting surveys of cowpea storage practices and forming a panel of farmers to evaluate project technologies.

C. Training Workshops, Conferences and Publications

1. Participatory Research Workshop: The participatory research workshop presented by Drs. Ferguson and Butler appears to have been the beginning of this focus which was mentioned previously.
2. Other Presentations and Publications:

Presentations:

"Component Breeding: A Strategy for Bean Improvement in Eastern Africa and Other Regions Where Beans Are Grown as Mixtures." Paper co-authored with Susan Sprecher and presented at the First SADCC Regional Bean Research Workshop, Mbabane, Swaziland, October 4-7, 1989.

"Agriculture and Nutrition in Malawi: Exploring the Links." Paper co-authored with Ann V. Millard and Stanley Khaila and presented at the American Anthropological Association Symposium: Agriculture and Nutrition: Exploring the Links (organized by Ferguson and M. Graham), Washington, DC, November 1989.

"So the Grandparents May Survive: Farmer Participation in Bean Improvement in Malawi." Paper presented at the Ninth Sokoine University of Agriculture--Bean/Cowpea CRSP and Second CIAT/SADCC Bean Research Workshop, Morogoro, Tanzania, September 17-22, 1990.

Publications:

The Women and International Development Annual, Vol. 1. Edited with Rita S. Gallin and Marilyn Aronoff. Boulder, CO: Westview Press, 1989.

"Women and International Development: Creating An Agenda." Co-authored with Rita S. Gallin and Marilyn Aronoff. In Rita S. Gallin, Marilyn Aronoff and Anne Ferguson (eds.), The Women and International Development Annual, Vol. 1. Boulder, CO: Westview Press, 1989, pp. 1-24.

Accepted for Publication:

Harvest of Want: Struggles for Food Security in Mexico and Central America. Edited with Scott Whiteford. Boulder, CO: Westview Press.

"Social Dimensions of Food Security and Hunger: An Overview." In Harvest of Want: Struggles for Food Security in Mexico and Central America. Edited with Scott Whiteford. Boulder, CO: Westview Press.

The Women and International Development Annual, Vol. 2. Edited with Rita S. Gallin. Boulder, CO: Westview Press.

"Gender, Class and Ethnicity: Exploring the Links." In The Women and International Development Annual, Vol. 2. Edited with Rita S. Gallin. Boulder, CO: Westview Press.

"Crop Improvement Programs and Nutrition in Malawi: Exploring the Links." Co-authored with Ann Millard and Stanley Khaila. Food and Nutrition Bulletin.

II. FUNDING FY 90

No funding or fiscal management issues were mentioned in the Annual Report.

III. PLANNING

Primary efforts for FY 91 and the project extension focus on much-needed development of a model of socio-economic impact evaluation and participatory research strategies to be used by CRSP PIs and others. Both of these elements are extremely important if the Bean/Cowpea CRSP is to continue its successful incorporation of WID and social science elements in its projects. Additionally, many projects which had not previously shown an interest in these areas are beginning to do so while others are moving rapidly toward the need for farmer field trials and even dissemination of technology. The need for these tools will be even more crucial in the next project extension.

IV. STATUS IN FY 90

Dr. Ferguson's work in the CRSP has been excellent. She seems to have been able to move from the status of a single voice encouraging social science involvement to an expert in great demand in a variety of projects. The continued growth of incorporation of WID and social science elements in the CRSP is excellent. However, there are tools to be developed that are essential to the institutionalization of these elements in the total CRSP. These tools certainly include the model of socio-economic impact evaluation and participatory research strategies proposed for development in the next extension.

V. OVERALL RATING: 1—Highly Satisfactory

TABLE 1
BEAN/COWPEA CRSP PROGRESS IN WID/SOCIAL SCIENCE INTEGRATION

PROJECT	LEVEL OF WID INCORPORATION, 1989 EXTENSION PROPOSAL	CURRENT LEVEL OF WID AND SOCIAL SCIENCE INCORPORATION	REPORTED PROGRESS MADE, 1990	PROGRESS NEEDED
CAMEROON/ PURDUE UNIVERSITY	<ul style="list-style-type: none"> •Not applicable 	<ul style="list-style-type: none"> •Recognition of the roles of women; •Incorporation of early input from women and other farmers in technical design and evaluation; •Excellent incorporation of WID/social science to date. 	<ul style="list-style-type: none"> •Recognition of women's roles; •Incorporation of ideas gained from understanding of farmers into research plans. 	<ul style="list-style-type: none"> •Maintain current level of commitment; •Consider greater focus on farmer selection criteria in future research; •Very important to consider issues related to release of genetically engineered products in Host Countries--an issue for the total CRSP.
DOMINICAN REPUBLIC/ UNIVERSITY OF NEBRASKA	<ul style="list-style-type: none"> •Assumption that new technology will be adopted and will result in increased production; •No other mention of WID or social science issues. 	<ul style="list-style-type: none"> •Clear concern for and interest in including women in training activities; •Virtually no incorporation of social science in research process; •Minimal effort to involve farmers and consumers in process of technology development and evaluation. 	<ul style="list-style-type: none"> •Assumption that new technology will be adopted and will result in increase production; •Record of involvement of women scientists in the project as well as training of women. 	<ul style="list-style-type: none"> •Maintain level of including women in training activities; •Consider integration of farmers and consumers into the research process, perhaps through use of participatory research methodologies; •There is a great deal of dependency on faith that adoption of new technology will occur.
DOMINICAN REPUBLIC/ UNIVERSITY OF WISCONSIN	<ul style="list-style-type: none"> •Not applicable. 	<ul style="list-style-type: none"> •Clear concern for and interest in including women in training activities. 	<ul style="list-style-type: none"> •Training of women; •Discussions with an unidentified number of individuals during a field trip to the DR regarding ultimate adoption of the project's technology. 	<ul style="list-style-type: none"> •Maintain level of training for women; •Short interviews in the DR do not assuage concern over testing and release of genetically engineered products in Host Countries--an issue for the whole CRSP.

PROJECT	LEVEL OF WID INCORPORATION, 1989 EXTENSION PROPOSAL	CURRENT LEVEL OF WID AND SOCIAL SCIENCE INCORPORATION	REPORTED PROGRESS MADE, 1990	PROGRESS NEEDED
ECUADOR/ UNIVERSITY OF MINNESOTA	•Not applicable.	•Currently there is no incorporation of WID or other social science into the project and no anticipation of the need to understand issues related to cultivar acceptability; •Concern for and interest in including women in training activities and including women scientists in project.	•Training of women and the involvement of women scientists in the project; •Some plans for an increased focus on WID in 1991.	•Seems to be a significant need for greater understanding of cultivation practices of small-scale farmers and current cultural practices in anticipation of efforts to disseminate new technology.
HONDURAS/ UNIVERSITY OF PUERTO RICO	•Assumption that new technology will be adopted and will result in increased production.	•Appears to be an awareness of the constraints faced in small-scale farmer bean production.	•Collaboration with the National University of Honduras to focus on measures of acceptance of new bean varieties.	•With a move toward inclusion of farm trials in research activities, may need to become familiar with participatory research methodologies.
MALAWI/ MICHIGAN STATE UNIVERSITY	•Social science and WID elements were evident throughout the extension proposal.	•WID has been included as a focus of this project since its inception; •The WID/social science focus has included gender division of labor and decision-making, and farmer's varietal preferences.	•The roles of women in bean production are stressed; •Participatory research methodologies are being used to gain additional information so research results will assist women and small-scale farmers.	•Maintain current level of progress.
MEXICO/ MICHIGAN STATE UNIVERSITY		•Minimal incorporation of WID or other social science elements into this project.	•No report on WID; •No integration of social science reported.	•There is a need for greater farmer involvement in the research effort; •Consideration of the culinary characteristics of the various varieties produced is important and will provide crucial information to breeders.

PROJECT	LEVEL OF WID INCORPORATION, 1989 EXTENSION PROPOSAL	CURRENT LEVEL OF WID AND SOCIAL SCIENCE INCORPORATION	REPORTED PROGRESS MADE, 1990	PROGRESS NEEDED
NIGERIA/ UNIVERSITY OF GEORGIA	<ul style="list-style-type: none"> •WID and social science element were evident throughout the extension proposal. 	<ul style="list-style-type: none"> •Researchers have incorporated social science elements into their research, including socio-economic baseline data; •They have expressed an interest in incorporating similar information in their new Host Country efforts. 	<ul style="list-style-type: none"> •Acceptability tests of new products involving rural women and low-income families; •Overall focus on lessening the labor burden in food preparation by women. 	<ul style="list-style-type: none"> •Important to bring this level of interest to the new Host Country when that is determined; •Should consider a budgetary allocation for coordination of social science/WID research within the project.
SENEGAL/ UNIVERSITY OF CALIFORNIA- RIVERSIDE		<ul style="list-style-type: none"> •Much progress has been made in efforts to incorporate WID and social science issues in the research during this extension period. 	<ul style="list-style-type: none"> •An economist from the Farming Systems Department at ISRA was seconded to the project during 1989 and a sociologist was hired in 1990 to focus on WID; •With staff available, socio-economic studies will consider acceptability of new cowpea strains, effectiveness of storage methods, and significance of consumption and marketing of fresh cowpeas; •The project has collaborated with the Senegal Food Technology Institute on food quality evaluations of advanced lines. 	<ul style="list-style-type: none"> •The Mini-Kit trials seem to be the perfect tool for incorporating greater farmer involvement and decision-making into the research effort through the application of participatory research methodology.

PROJECT	LEVEL OF WID INCORPORATION, 1989 EXTENSION PROPOSAL	CURRENT LEVEL OF WID AND SOCIAL SCIENCE INCORPORATION	REPORTED PROGRESS MADE, 1990	PROGRESS NEEDED
TANZANIA/ WASHINGTON STATE UNIVERSITY	•WID and social science issues were an integral element of the extension proposal.	•The project has included a social science component since its inception and has an excellent record of training women researchers and students.	<ul style="list-style-type: none"> •The project reports farmer participatory research/on-farm trials and a new smallholder farmer on-station program; •The ongoing commitment to WID and small-scale producers is reiterated; •An agricultural anthro- pologist has been appointed 25% time to the project and has already been involved in work in Tanzania including a workshop on participatory research methodology. 	•Maintain excellent level of incorporation of WID and social science issues in the project.

IV. PROGRAM EVALUATION: FISCAL AND ADMINISTRATIVE

After a decade of operations, the Bean/Cowpea CRSP has settled into a pattern of standard operating procedures that conform to U.S. Government grant guidelines and acceptable accounting practices and facilitate achievement of the CRSP's objectives.

With regard to fiscal matters, a budget process has been developed through trial and adjustment which works well for this CRSP (i.e., the participating U.S. and HC institutions and PIs). The process is now in place and it is routine, efficient and fair. Its notable features include: (1) adjustment and accommodation to the vagaries and unpredictabilities of A.I.D. financing; (2) maximum participation of CRSP entities (i.e., TC, BOD, PIs and MO/ME); (3) timely release of funds and timely receipt of expenditure reports; (4) up-to-date monitoring of the flow of funds; and (5) flexibility to transfer unspent funds to points of need within the system.

On the administrative side, the Management Office, which handles the day-to-day affairs of the CRSP, is minimally staffed with a Program Director, Deputy Director, Administrative Officer and a Secretary (3.65 FTEs) with social science, biological science and financial-administrative competence. In previous EEP reports, it has been noted that the MO capacity has been so limited that the monitoring of research and administrative aspects of projects has been marginal in our opinion. We now note that in FY 90, additional significant work has been asked of, and delivered by, the MO. These include leadership and legwork in organization, operation and support for the CRSP Council; participation in the planning of a Sustainable Agriculture and Resource Management CRSP; leadership and support in generation and implementation of buy-ins; responsibilities connected with planning and implementing impact studies; leading the development of documentation for information activities with A.I.D., the Congress and others; a major audit and follow-up activity in one project; and the organization of a major Bean/Cowpea CRSP conference that resulted in a report of ten years' accomplishments by the CRSP. We note that these extras were taken on without added human resources and were accomplished with but one or two glitches in the conduct of the basic administrative operations of the MO. These extras were performed by further stretching an already thin MO operation, and we commend the staff for going the extra mile. However, we believe that this stretching cannot continue indefinitely. Further, we believe that the extras that the MO will be called upon to do will, if anything, increase. We thus urge the BOD and A.I.D. to take cognizance of this situation and elect appropriate actions to adjust thereto.

EEP members, including the Chairperson, visited the Bean/Cowpea CRSP Management Entity/Management Office during FY 89. There is evident commitment and support for the Bean/Cowpea CRSP at all levels of Michigan State University. This has been, and is being, reflected in MSU's staffing and administrative support for the Management Office and in the overall operation of a highly successful CRSP.

Overall Rating: 1—Highly Satisfactory

V. PROGRAM EVALUATION: PROJECT RATINGS

A. Bases for Evaluation: Rating Categories/Format

Using guidelines provided by BIFAD and A.I.D., a Scope of Work was prepared which provided for evaluation of progress, funding, plans, and status/prospects for each CRSP project (Attachment A). These criteria were assessed on the basis of reports submitted by the projects' Principal Investigators, site visits to HC institutions, data provided by the MO, and discussions with MO and A.I.D. officials. Numerical and adjective ratings are based on assessment of the criteria against the plans spelled out for FY 90.

<u>Category</u>	<u>Rating</u>
1	Highly Satisfactory
2	Satisfactory
3	Unsatisfactory

B. Summary of Ratings

Category 1: Highly Satisfactory
Cameroon/Purdue
Dominican Republic/UNL
Dominican Republic/UWI
Ecuador/UMN
Honduras/UPR
Senegal/UCR
Tanzania/WSU
Women in Development

Category 2: Satisfactory
Brazil/BTI
Guatemala/Cornell
INCAP/WSU
Malawi/MSU
Mexico/MSU
Nigeria/UGA

Category 3: Unsatisfactory
None

VI. THE FIVE-YEAR EXTENSION PROPOSAL

The EEP has studied the five-year proposal as currently conceived. We think it represents a logical and potentially productive next-phase of a much-needed program. We are pleased to note the intent to continue cowpea utilization research and food safety, food science and nutrition activities on beans. As noted elsewhere, we encourage integration of these activities with the production research of the CRSP insofar as it makes sense.

We have also noted elsewhere the need for continuing economics participation, again as an integrative activity. This would complement the current social science work of the leader of the WID program.

Following are project-specific comments concerning the extension:

Cameroon/Purdue/Murdock: This project has made exceptional progress in assembling baseline data, characterizing the problem, devising a strategy and developing highly practical technologies that provide viable options even for low-resource peasant farmers ahead of schedule. This promising technology requires further refinement and testing for at least the next two-three years. Simultaneously, the project has demonstrated the potential for enhancing seed and pod resistance to bruchids through genetic manipulation. At present there are excellent possibilities for conventional breeding approaches (recombining the best varietal sources of resistance with adapted materials), wide crossing (between wild and cultivated species) and genetic transformation by introducing alien genes into adapted cultivars. The expertise and methodologies developed could eventually be expanded to deal with other major insect problems of cowpeas like thrips, aphids, pod bugs, *Maruca* sp., and *Laspyresia* sp. We strongly support the proposed extension.

Dominican Republic/UNL/Coyns: This project has been quite productive both for the HC and for the U.S. We commend the excellent collaboration between the U.S. and HC scientists and institutions and the inter-project cooperation with the Honduras/UPR and DR/UWI projects. We take some exception to the TC comments concerning duplication with the Honduras project. We see these efforts as fully cooperative and collaborative and would not favor placing constraints on those engaged in multiple disease investigations in these projects. We do concur with the TC comments concerning regional emphasis (consonant with Honduras/DR and other collaboration) and attention to participatory research. We strongly support continuation in the five-year extension.

Dominican Republic/UWI/Maxwell: The EEP commends the project for past efforts and strongly supports continuation with substantially enhanced funding in the five-year extension of the CRSP. Host Country collaboration and a significant training budget are notable needs to more fully capitalize on the UWI efforts. A.I.D., the MO and UWI need to begin now to prepare for movement of transgenic plant materials that will be generated in this project within the next grant period.

Ecuador/UMN/Graham: The EEP commends this project for the rapid and excellent start-up it has made and strongly supports its continuation, with substantially enhanced funding, in the five-year extension.

Honduras/UPR/Beaver: The EEP is in general agreement with TC findings and recommendations and supports inclusion in the extension. However, we do not agree with the recommended narrowing of focus. This policy is unrealistic in situations where four or five diseases are prevalent. Their relative importance may change from year to year and/or location to location, and a primary goal of the program is development of multiple disease resistance. Under these circumstances, in both the HC and U.S., individual projects are obliged by their constituents to address all primary deterrents to production within the limits of their capabilities. Of course, some more basic studies on particularly intractable problems (e.g., BGMV) requiring highly sophisticated procedures and facilities can only be carried out by laboratories with appropriate capabilities.

Malawi/UCD/Gepts: The EEP supports the extension of this project and concurs fully with the TC's evaluation of the five-year extension proposal. They found the extension proposal to be an excellent blend of biological, social science and field research and commended the project for its combination of fundamental and applied science.

Mexico/MSU/Kelly: The project made good progress in terms of developing useful farm technology (new varieties). However, there is no convincing evidence that the improvements observed are attributable to increased tolerance to drought but may result from enhanced adaptation to the unique conditions of semiarid highlands and disease resistance incorporated through the breeding process.

The extension period will allow the project to focus anew on the unique production problems of the semiarid highlands; to address the bean plant responses to limited and erratic rainfall conditions, separately from soil and disease effects; and genetically enhance new germplasm for improved performance under prevailing conditions of disease—including root rots, drought, low temperatures and other undefined soil problems. The EEP was impressed with the overall scope and progress of the HC activities and recommend continuation of the project during the 1992-97 extension.

Senegal/UCR/Hall: The EEP commends this project for its consistent productivity; its holistic approach to cowpea research, including collaboration with other institutions (i.e., IITA, SAFGRAD, CILSS, the Cameroon, etc.); and its training and institutional development activities in Senegal. We think the project has maximized use of resources available to it. We think it is a key element in the five-year extension and urge its inclusion.

Tanzania/WSU/Silbernagel: The EEP supports the extension of this project. Although the TC has concerns about the holistic approach, the EEP believes that this project has an excellent potential for development of an integrated production/utilization project with regional impacts at Sokoine. The EEP supports the continued development of a strong socio-economic component in the extension proposal.

WID/Ferguson: The EEP supports the continued inclusion of the Women in Development component in the five-year extension proposal. We are extremely supportive of the development of a socio-economic impact evaluation model and of participatory research strategies to be used by PIs in the extension. We support additional funding for WID (with the possible inclusion of additional personnel at the project level) for these activities as well as the growing

project involvement of the WID Specialist. The strength of WID activities in the Bean/Cowpea CRSP has been an asset to the total program and has progressed admirably to be an integral element in the CRSP's past and future success.

Training: The EEP supports the inclusion of training as a critical part of the five-year extension proposal. It is crucial for the extension proposal to include a clear analysis of training-related issues which will be important to the continued success of the CRSP. It should also include a concise policy for dealing with those issues, including: (1) training requirements of new vs. sustained projects; (2) training policies related to actual or anticipated Host Country turnovers; and (3) training as a tool in developing depth of Host Country leadership, especially in countries where the Host Country PIs are being promoted in their own research systems, thus losing their ability to provide significant time to the CRSP.

ATTACHMENT A

FY 90 EXTERNAL EVALUATION PANEL SCOPE OF WORK

I. PROGRESS DURING FY 90

- A. Specific research contributions in FY 90 toward amelioration of national (HC and U.S.) and global constraints. Cite constraint and specific contribution, with special regard to the following:
1. Research in process in Host Country and in U.S.
 2. Research results disseminated and currently in use in Host Country and U.S. Give examples such as:
 - a. Improved cultivars; inoculants; tests; methods; systems; and technical papers, reports and bulletins produced and released for public use.
 - b. Evidence of extent of use to date.
 3. Other research-related results, such as:
 - a. Germplasm conservation and use.
 - (1) Accessions collected/acquired/in storage and kinds and amounts distributed domestically.
 - (2) International exchange.
 - b. Seed production (or other materials) and distribution of CRSP-produced cultivars (or materials).
 - c. Impact of other CRSP-produced or -recommended technology, including production inputs such as fertilizers, inoculants, insecticides, equipment and machines.
 - d. Project impact on production and consumption of beans and cowpeas (e.g., on-farm trial results and/or changes in production statistics on development and adoption of new products or processes).
 - e. How the research findings specifically address the needs of small-scale farmers and women.
 4. Changes in national production of beans and cowpeas in Host Country:
 - a. Hectares planted.
 - b. Yields per hectare.
 - c. Total production.

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- B. Institutional development and training, i.e., strengthening Host Country bean and/or cowpea research and improvement systems.
 - 1. Cite the changes since FY 89.
 - 2. Over life of project (where are we?).
 - 3. In prospect (where are we going and how long to get there?).
 - 4. Project training to be completed by the end of this extension period (1992).

- C. Progress achieved in relation to the objectives stated in the Extension Proposal log frame.
 - 1. How long has this CRSP project been engaged in the lines of research addressing these objectives?
 - 2. What were the original time estimates for achieving the objectives of the research referred to in Item 1 above?
 - 3. Estimated time remaining to achieve the objectives referred to in Item 2 above. Is the project on schedule, ahead of schedule or behind schedule? Give reasons/explanations.
 - 4. Relation of the lines of research referred to in Item 1 to other research being conducted in and/or by the Host Country, other countries and the IARCs. Complementary/supplementary? Duplicatory? Unique? Please describe and explain/justify, if necessary.
 - 5. Give an update on the likely contribution of the lines of research to the Host Country. To the U.S. To amelioration of global constraints.

- D. Evidence of biological/social sciences integration.
 - 1. Identification of and attention to relevant WID issues.
 - 2. Identification of and attention to other social and/or food science issues (or production issues if not production project).

- E. Collaboration with other Bean/Cowpea CRSP projects, linkages with other CRSPs, and other external groups not included in C.4. above.

II. FUNDING/FISCAL MANAGEMENT IN FY 90

- A. Audit/project management reviews.
 - 1. Date, by whom, and findings and follow-up.
 - 2. If no audit, has one been requested?

- B. Adequacy of funding (to accomplish objectives) from:
 - 1. A.I.D.
 - 2. Host Country--comments/actions.
 - 3. U.S. university--comments/actions.
- C. Problems regarding funding, budgeting, release of funds, procurement and other--in U.S. and Host Country.
- D. Adequacy of current management, policies and procedures (especially regarding follow-up on use of funds and use of equipment).
- E. Activity towards buy-ins and/or other funding.

III. PLANNING

- A. Review of FY 90 workplan during FY 90.
Adjustments/changes/additions/ deletions--ME notified? TC?
- B. Plans for FY 91.
 - 1. Research in Host Country and U.S.
 - 2. Expected changes/additions/deletions from FY 90 regarding funding, personnel, research activities, commodities or other and their reasons
(i.e., availability of funds; failures; marginal activities; inadequate performance; unrealistic plans).

IV. STATUS IN FY 90

- A. Appropriateness of activities to goals of Global Plan.
- B. Balance between research and training.
 - 1. Give expenditures for research and training in FY 90.
 - 2. Relate these expenditures to research and training plans for FY 90, made in FY 89.
- C. Balance of domestic vs. overseas activities with respect to program constraints.
- D. Level of collaboration/cooperation between U.S. and Host Country institutions and personnel.
 - 1. Describe the process/procedures followed for:
 - a. Research planning for FY 90.
 - b. Preparation of budgets for FY 90.

- c. Decisions regarding training CRSP personnel in FY 90.
- d. Decisions regarding publications/presentations in FY 90.
- E. Relative contributions of collaborating institutions and individuals towards accomplishment of objectives.
 - 1. Give U.S. (U.S. university and A.I.D.) and Host Country contributions to the FY 90 budget. Note whether the HC and U.S. university contributions were in-kind or cash.
 - 2. Other contributions by HC institution(s).
 - 3. Other contributions by the U.S. institution.
 - 4. Relate above to item G below regarding cost effectiveness.
- F. Interest, involvement and support of USAID Mission and/or U.S. Embassy.
- G. Cost effectiveness, especially regarding level of activity vs. funding.
- H. Evidence of institutionalization in Host Country/in U.S.
 - 1. Faculty recognition for international activities.
 - 2. Integration of domestic and international commodity research programs with CRSP projects.
 - 3. Internal project management and institutional management support.
 - 4. Student/professor interactions.
- I. Other comments.

V. PUBLICATIONS AND PRESENTATIONS IN FY 90

VI. OVERALL RATING

- A. General strengths
- B. General weaknesses
- C. Recommendations

ATTACHMENT B

FY 90 EEP SITE VISIT OUTLINE

1. Project Progress
 - a. Adherence to log frame and project objectives
 - b. Research achievements in FY 90
 - c. Expected additional research achievements within the next twelve months
 - d. Adjustments made as a result of research findings including:
 - (1) Changes in research direction
 - (2) Counter-productive efforts identified and terminated
 - (3) New efforts initiated based on prior results (next steps begun)
 - e. Future research needs
 - f. Training achievements in FY 90
 - g. Expected additional training achievements within the next twelve months
 - h. Future training needs
 - i. Appropriateness of social science/WID/food and nutrition attention in project research
 - j. Appropriateness of research to small-scale farmer and impact on small-scale farmer to date, kinds of actions taken, options available for research dissemination
 - k. *Recommendations to be discussed by EEP*
2. Personnel
 - a. Paid/unpaid
 - b. Adequate number and type?
 - c. Involvement of women
 - d. Effectiveness
 - e. Level of U.S./Mission team communication
 - f. *Recommendations to be discussed by EEP*
3. Equipment and Facilities
 - a. Availability—reason for unavailability
 - b. Adequacy—reason for inadequacy

c. Measures in process or needed to correct problems

d. *Recommendations to be discussed by EEP*

4. Funding

a. Extent of HC contribution and impact

b. History of CRSP A.I.D. funds in HC and impact in HC and region

c. Additional adjustments that could be made if future funding reductions

d. Other funds complementing CRSP projects

e. *Recommendations to be discussed by EEP*

5. Administration of Project

a. Government level

b. Institutional level

c. Fiscal management procedures

d. Impact of budget reductions

e. *Recommendations to be discussed by EEP*

6. USAID Mission Involvement

a. Mission understanding and backing of project objectives

b. Mission financial logistic and programmatic support of project

c. Mission interests for project future

d. *Recommendations to be discussed by EEP*

7. Linkages

a. Host Country agencies and organizations, including extension

b. International agencies and organizations

c. *Recommendations to be discussed by EEP*

8. Summary

a. *Specific project strengths*

b. *Specific project weaknesses*

c. *Reviewer comments*

FY 90 EEP REVIEW

BRAZIL • BOYCE THOMPSON INSTITUTE • ROBERTS

Insect Pathogens in Cowpea Pest Management Systems for Developing Nations

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

- a. Control of *Empoasca* leafhoppers with *Zoophthora radicans*: Laboratory tests initiated in 1989 to determine the effect of temperature on spore germination and the host invasion process were completed and the data analyzed. Lack of high temperature, wind and drought tolerance lessens (or eliminates) the applicability of the technology in the warm tropics. Although the report notes that the results of these tests might encourage an attempt to identify strains to be used in the warm tropics by selecting for germination at high temperatures; instead, field trials in beans were conducted in southern Brazil where environmental conditions are more favorable to disease transmission than in the northeast. Though trials in the south were successful, there has been no success in applying the technology to cowpeas in northeast Brazil.
- b. Control of the cowpea curculio with *Metarhizium anisopliae* and *Beauveria bassiana*: A low-cost, low-technology method has been developed for biological control of *Chalcodermus* weevils and is currently being tested in field trials. Control has consistently been at the level of 30-50 percent. However, there are insufficient data available to determine economic feasibility.
- c. Control of bruchid beetles in stored cowpeas with *Beauveria bassiana* and *Metarhizium anisopliae*: Recently completed tests showed that fungal treatments provided levels of control nearly equal to a commercially produced pesticide, Vertimec.
- d. Biology of *Cerotoma arcuata*: In continuing research on these important cowpea and bean defoliators, FY 90 laboratory studies revealed that the larval stage has three instars and that females produce a mean of 1,291.6 eggs. Mean longevity of females under laboratory conditions is 68 days and of males is 69 days.

- e. Compatibility of entomopathogenic fungi with chemical insecticides: The effects of several insecticides on two of the most likely fungi for insect control were tested under laboratory conditions.
 - f. Control of cowpea/cotton intercrop pests with *Beauveria bassiana*: At the request of Host Country counterparts, laboratory tests were conducted to determine the susceptibility of the cotton boll weevil to *Beauveria bassiana*. Tests indicated susceptibility. In field trials, the fungus alone was not effective against the boll worm but it was successful when combined with a pesticide and would possibly allow for a reduction in the amounts of pesticide used.
2. Research results disseminated and in use in the U.S. and HC
- a. Control of *Diabrotica* larvae with *Beauveria* and *Metarhizium*: Improvements were made on bioassay techniques for applying *M. anisopliae* and *B. bassiana* conidia to *Diabrotica* larvae. The new techniques allow for accurate determination of dosage rates.
 - b. Storage of dry mycelial particles: Study results are promising in relation to the potential for industrial-scale development of mycelial particles as a practical form of inoculum. However, studies are not yet complete.
 - c. Control of scarab grubs with *Metarhizium* and *Beauveria* mycelial particles: Bioassay of different types of inoculum against Japanese beetle grubs showed that mortality occurred significantly quicker in mycelium compared to conidia-treated soil.
3. Other research-related results
- a. Germplasm conservation and use: Ten strains of entomopathogenic fungi were added to the IPRC/Brazil germplasm collection during the year.
 - b. Seed production (or other materials): No comment.
 - c. Impact of other CRSP technology: Other technology developed include methods for mass production of fungal pathogens and the design of a spray-application chamber. The impact of the former is unclear in the annual report. In the case of the spray-application chamber, several have been built and are in use in Brazil.
 - d. Impact on production and consumption of beans/cowpeas: No comment
 - e. Needs of small-scale farmers and women: It is, to date, unclear whether or how the technology developed in this project will address the needs of small-scale farmers and women. FY 90 marked the first effort of the project to

examine the socio-economic issues that might have an impact on the acceptance of technology developed by the project. Additionally, many of the advances made through project research are a long way from actual use in farmers' fields, and those that have been especially successful are not well suited to the ecological areas of Brazil where the small-scale farmers are predominant.

4. Changes in national production in Host Country

All proposed technologies are still in the experimental stage and have had no impact on production.

B. Institutional Development and Training

1. Changes since FY 89

The past year seems to have included a beginning focus on the institutionalization of research capacity in the State of Ceará, the major cowpea-producing state in Brazil. Major efforts include an upgrading of the research laboratory at Pitaguari near Fortaleza.

In FY 90, Mr. Bonifacio Magalhães completed his doctoral program at Cornell/BTI and returned to Brazil and his position as HC PI.

2. Over life of project

Institutional development activities have included the establishment of two microbial control units in Brazil teamed with project training. Training has included short courses for more than 100 agronomists as well as long-term degree training (5 M.S., 2 Ph.D.).

3. In prospect: No comment

4. Project training to be completed by end of extension period

The two remaining CRSP-supported graduate students will complete their degrees in FY 91.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

The focus of this research has not changed since 1982.

2. Original time estimates for completion

Objectives were planned to be met at the end of FY 91.

3. Progress in relation to proposed schedule

Researchers anticipate that they will have achieved their objectives at the end of FY 91. However, this assumption is based on scientific developments and not on the application of those developments and resultant technology to small-scale farmers in the northeast of Brazil. No doubt, the process of technology development has been excellent. However, the focus on the end users of that technology has only just begun.

4. Relationship to other research

The annual report noted that this group is the only group in the world working on the microbial control of cowpea pests.

5. Contribution of lines of research to HC, U.S. and globally

Clearly, there has been an acceptance of this research topic and its role in an integrated pest management system in Brazil. The institutionalization of the process and the expertise will certainly be a plus to Brazil. On the other hand, the actual adoption of technology from the project seems to be so far in the future, and the level of knowledge about the potential adopters of the technology is so small, that it is impossible to predict what contribution might be made by the research and technology themselves.

D. Evidence of Biological/Social Sciences Integration

FY 90 marked one of the first efforts to focus on social science within the project. A rapid rural appraisal was conducted in Ceará State with a focus that included production systems and socio-economic variables. The research results were presented as baseline data to be used to assess the impact of new technologies on small-scale farmers and women.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

Working relationships exist with the USDA Plant Protection Research Unit at Cornell; CIAT; and Host Country researchers in Ceará State, Brazil that were mentioned earlier.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews: None

B. Adequacy of Funding by CRSP Participants: All adequate

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.: None

D. Adequacy of Current Policies and Procedures: Adequate

E. Activity Toward Buy-Ins and/or Other Funding: None

III. PLANNING

- A. Review of the FY 90 Workplan: Not included in annual report
- B. Plans for FY 91: Not included in annual report

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

The concept of developing insect disease agents for use in integrated pest management efforts is certainly appropriate to the goals of the Global Plan. Similarly, the research activities conducted in this project have been appropriate. It is the lack of inclusion, until relatively recently, of the social science elements of the adoption process that could confound the dissemination of any new technology that provides a rift between this project and the goals of the Global Plan.

B. Balance Between Research and Training

Excellent—This project will leave an institutionalized research capacity in the Host Country because of the level of attention paid to long- and short-term training.

C. Balance of Domestic vs. Overseas Activities

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Cooperation and collaboration has been good, especially with EMBRAPA/CNPAF and BTI. It is unfortunate that collaboration with EPACE, in the area of Brazil in which cowpeas are grown and in which small-scale farmers are in the greatest need of assistance, has only just begun.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

This is reported as having been appropriately balanced throughout the life of the project.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy: None

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding: Not reported

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

Dr. Donald Roberts, the U.S. PI, was awarded the L. O. Howard Distinguished Achievement Award by the Eastern Branch of the Entomological Society of America in October 1989—largely in recognition of his international accomplishments.

2. Integration with domestic and international commodity research programs

The activities of BTI are integrated with the research program of the USDA Plant Protection Research Unit located on the Cornell University campus. The laboratories established and assisted in Brazil are important parts of their national and state programs.

3. Internal project management and institutional management support: Excellent
4. Student/professor interactions: Excellent

V. PUBLICATIONS AND PRESENTATIONS

U.S.: Eight research papers/reviews; eight presentations/abstracts
HC: Seven research papers/reviews; four presentations/abstracts

VI. OVERALL RATING: 2—Satisfactory

- A. General Strengths: No comment
- B. General Weaknesses: No comment
- C. Recommendations

It has come to our attention that Dr. S. Singh at IITA has an interest in the organisms developed in this project. We suggest that the organisms be made available for incorporation into the collection at IITA.

FY 90 EEP REVIEW

CAMEROON • PURDUE UNIVERSITY • MURDOCK

Preservation of Post-Harvest Cowpeas by Subsistence Farmers in Cameroon

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

The Cameroon/Purdue/IRA CRSP project was initiated on March 1, 1987. Allowing for start-up, the project has been active for only about three years. Nonetheless, much has been accomplished toward mitigating insect-caused losses to cowpeas in storage during this short period. The strategy adopted has been to first understand the problem and then to devise practical approaches to alleviating in-storage losses from insects: primarily *Bruchidius atrolineatus* and *Callosobruchus maculatus*.

From the outset, it was recognized that the problem was complex and poorly understood, including poor producer/consumer awareness and attitudes about in-storage losses, the insects involved and the post-harvest storage practices in the region (northern Cameroon). Therefore, a series of studies and surveys were carried out for three to five weeks of the cowpea storage season during the first three years of the project. The surveys were conducted by Dr. Jane Wolfson of Purdue University in collaboration with IRA scientists, and have now been completed and analyzed. Concurrently, investigations have begun on developing improved technologies for reducing storage losses, such as: solar disinfestation, insect deterrents (ash, biologicals, insecticides), containerization (drums, double bags, etc.) and breeding for pod/seed resistance. The results are briefly summarized below.

- a. Observations on cowpea production and storage: Surveys and studies in northern Cameroon were carried out by Dr. Wolfson during December (year 1), January (year 2) and March (year 3) with the objectives of (1) characterizing cowpea storage conditions, (2) extending studies into Waza and further north, and (3) seeking further information on storage economics and losses. Interviews were carried out with 117 farmer households from which cowpea samples were collected, and 29 cowpea samples were purchased from 11 local markets. The areas studied included Maroua, Mokolo, Koza Mora and Bogo (first two years); and around Waza and north of Waza in 1990. Among the crucial findings were:

(1) Most farmers (102 out of 117) stored cowpeas on pole platforms (*dankis*) for varying periods after harvest:

- for 1-2 months = 39 percent
- for 3-5 months = 22 percent
- for 6 months or more = 28 percent

Insects were the key factor in moving stored cowpeas off *dankis*. Farmers not using *dankis* (15) treated for insect control immediately after harvest.

(2) Cowpeas are very important in the daily diet of farmers in the areas surveyed: 62 percent consume cowpeas every day and, of these, 91 percent eat them in both daily meals. Less than 20 percent consumed cowpeas less than four times a week. If the farmer runs out, 83 percent will purchase more cowpeas from the market if funds are available.

(3) Cowpea cropping practices studied indicated that individual households produced between 0.25 and 0.50 ha with larger households producing up to 1.0 ha. Of these, about one-fourth (27 percent) were grown as a monocrop and the balance intercropped with sorghum, millet or cotton. About 90 percent of the farmers rotated either their fields or rows within fields. About one-third (31 percent) of the growers applied insecticides to cowpeas in the field in two to ten applications usually using cotton insecticides (SODECOTON). Reasons for not using insecticides were: inaccessibility, lack of information, lack of cash, toxicity to companion crops (e.g., sorghum), and fear of toxicity.

(4) Insect damage in storage in samples collected ranged from negligible up to 97 percent of seeds having insect emergent holes. Best storage methods (lowest number of holes) were: storage in drums (airtight), with ash, with herbs and with insecticides (about 16 percent of farmers treated their seeds with insecticides). However, some untreated pods from *danki* storage suffered comparatively little damage.

(5) Farmer cowpea preferences and growing practices were studied in a second survey of seventeen villages in two major farming system zones by Dr. L. Kitch and Mr. G. Ntoukam. In this study, the near area planted to cowpea was 0.5 ha per farm unit. About 60 percent of the crop was interplanted with other crops. If monocropped, it was usually a bred variety (VYA, BR-1 or BR-2). The primary constraint to production was insects: 89 percent of the respondents said field insects are a problem, while 55 percent named storage insects.

Two-thirds of the farmers stored their crop for at least one month after harvest; and about 90 percent used some kind of treatment (34 percent use insecticides, 34 percent ash and 19 percent herbs). Most farmers preferred large white seeded types but some liked brown or red seeds (usually rough or wrinkled testas). Preferred pod types were long, large, non-dehiscent and white. About 80 percent of those surveyed used green cowpea leaves as a food (sauce) and 90 percent used the harvest aftermath for forage.

- b. Seed and pod resistance to cowpea weevil: There is increasing evidence that a reasonable level of weevil resistance occurs in some seed and pod types. The project proposes to combine these characters to reduce damage in storage. The IITA has developed several good resistant seed lines and also recognizes the importance of pod deterrence if the pod wall remains intact. Screening of thirty cultivars for pod wall antibiosis identified ten genotypes with intact pod mortality exceeding 95 percent. Factors related to desirable storage characteristics include: thick seed coat and cotyledon characters (e.g., hardness); pod wall thickness; breakage index; pod strength; pod/seed ratio; and seed cavity space. These factors correlated highly with total mortality and pre-establishment larval mortality.

A long-term breeding plan to combine desirable pod and seed resistance characters has been prepared by Dr. Kitch. Initial crosses have been made between five sources of resistance (IITA) and the Cameroon varieties VYA and Maroua 16. F₁s are being grown out to harvest F₂s by December 1990.

- c. Ash for preservation of cowpeas: The use of ash for cowpea storage is widespread in northern Cameroon. However, some farmers are not confident ash storage is effective. Studies to follow-up on this practice were carried out at Purdue and showed that:
- (1) Ash mixed with cowpeas arrested the development of the weevil; but complete cessation of weevils required 3 volumes of ash to 4 volumes of cowpeas.
 - (2) A 3 cm layer of ash on top of the container of stored seeds prevented reinfestation by weevils.
- d. Solar disinfestation of cowpeas: Previous experiments indicate that heating cowpeas to 57°C for a few minutes kills all stages of the weevil without affecting germinability or cooking time. Further studies by Mr. Endondo Chevalier showed that seed germination of CB5 was not significantly reduced by exposure to 80°C for one hour; but that germination was significantly reduced by exposure to 85°C or higher. These experiments will be continued using Cameroon-released varieties VYA, BR-1 and BR-2.

Recent studies on a simple solar heater demonstrated that two layers of plastic (black below the cowpeas; clear above), assembled in 3 m x 3 m sheets, will generate sufficient heat to treat 50 kg of cowpea seeds at a temperature of 70°C.

- e. Evidence of extent of use to date: Promising technologies will be tested under farmers' conditions to compare four treatments: ash storage, solar disinfestation followed by triple bagging (clear plastic bags), triple bagging (no solar treatment) and long-term *danki* storage of BR-2 which has breakage resistant pods and seed resistance. These will be compared with a local method in each village. Recommendations will be formulated and disseminated based on results of these studies.
2. Research results disseminated and in use in the HC and U.S.:
None as yet
 3. Other research-related results
 - a. Germplasm conservation and use: Seed resistance bioassays were carried out on 166 Wolfson collections and produced 5 resistant lines (all derived from IITA's TVu2027). An additional large collection made by Dr. Kitch and Mr. Ntoukam was evaluated in Cameroon where eight promising genotypes were identified and sent to Purdue for further study.

A potentially very useful character (resistance to flower thrips) was also identified in some local collections made near Mayo-Oldeme, a remote area in the Mandara mountains, where insecticides are not used.

Pod resistance bioassays were carried out on 300 exotic and 150 local cultivars to screen for additional sources of pod resistance.
 - b. Seed production: This project has in the past assisted the Projet Semencier by supplying foundation seeds. However, virus infestation in the research plots has interrupted this activity. The project is currently attempting to produce virus-free seeds of the three IRA-released varieties for seed increase in 1991.
 - c. Impact of other CRSP technology: Interest has been expressed in using solar heating for other crops and utilizing the Purdue-developed biomonitor (detects live insect activity in seeds) for other research applications.
 - d. Impact on production/storage of beans/cowpeas: Surveys indicate that varieties recommended by IRA in northern Cameroon are being adopted by farmers (1 in 4). Results of investigations on insecticide use in the field are being shared with SODECOTON; but other findings are premature.

- e. Needs of small-scale farmers and women: The surveys carried out by Drs. Wolfson and Kitch point up the importance of cowpeas. Improved technology would be for these disadvantaged groups. In particular, ash storage and solar disinfestation is likely to have a major impact on small growers.

4. Changes in national production in Host Country: No data is available.

B. Institutional Development and Training

1. Changes since FY 89

The project is making good progress in developing a team of IRA researchers: entomologist, agronomist and breeder. Mr. Endondo Chevalier completed his M.S. degree in Agronomy (Advisor--Dr. Herb Ohm) at Purdue in August 1990 and returned to Cameroon. Plans are proceeding for Mr. Georges Ntougam to come to Purdue to commence studies on his Ph.D. in Entomology; and a cowpea breeder, Mr. Boukar Ousman, will work on cowpea breeding for resistance to storage pests with Dr. Kitch. Eventually Mr. Ousman will require higher training.

2. Over life of project

The objective of the project is to build a three-man scientific team that now appears to include: Mr. G. Ntougam, Entomologist; Mr. E. Chevalier, Agronomist; and Mr. B. Ousman, Cowpea Breeder.

3. In prospect

Immediate needs are to provide Ph.D. training for Mr. Ntougam and M.S. degree training for Mr. Ousman.

4. Project training to be completed by end of extension period

Current objectives will be achieved.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

The project has been actively pursuing its objectives for only about three years.

2. Original time estimates for completion

Three years was estimated for achieving initial objectives; five to seven years will be required to fully attain present goals.

3. Time required to achieve objectives

The project is on schedule. The following progress has been made:

- a. Greater understanding has been achieved as to the importance of the cowpea to the Cameroon, its role in the farm family nutritional economy, the role of women in cowpea production and utilization, and the problems of post-harvest processing/storage.
- b. Ash storage technology has been developed and refined, and the procedure described for demonstration in several villages.
- c. Considerable progress has been made on solar heating disinfestation with batches of up to 50 kg of seeds.
- d. Investigations are underway on double/triple bagging, use of botanicals and storage with insecticides (K-Othrine, others).

All reasonable expectations for the project have been achieved, although new directions--such as seed and pod resistance to storage pests--are strongly indicated.

4. Relationship to other research

The research is highly complementary and is not duplicated anywhere else. Moreover, the technology being developed could be useful in other regions and with other crops.

5. Contribution of lines of research to HC, U.S. and globally

The research findings will have widespread impact on many grain crops including both legumes and cereals.

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

Dr. Wolfson has done the household surveys which stress the roles of both women and men in growing, processing and marketing cowpeas. Women have primary responsibility for storage in most households. They are involved in cowpea production in 92 percent of the households, although they often shared this responsibility with men. Gender-specific responsibilities depended on ethnic group. This information has profoundly affected the CRSP strategy in Cameroon.

2. Other social and/or food science issues

These may emerge as Dr. Wolfson's results are analyzed and reviewed. The technologies developed will also impact directly on low-resource farmers and their families.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

Good relations, sharing of information, exchange of materials (germplasm) and active collaboration is in progress with: Bean/Cowpea CRSP projects--Senegal/UCR/Hall, Nigeria/UGA/McWatters,

Brazil/BTI/Roberts; IITA; several Italian institutes; Drs. Chambliss and N. Singh/Auburn University; Dr. N. Young/UMN; and Dr. Pratt/Ohio State University.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

Audits are carried out on a yearly basis by both institutions, but dates are not fixed.

B. Adequacy of Funding by CRSP Participants

1. From A.I.D.

Funding by A.I.D. is not adequate to support training needs, data analysis and inflationary salary increases. The local Mission, therefore, supported a significant buy-in for FY 90 and was encouraged to do so for a third year (not yet certain) in order to assure continued project achievements.

2. From Host Country

Host Country funding and support has been substantial, but the recent national economic emergency affects all projects.

3. From U.S. university

U.S. institutional support has been more than adequate to match the A.I.D. funding.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

The normal course of reimbursement of funds requires from one to several months, owing to currency devaluations, monetary conversions, distances involved and procedures used. A *modus operandi* has been established to cope with the problem.

D. Adequacy of Current Policies and Procedures

The most serious problem has been a delay in the approval (by A.I.D.) of a Toyota or Nissan truck. This delay seriously hampers field operations.

E. Activity Toward Buy-Ins and/or Other Funding

The project has reached a critical stage in expanding of field testing and farmer demonstration of the new technologies. This requires both personnel and equipment. Vehicles and operational expenses are of primary concern. A one-year USAID Mission buy-in of \$81,000 was most useful and timely. However, continuation of this support is urgently needed in FY 91.

A draft pre-proposal for additional buy-in support covering the years 1991-94 has been submitted to the local Mission but has not yet been accepted nor approved.

Other support for various project components has been received from a French project in Maroua (\$8,000), from the EEC (\$6,000) and from SAFGRAD/RENACO (\$2,000).

Backup research at Purdue at least partially relevant to this CRSP project includes at least six grants from USDA, USAID, IITA and Purdue "Crossroads '90."

III. PLANNING

A. Review of the FY 90 Workplan

The FY 90 plan developed mutually by U.S. and HC PIs (over a two-week period at Purdue) has been followed with only minor modification.

B. Plans for FY 91

1. Plans for FY 91 will be developed at the spring annual meeting of the HC and U.S.
2. Five-year (1992-97) project extension proposal has been prepared for consideration.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

The goals are on target. Highly promising technologies have been developed and are being refined for inclusion in farmer's trials. These include ash storage, solar heating, special storage containers (drums, double bags, etc.), use of insecticides or fumigants, and development of varieties with seed and pod resistance to cowpea weevils. These will provide a range of storage options for even the smallest subsistence farmer. Moreover, the technology developed (except for genetic resistance) is non-specific to site, culture or commodity and, therefore, could have wide applicability.

B. Balance Between Research and Training

Balance is good. Project will train one HC scientist on a continuing basis until a team of trained IRA researchers is available: two agronomy M.S. degrees (one plant breeder) and an entomologist Ph.D. In order to maintain momentum while one researcher is being trained, NCRE may provide training for an additional scientist in phase III.

C. Balance of Domestic vs. Overseas Activities

Balance is about right. The more basic aspects of technology development are initiated at Purdue and the more applied aspects are carried out in Cameroon.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Highly satisfactory--The IRA and Purdue scientists plan their research collaboratively in an annual two-four week review. In addition, Purdue researchers spend varying periods of up to several months a year assisting in carrying out research and surveys and administering the project in Cameroon.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

Each partner contributes equally toward the accomplishment of mutual objectives.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

USAID Mission/Yaounde has been very supportive of the project. One buy-in (\$81,000) was provided in 1990; and a second pre-proposal has been submitted for their consideration.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

Results to date are highly cost effective by virtue of useful technology developed and project leverage attained.

H. Institutionalization of HC/U.S. Components

The IRA has assigned three full-time scientists to the project, reflecting a long-term commitment. The IRA/CRSP facilities at Djarengol (Maroua) in the main building and recently committed to the project are indicative of the interest and determination of IRA to support the project. Moreover, training of scientists and technicians and collection of survey data, record keeping and other procedures have advanced to the level where a fully functional entomology laboratory is now operation at Djarengol (Maroua).

I. Other Comments

A senior, experienced scientist is urgently needed at Maroua to: (1) carry out numerous project management duties on-site and assist younger IRA scientist; (2) carry out breeding work (long-term); (3) collaborate on continuing entomological studies including storage technology development; and (4) coordinate and collaborate with NCRE phase II project and Testing and Liaison Units on developing technological packages for small-scale farmers.

V. PUBLICATIONS AND PRESENTATIONS

Seven directly relevant papers are in preparation or press during FY 90. An additional nine papers focus on some closely related, more basic aspects of insect behavior and feeding.

VI. OVERALL RATING: 1--Highly Satisfactory

A. General Strengths

1. The project has an extraordinarily well-developed infrastructure and is massively leveraged through the very wide scientific base undergirding highly focused objectives.
2. Exceptionally rapid progress has been made toward the project's goals and objectives.

B. General Weaknesses

This project requires additional in-country support to expand and refine on-farm research.

C. Recommendations: See VII. below

VII. FIVE-YEAR EXTENSION PROPOSAL

This project has made exceptional progress in assembling baseline data, characterizing the problem, devising a strategy and developing highly practical technologies that provide viable options even for low-resource peasant farmers ahead of schedule. This promising technology requires further refinement and testing for at least the next two-three years. Simultaneously, the project has demonstrated the potential for enhancing seed and pod resistance to bruchids through genetic manipulation. At present there are excellent possibilities for conventional breeding approaches (recombining the best varietal sources of resistance with adapted materials), wide crossing (between wild and cultivated species) and genetic transformation by introducing alien genes into adapted cultivars. The expertise and methodologies developed could eventually be expanded to deal with other major insect problems of cowpeas like thrips, aphids, pod bugs, *Maruca* sp., and *Laspyresia* sp.

FY 90 EEP REVIEW

DOMINICAN REPUBLIC • UNIVERSITY OF NEBRASKA-LINCOLN • COYNE

Biology, Epidemiology, Genetics, and Breeding for Resistance to Pathogens of Beans with Emphasis on Those Causing Bacterial and Rust Diseases

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and in U.S.

The research under this project is conducted at three locations: in the Dominican Republic (DR), in Puerto Rico (PR) and in the U.S. Substantial collaboration extends to CIAT in Colombia and through CIAT to other Latin American countries via its networks. Useful cooperation is afforded through the Honduras/University of Puerto Rico, Dominican Republic/University of Wisconsin, and Tanzania/Washington State University CRSP projects and through a regional research project and industry connections in the U.S.

The main thrust of the program is improvement of red, mottled, and black beans for use in the Caribbean, the Andes and East Africa and of white and pinto beans for use in the U.S.

Principal diseases of concern are common, web and halo blights (CB, WB, HB), golden and common mosaic viruses (BGMV, BCMV) and rust. The program also involves breeding for multiple disease resistance and for other favorable traits such as heat tolerance, yield, seed type and earliness.

2. Research results disseminated and in use in the HC and U.S.

- a. Improved cultivars, inoculants, etc.: *Cultivars*--The recently introduced PC-50 cultivar has been increased, grown and well received in the Dominican Republic. Great Northern dry bean cultivar Starlight (formerly GN NE-85-43) was released in Nebraska. This cultivar has larger and brighter white seed than any of the currently grown cultivars. The cultivar has resistance to rust and its upright open plant canopy provides an avoidance mechanism to the white mold fungus. The pods of this cultivar express high resistance to the bacterial diseases common blight and halo blight.

Genetic Traits--Information on the trait's non-specific resistance to rust (leaf pubescence) and leaf and seed pod resistance to the common blight bacterium in dry beans was disseminated and is in use.

Methods (Cell and Tissue Culture)—No literature exists indicating regeneration of explants from cotyledons and embryonic axes or from callus in common beans (*Phaseolus vulgaris* L.). In FY 90, the project produced viable and fertile plants from both cotyledonary and explants of four common bean genotypes on Gamborg's B₅ medium supplemented with benzyladenine. Both of these techniques can be used in genetic transformation systems. Also regeneration from embryonic axes may be used to increase the efficiency of hybrid plant recovery from embryo cultures in interspecific crosses. This research was reported to peers at the national annual meetings of the Plant Growth Regulator Society of America and the American Society for Horticultural Science during 1990. Success also was achieved (a first report) with two bean genotypes in regeneration of embryonic callus in culture. The plantlets have not yet been transferred to pots.

- b. Evidence of extent of use to date: Cultivars—Ing. Freddy Saladin reported that enough seed of the new Pompadour cultivar PC-50 was produced during the past year to plant 60 percent of the bean crop in the Dominican Republic. A survey of the acceptance of PC-50 by growers in the DR indicated that 92 percent of growers surveyed liked the new cultivar and would like to plant it again. Popularity of the variety was due to high yields, seed purity, large seed size and attractive color, wide adaptation, and type of plant architecture.

Four strip tests of the new GN Starlight were grown on farmers' fields in western Nebraska in 1990. Five growers produced certified and/or foundation seed of the new cultivar while approximately 3,000 lbs of foundation seed were produced in Idaho. Grower response was favorable.

Genetic Traits—Germplasm possessing non-specific resistance (pubescence) to rust and high tolerance to common blight were distributed for use in breeding programs in Tanzania, CIAT, Puerto Rico, Dominican Republic, North Dakota and Michigan.

3. Other research-related results

- a. Germplasm conservation and use: Accessions—A Pompadour landrace collection was deposited in the Plant Introduction Station, Pullman, WA. An additional collection of Pompadour landraces was made in the DR during 1990 and stored in the seed bank at the Arroyo Loro Experiment Station, San Juan de la Maguana.

International exchange—The Caribbean Adaptation Nursery was sent by UPR to cooperators in the Dominican Republic, Haiti, Jamaica, Guatemala (to evaluate for golden bean mosaic virus resistance) and Panama (for evaluation of web blight resistance). A common blight nursery (CIAT) was evaluated at the Fortuna Substation, Puerto Rico; and Andean origin CIAT lines were tested for rust and hairiness.

- b. Seed production: Seed of the new PC-50 was increased and distributed to farmers by the Seed Department, Ministry of Agriculture, Dominican Republic. About 60 percent of the dry bean crop was planted to this cultivar. Seed of two breeding lines was increased for release in 1991. V-030 (UPR) is a white seeded, early maturing, high yielding line with resistance to rust. A black seeded line, H-270 (derived from the MSU breeding program), has an erect plant architecture, good yield potential, and rust resistance. H-270 will replace Venezuela-44 (susceptible to rust in the DR).

XAN 174, XAN 176, and XAN 178 (CIAT) and Belneb #1 (USDA and Nebraska) were found to have high levels of resistance to common blight (Puerto Rico). Preliminary tests indicate that Belneb #1 also has resistance to BCMV. Resistance to common blight in these lines is derived from Nebraska-developed common blight resistant germplasm. Indeterminate Pompadour-type landraces were found to have higher tolerance to common blight than the determinate landraces (tested at UPR).

Seed of the NE breeding lines Pinto EP-1 (resistant to common blight and BCMV) and GN 85-55 (resistant to common blight, rust, and BCMV) has been increased and release of the lines is planned for 1991 (NE). EP-1 is the first pinto breeding line with high resistance to common blight. GN breeding lines ND6-89-7 and ND6-89-15 also look promising for possible release.

- c. Impact of other CRSP technology: At the recommendation of the bean research group in the DR, the planting of beans and other crops that are hosts to whitefly was suspended in the San Juan de la Maguana valley for a period of several weeks. This fallow period appeared to have reduced whitefly populations and, consequently, the incidence of BCMV.
- d. Impact on production/consumption of beans/cowpeas: It is expected that the introduction of PC-50 will contribute to increased, as well as more stable, yields and increased bean consumption, provided there are price incentives to grow the crop and that the price of beans is affordable to poor people. At the moment, because of the deteriorating economy, the poor can afford to buy only limited amounts of beans.
- e. Needs of small-scale farmers and women: Improved yield potential and stability and greater levels of disease resistance should increase the income of small-scale farmers and result in greater availability of beans to DR consumers. Disease resistance will reduce the need to use pesticides.

4. Changes in national production in Host Country

- a. Commercial: Government statistics on bean production in the DR are unreliable, so data is not presented here.

- b. Bean seed: It is estimated that 60 percent of the bean crop in 1990 in the DR was planted to PC-50. The mean yield of the new cultivar PC-50 obtained from a survey of 52 growers (random sample) from across the country was 987 kg/hectare this past year compared to the mean country yield of 505 kg/hectare for the period (1978-1988).

B. Institutional Development and Training

1. Changes since FY 89

- a. Ms. Graciela Godoy was awarded her Ph.D. (Plant Pathology), UNL, and returned to the DR project. She was appointed Co-PI in October 1990, as she assumes increased responsibility for research. It is expected that Mr. Eladio Arnaud will be a Co-PI when he returns after completing his Ph.D. Dr. Haytham Zaiter (Syria) completed his post-doctoral training and accepted a Department of Agronomy position, American University of Beirut, Lebanon.
- b. Mr. Fernando Oviedo and Ms. Mercedes Rodriguez were assigned to permanent positions in SEA, and the former participated in a plant breeding course sponsored by CIAT.
- c. Mr. Miguel Herrera received informal training in bean breeding at UPR.
- d. Ing. Alfonsina Sanchez continues to receive partial support from the project to pursue her M.S. degree in Crop Protection (UPR).
- e. Mr. Matthew Blair traveled to the DR in March 1990 to evaluate bean genotypes for BGMV resistance. Mr. Blair plans to conduct a major portion of his M.S. thesis research in the DR during 1991.
- f. Bean researchers from Panama, Guatemala, Costa Rica, Mexico and the Dominican Republic visited the research plots at the Isabela Substation in February 1990 as part of a PROFRIJOL tour of the Caribbean. Ing. Cristobal Adames participated in this tour.
- g. Ing. Samuel Concepcion spent four months at the Escuela Agricola Panamericana assisting the Honduras Bean/Cowpea CRSP project conduct research with rust.
- h. Mr. Mohamed Meskine (Morocco) (funded by MIAC) started his M.S. program in Plant Pathology (bean rust) Fall 1990 under the direction of Dr. J. R. Steadman.

2. Over life of project

When the cooperative project was started (1981-82), the DR bean program lacked sufficient trained personnel, had insufficient facilities, vehicles, and little equipment, and lacked financial

support to conduct a bean research program. Nine students have since received M.S. or Ph.D. degrees. A viable bean research program has been developed in the DR. Facilities have been improved, particularly at Arroyo Loro Experiment Station, where screenhouses, work rooms, a seed storage room (controlled environment) and a plant pathology laboratory have been established. Basic laboratory equipment, two vehicles and two motor bikes were purchased. The bean (legume) team has earned a good reputation for conducting bean research and, consequently, has begun to attract support from other donor agencies such as PROFRIJOL. During the past few years the DR Ministry of Agriculture (SEA) has supported a greater portion of the salaries of eight researchers comprising the bean research group. Long-term assistance, however, will likely be necessary. The economic outlook in the DR and other developing countries has continued to worsen, especially due to the Gulf crisis. At present salary levels and with increasing inflation it is difficult for SEA to maintain staff members with advanced degrees. All those receiving M.S. degrees are now employed outside the project in the DR, except one who is at the Arroyo Loro Experiment Station (F. Oviedo), one in Puerto Rico, and one who is pursuing a Ph.D. degree at UNL.

3. In prospect: No comment in annual report
4. Project training to be completed by end of extension period

It is expected that Mr. Eladio Arnaud (non-Title XII funds) and Ms. Debbie Fujimoto (Canada) (some research supported by Title XII funds) will complete their Ph.D. degrees in 1991. Mr. Arnaud plans to return to the Title XII project in the DR. Dr. Mohamed will be hired (Title XII funds) as a post-doc in Plant Breeding and Genetics in 1991 when he receives an appropriate visa. Expected to complete M.S. degrees are: Mr. Guen Hwa Jung (Korea) (UNL/Title XII funding), Ing. Alfonsina Sanchez (DR)(UPR/partial Title XII funding) and Mr. Matthew Blair (UPR/partial Title XII funding). Dr. Margaret Mmbaga will complete her post-doctoral assignment in Plant Pathology within this period.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

Research on various aspects of CB and rust (as outlined in Log Frame FY 89-92) has been conducted since the extension of the project in 1985. When the project was merged with UPR in 1987, attention was also given to other disease constraints, particularly web blight and BGMV (See Log Frame FY 89-92) along with improved yield and adaptation of beans.

2. Original time estimates for completion

It was considered that ten years would be required to develop and introduce new disease resistant dry bean varieties.

3. Progress in relation to proposed schedule

The project is on schedule. Several varieties have been released and some promising new lines are being prepared for release.

4. Relationship to other research

This is the only CRSP project involved with diseases of beans in the lowland tropics. The research conducted by project personnel is well integrated into the national DR legume program. The research also benefits (both complementary and supplementary) dry bean research projects throughout the Third World, including East Africa, and assists CIAT and U.S. programs through fundamental research on resistance to and the epidemiology of diseases affecting bean production. Project members also cooperate with CIAT in planting dry bean nurseries (Caribbean Adaptation Nursery, common blight and rust nurseries). Also CIAT materials are evaluated for reaction to web blight and BGMV. Germplasm (sources of non-specific resistance to rust and resistance to common blight), and information derived from the project are being utilized around the world in bean-producing countries and by CIAT.

5. Contribution of lines of research to HC, U.S. and globally

A bean breeding program has been established in the DR. Bean germplasm has been identified which can serve as sources of resistance to the most important diseases (rust, common blight, BGMV and web blight) in a number of developing countries, at CIAT and in the U.S. Improved cultivars have been released in the DR (PC-50 is now grown on 60 percent of DR bean acreage), in Nebraska (GN Starlight released in 1990) and in Puerto Rico. The DR breeding program will release two new cultivars in 1991 (a white seeded and a black seeded line). The DR program also has developed new lines with greater levels of disease resistance than traditional varieties. More testing is needed in order to determine the performance of these lines on small farms. Limited quantities of seed of recently released varieties have been multiplied by SEA. Disease management schemes, especially for CB, have been improved by research on survival of the bacteria on weed hosts and on bean leaves and debris. Rust genetic management has made progress through knowledge of leaf pubescence and virulence, but more epidemiological data is needed.

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

Women have played an important role in the UNL/DR project. Dr. Anne Vidaver, internationally renowned bacteriologist and Head of the Department of Plant Pathology at UNL, is an investigator on this project. Dr. Graciela Godoy received her Ph.D. in Plant Pathology at UNL in 1990 and returned to the DR to become a project Co-PI. Dr. Mildred Zapata received her Ph.D. in Plant Pathology at UNL two years ago and is now an assistant professor

at UPR-Mayagüez, working part-time on the CRSP with Dr. J. Beaver. Dr. Margaret Mmbaga currently holds a visiting scientist position with Dr. J. R. Steadman. Ms. Lisa Sutton (M.S.) is a half-time assistant to Dr. D. P. Coyne. Three out of eight technical personnel on the project at the Arroyo Loro Experiment Station are women, while the former assistant to the PI (DR) was a woman. In addition, four women (DR) have been sent overseas for training (CIAT, Costa Rica, UPR and UNL).

2. Other social and/or food science issues

The development of beans with improved seed qualities and yield will contribute to improved nutrition of women and families, provided economic incentives continue to encourage bean production.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

1. The Bean/Cowpea CRSP projects in the DR and Honduras continue to be closely linked. Both countries benefit from an exchange of germplasm. A red mottled line from the DR proved to be a source for both the "I" gene for resistance to bean common mosaic virus and red seed color. The dense pubescence found in the Pompadour germplasm collection has been transferred to small red breeding lines and may provide race non-specific resistance to rust. Small red lines are being used as parents in an attempt to improve the heat tolerance of red mottled beans. Ing. Concepcion provided assistance to the Honduras CRSP project on pubescence and non-specific rust resistance in beans. Small red lines from the Honduran project were also evaluated for resistance to BGMV in the DR this past year.
2. The project also collaborates with the other Bean/Cowpea CRSP projects which deal with bean diseases. Bean lines were sent to Dr. Silbernagel for use in East Africa and he has increased breeding lines in a winter nursery in PR for use in the CRSP project in Tanzania. The project has trained a scientist from Uganda (CB) and given training in Africa. The project also collaborated with Dr. D. P. Maxwell, UWI, in the collection of plant samples for his molecular studies on bean golden mosaic virus, supplying germplasm and field sites, identifying trainees, and overall has integrated well with this project.
3. The DR project works closely with the CIAT bean research program. A common blight nursery was planted in PR in collaboration with CIAT. The dry bean Caribbean Adaptation Nursery was planted in several countries in the basin in 1990. Several other cooperative nurseries are conducted both in the DR and PR. Travel is planned so that trips to the DR by CIAT and Bean/Cowpea CRSP personnel (UPR, UNL, UWI) can coincide.
4. Results from research conducted in the DR will be useful now in Jamaica and in the future in Haiti.

5. Puerto Rico is a member of PROFRIJOL which provides an opportunity for the exchange of information among bean researchers in the region.
6. A Midwest regional dry bean nursery was planted in Nebraska (organized by Dr. K. Grafton, North Dakota) to evaluate publicly developed varieties of white, pinto and navy beans.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews: Not reported on

B. Adequacy of Funding by CRSP Participants

1. From A.I.D.

Funding from A.I.D. has been marginally adequate. A crisis is approaching in the area of transportation. With the dilapidated condition of the current equipment and the increased need brought on by returning Ph.D.s, a new and reliable vehicle is desperately needed.

2. From Host Country

The DR economy is in a deteriorating state. Inflation is rampant and the Gulf crisis is draining foreign exchange (domestic energy is from imported oil exclusively). Thus, although the HC has performed well in the past and has good intentions for the future, it may not be able to deliver real resources at the projected level. Loss of trained personnel to private industry continues to pose problems as well.

3. From U.S. university: No problems reported

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

A major problem is transportation. Because of limits on funding and the need to use budgeted funds for materials and supplies, supplemental salaries, and operating costs to support ongoing research, a new vehicle purchase has not been possible. Purchase of a used vehicle and leasing have been investigated and are nonviable options. The government has no vehicles to provide the project and the Mission has not been able to help. Motor bikes are considered death sentences by some workers. Thus, procurement of adequate transportation remains a major limitation in the DR with a flat-rate A.I.D. budget.

Loss of trained researchers to private industry has continued as purchasing power of the Dominican peso has lost over 20 percent in recent months. The government has increased salaries (25 percent in August 1990) and has instituted a system of rewarding researchers with advanced degrees, but recent petroleum prices and other inflationary trends have negated these gains.

D. Adequacy of Current Policies and Procedures

The use of advance funding and reimbursement on the basis of valid receipts has worked well for both the U.S. and DR accounting systems. Visits and phone calls keep everyone up-to-date on use of funds and equipment. A new grant proposal system has been introduced in the DR whereby a short proposal listing objectives, procedures and funding needs is prepared by investigators. Proposals are reviewed by PIs and Co-PIs from UNL, UPR and DR, with recommendations forwarded to the project initiators. For the 1990-91 season, 23 proposals were submitted. A few projects were rejected for marginal relevance to CRSP objectives or the need to focus research at one location (Arroyo Loro Station), some projects were modified, and some were deferred for future consideration. The process was considered worthwhile, and the project will attempt to incorporate UWI, UNL and UPR proposals in the future.

E. Activity Toward Buy-Ins and/or Other Funding

The research program at UNL has utilized a USDA competitive grant, local industry grants, company grants, USAID scholarships, and regional research funds to expand UNL bean research. UPR has utilized local industry support and other USAID-funded legume projects for the bean program. In the DR, PROFRIJOL has contributed to bean research. A UN-funded project helps with on-farm testing. A PL480 seed production project has been approved by USAID but still needs final approval by the DR government. The USAID-funded project of MUCIA with Instituto Superior Agricultura will be approached to find opportunities to cooperate. A private DR foundation (partially USAID supported) also offers individual grant opportunities.

III. PLANNING

A. Review of the FY 90 Workplan

No information on workplan changes for FY 90.

B. Plans for FY 91

Plans for FY 91 were reviewed in connection with the EEP review. One major change has been the establishment of Co-PIs in the HC and the protocols to be followed in making the returning Ph.D.s full members of the team. A serious search is in progress to solve the transportation problem. This may require reduction in personnel and/or deferral of some program.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

1. This project is one of three remaining Bean/Cowpea CRSP projects dealing with bean diseases. In the recently published CIAT publication on bean production problems, it states: "of the major world crops, beans are probably one of the most susceptible

to disease and insect attacks diseases and pests constitute the major factor that significantly lowers on-farm yield." The project is attempting to improve the resistance of red mottled beans. This seed type is grown in the Caribbean, the Andes and in East Africa. In addition, pinto and large and small white beans are being improved for multiple disease resistance.

2. The project in the Dominican Republic is the only project in the Bean/Cowpea CRSP attempting to develop beans for altitudes less than 1000 m. Diseases such as CB, BGMV and web blight are important factors limiting bean production in lower altitudes. Puerto Rico is the only U.S. location where whiteflies and BGMV can be studied in the field. There should be more attention paid to the ecological consequence of increased cultivation of beans in the mountainous regions of the tropics. Increased population pressure has resulted in areas being cultivated which cannot sustain bean production over a number of years. Cultivation of beans on the coastal plains during the cool season provides an alternative to increased production in the mountains. This system can be applied to other countries.
3. This DR project is the major one located in the Caribbean. Germplasm and research information developed by the project should be useful throughout the region including needy countries such as Haiti and Jamaica.
4. Resistance strategies, race non-specific rust resistance, common blight and bean golden mosaic resistance sources, and general disease management strategies as well as improved germplasm will be available for the bean community in Africa, Central and South America, and North America.

B. Balance Between Research and Training

Training costs in FY 90 = \$6,000
Research costs = \$180,000

Training costs projected for FY 91 = \$15,600
Research costs = \$167,400

In order to maximize research output with an initial decline in the budget and now flat-rate funding, project resources were diverted from graduate training to technical assistance. However, the need for continued training resulted in the use of other options. The project has had three LASPAU scholars, two departmental assistantships (UNL and UPR), a shared assistantship with a BNF project, CIAT training grants, USAID Morocco project assistantship and visiting scientists. Short-term training at CIAT, UNL and UPR for breeding and pathology has been conducted. Thus, although CRSP project resources heavily favor research support, the project has balanced training by using other financial sources. There will be a continuing need to train DR researchers as the DR economic problems create legume program turnovers. Plans are to pursue the USAID-

sponsored MUCIA project for future training opportunities in the DR. The FY 91 plans have taken into account CRSP-sponsored training as well as the many other training opportunities.

C. Balance of Domestic vs. Overseas Activities

The activities on the project involve basic research being done primarily at UNL and some at UPR while applied research is underway at all institutions. This year the level of basic studies in the DR will increase as some other sources of funding are found (i.e., private foundation) and more highly trained researchers such as Dr. Godoy and Ing. Oviedo are now conducting experiments. The research, especially basic, will be more collaborative.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Research planning as well as budget development for FY 91 was done at the Bean/Cowpea CRSP PIs' meeting held at Michigan State University in May 1990. Research progress was first discussed and then specific plans for the next year were formulated based on the overall project objectives. Training needs in the DR were defined and potential students/trainees identified. Non-CRSP funding possibilities were also explored. Budget plans were formulated at this time as the MO had been given the FY 91 amount by then. Other trips to DR, PR or international meetings were determined and these trips attempted to have UNL, UPR, DR, UWI and CIAT representatives available each time. During these trips for research data collection or presentations, further interactions on budget, research, training and publications occurred.

For FY 90 the project instituted a research proposal format. For this year DR/UNL investigators drafted a brief (1-2 pp.) write up that covered objectives, procedures, budget and addressed overall project objectives. These proposals were reviewed by UPR, UWI, UNL and DR Co-PIs, resulting in the elimination of some projects while others were modified and approved. CIAT also was sent a copy of the research proposals. This approach should improve collaborative interactions.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

1. U.S. and HC institutions

U.S. contributions for FY 90 were \$71,190. These contributions were based on percent time of PI, Co-PIs and investigators devoted to the project plus benefits and overhead. HC contributions were U.S.\$32,200 derived from salary and benefits of PI and investigators paid by SEA.

2. Other funding

As in most projects, there are contributions such as laboratory supplies, secretarial assistance, greenhouse supplies, labor,

etc. that cannot be conveniently documented. Both U.S. and HC have coordinated integrated bean improvement programs that rely on many contributions to be successful.

Regional Research (USDA) funding for project W-150 has given the UNL/UPR bean program support for increased involvement in national and international nurseries, germplasm exchange and coordination of the project with other domestic bean improvement programs. The Nebraska Dry Bean Commission (NDBC) funds some travel to western Nebraska breeding and disease management nurseries, technical assistance for plot maintenance, and data acquisition and a few supplies. A small grant program from the chemical and seed industry is used for travel to meetings and hourly technical assistance. The dollar amount estimates for these sources in FY 91 are \$13,000 for W-150, \$10,000 NDBC, and \$3,000 from industry. In FY 90, \$7,500 was available from a CSRS competitive grant on bean rust non-specific resistance. A renewal effort for a CSRS grant in FY 91-92 is contemplated. The DR also has PROFRIJOL (Swiss funded) support for specific bean research objectives in the HC.

A.I.D. provides funding that allows the basic bean or legume programs of the DR, PR, and UNL to interact collaboratively on objectives that have local, regional and international impact. The money A.I.D. provides would not be enough to fund, for example, a breeding program *per se* with a breeder, pathologist, entomologist and agronomist along with the laboratory, greenhouse and field facilities needed. The institutional bean programs have highly qualified personnel as well as facilities but lack adequate operating funds and technical support personnel to assist in the research. The system of mutual contributions works well and is an excellent concept.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

The Mission continues to give token support to the project. It has been suggested by them that additional support for bean research may be obtained from a research foundation that has been established in the DR. The existence of the general problem of core funding vs. Mission funding, staff attrition, and the Brooke Amendment status of the DR means the DR Mission cannot spend much time on the project.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding: Appears to be quite cost effective

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

Dr. Coyne received the Nebraska Chapter of Gamma Sigma Delta Award of Merit in November 1989. The Nebraska bean improvement research and extension program (includes CRSP) has been nominated for the UNL/Agricultural Research Development/Institute of Agriculture and Natural Resources Team Effort Award. Ing. Saladin was selected

as president of PROFRIJOL project. Drs. Vidaver and Steadman were invited to participate in Biotechnology in Developing Countries panels convened at CIAT in Cali, Colombia and the National Research Council in Washington, DC, respectively. Dr. Vidaver was recognized with a UNL award for her efforts as Interim Director of the Biotechnology Center at UNL.

2. Integration with domestic and international commodity research programs

The UNL and UPR breeding and bean improvement programs, as well as the DR legume program, are closely involved with the Honduras/UPR and DR/UNL as well as the DR/UWI CRSP projects. In addition, there is cooperation with USDA and the Tanzania/WSU, and Malawi and Mexico/MSU CRSP projects. The integration of rust resistance from the DR Pompadour landrace materials into U.S. and Honduran breeding programs and the integration of UNL-derived common blight resistance into Honduras and DR programs are examples of program integration. Disease management strategies have also been derived in the DR from basic information formulated in the U.S. and applied in the DR. Grad students from HCs have helped further basic research while in the U.S., but have taken the knowledge "home" and have begun to use it to improve HC research.

3. Internal project management and institutional management support

The UPR and UNL administrative support has been excellent. Both Grants and Contracts Offices have given time and expertise for the project. DR administrative support is also very good despite difficult economic conditions.

4. Student/professor interactions

Contact between student/professor has remained after return of students to HC duties. As an example, Dr. Godoy returned to work with Dr. Steadman on collaborative research in July 1990.

V. PUBLICATIONS AND PRESENTATIONS

An outstanding record of fifteen refereed and five nonrefereed technical publications in print, five refereed articles in press, and two nonrefereed reports attest the scope and high productivity of this project. Nine presentations were made at various meetings.

VI. OVERALL RATING: 1--Highly satisfactory

A. General Strengths

The breadth and depth of this program as it addresses many of the most serious constraints to bean production in the lowland tropics is the greatest strength. This has resulted from the dedication of the personnel involved and the excellent support of the U.S. and HC institutions and other cooperating organizations.

B. General Weaknesses

Whereas the biological research and the training components of this project are very strong, there seems to be a lack of attention to the socio-economic dimension. Aside from the training activities and the involvement of females in the research, little evidence of women's concerns is apparent. Similarly, the adequacy of baseline information (i.e., production and production economics) and consumption patterns and preferences is not apparent. If available, it needs to be documented in the FY 91 annual report. If not available, it needs studied attention in the immediate future. Finally, as suggested by the TC, more attention should be given to a participatory approach in the research.

C. Recommendations

A one-time infusion of funds for upgrading transportation would be helpful.

VII. FIVE-YEAR EXTENSION PROPOSAL

This project has been quite productive both for the HC and for the U.S. We commend the excellent collaboration between the U.S. and HC scientists and institutions and the inter-project cooperation with the Honduras/UPR and DR/UWI projects. We take some exception to the TC comments concerning overlap with the Honduras project. We see these efforts as fully cooperative and collaborative and would not favor placing constraints on those engaged in multiple disease investigations in these projects. We do concur with the TC comments concerning regional emphasis (consonant with Honduras, DR and other collaboration) and attention to participatory research. We strongly support continuation in the five-year extension.

FY 90 EEP REVIEW

DOMINICAN REPUBLIC • UNIVERSITY OF WISCONSIN • MAXWELL

Molecular Approaches for the Control of Bean Golden Mosaic Virus

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

This is a very fundamental research project which, in the main, attempts to characterize and understand the genetic nature and behavior of bean-infecting geminiviruses with the ultimate goal of freeing beans of the diseases caused by or the effects of the viruses. Thus, in the U.S., the research is confined to tightly controlled laboratory or plant growth facilities. In the HC (and in other environments across the region), bean germplasm is evaluated for tolerance or resistance to the viruses, and host materials are collected for laboratory evaluation in the U.S.

2. Research results disseminated and in use in the HC and U.S.

Molecular characterization of four isolates of bean-infecting geminiviruses has shown that the golden-mosaic-inducing isolates in the Caribbean and Central America are distinct from those in Brazil and that separate breeding programs for disease resistance should be developed for these two regions.

Sequencing of bean dwarf mosaic geminivirus (BDMV) DNAs A and B and comparisons with other geminiviruses showed that BDMV is a distinct bean-infecting geminivirus and is not closely related to other geminiviruses.

General and isolate-specific geminiviral DNA probes have been developed. These probes were used to detect geminiviruses in bean, weeds and other crop plants from a number of countries. Results indicate that weeds are not a major source of BGMV inoculum in the Dominican Republic.

In collaboration with Agracetus, Inc., clones of the four geminiviral isolates were found to be infectious by inoculating bean radicles with cloned DNA using electric discharge particle acceleration methods (particle gun). It was not possible to infect beans with cloned DNA by standard mechanical inoculation methods. This makes it possible to initiate mutational analysis studies to develop virus-derived schemes for the creation of transgenic plants with resistance to BGMV.

Sequence alignments of the putative replicative gene for the sequenced geminiviruses indicated that there may be an ATP binding site in this protein; and thus, this catalytic site is an appropriate target for evaluation of the dominant lethal scheme for creation of transgenic beans resistant to BGMV and other geminiviruses, e.g., the tomato geminivirus causing problems in Florida, the Mid-East and Central America.

Bean germplasm was evaluated for the Dominican Republic and CIAT. It was found that two landraces (Pompadour G and Pompadour J) from the Dominican Republic, which were thought to be resistant, were susceptible and did not give typical golden mosaic symptoms when infected with BGMV-DR. Also, there was a correlation between symptom development to BGMV-DR and moderate levels of field resistance to BGMV.

Several bean cultivars immune to BGMV were detected and these will be used in an inheritance study of factors controlling disease resistance to geminiviruses.

3. Other research-related results

- a. Germplasm conservation and use: Pompadour J and Pompadour G were collected by Ing. F. Saladin as part of the Dominican Republic/University of Nebraska CRSP project and these were evaluated in the Dominican Republic, Puerto Rico and Wisconsin. This seed has been provided to CIAT.
- b. Seed production (or other materials): Not applicable
- c. Impact of other CRSP technologies: Some interest has been expressed by researchers in the use of the pathovar specific DNA probes for the detection of *Xanthomonas campestris* pathovar *phaseoli*. These probes will be provided to CIAT, the University of Nebraska and the University of Puerto Rico for future studies.
- d. Impact on production/consumption of beans/cowpeas: Not applicable
- e. Needs of small-scale farmers and women: Technology is being developed which will provide better control strategies for one of the major constraints to bean production in Latin America. This will have a positive impact on yield and quality of beans. Every effort is being made to provide technical training for women. Nine women have received training in biotechnology during FY 90.
- f. Other research results of importance: The coat protein region of the bean common mosaic potyvirus, an RNA virus, was cloned.

Restriction fragment length polymorphism (RFLP) analysis of 26 isolates of *Xanthomonas campestris* pv. *phaseoli* and *Xcp*

var. *fuscans* indicated that considerable genetic variability exists in this pathovar. This should be considered when cultivars are evaluated for disease resistance.

B. Institutional Development and Training

This project has not had funds for training of HC personnel nor has there been a Host Country budget for this project. Other funds have been sought for training personnel and nine individuals have received training this year.

1. Changes since FY 89

Since FY 89, Ms. Maria Rojas (funded on a USAID scholarship from Costa Rica) has started a M.S. degree program; Ms. Ann Batista, a Ph.D. student in Molecular Biology, did a rotation in Dr. Maxwell's laboratory; Ms. Eunice Zambolim (funded by the Brazilian Government) is receiving special training in molecular virology of viruses; Ms. Mercedes Otoya from CIAT received three-months' training on RFLP analysis; and Ms. Mary Bett (funded by State research assistantship) is a Ph.D. graduate student who started a rotation in Dr. Maxwell's laboratory in August.

2. Over life of project

A PSTC/USAID grant provides funds through December 1991 for Ms. R. Teresa Martinez from the Dominican Republic to receive training in virology and vegetable crop pest management.

3. In prospect: See I.B.2. and I.B.4.

4. Project training to be completed by end of extension period

Ms. R. Teresa Martinez from the Dominican Republic (2.5 years, funded by PSTC/USAID), Ms. Mercedes Otoya from CIAT (3 months, funded by CIAT), Ms. Denise Smith from the U.S. (funded by State and Hatch) and Ms. Elisabeth S. Hidayat from Indonesia (funded by the World Bank) will complete an M.S. Ms. Eunice Zambolim from Brazil (one year funding by Brazilian government) will have received training in molecular virology of RNA plant viruses. Dr. Robert L. Gilbertson (funded by CRSP) from the U.S. will have received two years of training and he has accepted a faculty position at the University of California-Davis. He is also Co-PI on the Malawi/UCD CRSP project. It is expected that Dr. Wayne McLaughlin from the University of West Indies will receive three months of training in the summer of 1991.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

An intensive research program on BGMV was initiated in January 1987 when Dr. Gilbertson went to the University of Florida to receive training on methods for mechanical transmission of geminiviruses.

2. Original time estimates for completion

Cloning and sequencing BGMV-BZ, BGMV-GA, BGMV-DR and BDMV-CO:
This has been achieved.

Development of general and isolate-specific probes for above listed bean-infecting geminiviruses (four): This has been achieved and a manuscript has been accepted for publication in *Plant Disease*.

Develop a BGMV/protoplast system for virus replication studies:
This has not been achieved and may not be necessary since the full-length clones can be used to infect plants using the particle gun.

BGMV DNA modified by site-directed mutagenesis to form a dominant lethal: These experiments are underway for site direct mutagenesis of the putative ATP binding site in the AL1 gene product.

3. Progress in relation to proposed schedule

The research is on schedule as a result of extreme diligence of personnel involved and the contribution made possible by very substantial non-CRSP funds. It is estimated that the first dominant lethal scheme for plant virus resistance will be evaluated in a model system by the end of this extension period. Transgenic bean plants with the viral coat protein gene will be available for evaluation in the five-year extension period.

4. Relationship to other research

This project is the major research project in the world on bean-infecting geminiviruses and is not duplicated anywhere. It complements efforts of CIAT scientists who have done the initial characterization of the geminiviral isolates BGMV-GA, BGMV-DR and BDMV-CO. The project performed molecular characterization of these isolates. These research efforts are coordinated with Dr. Francisco Morales, CIAT virologist. He collects plant samples on his trips to Africa and South America and these samples are then probed with isolate-specific geminiviral DNA probes at UWI. This allows CIAT personnel to better understand the range of genetic diversity in bean-infecting geminiviruses and allows them to plan their breeding programs. The UWI team also works closely with Dr. Judy Brown, University of Arizona, in the characterization of bean calico mosaic geminivirus. She completed the host range and transmission studies and the UWI group cloned part of the virus. UWI studies on germplasm evaluation and inheritance studies are closely coordinated with the DR/UNL and Honduras/UPR CRSP projects.

The most closely related geminivirus research project is at Washington University, St. Louis, and is directed by Dr. R. Beachy. His research team has recently obtained a detectable

level of resistance to tomato yellow leaf curl geminiviruses in transgenic *Nicotiana benthamiana* plants expressing viral coat protein.

5. Contribution of lines of research to HC, U.S. and globally

Characterization of bean-infecting geminivirus has provided clear evidence that breeding programs need to be designed for specific regions, e.g., Brazil or the Caribbean and Central America. Also, the use of isolate-specific probes has shown that weeds may not be the main source of inoculum in the Dominican Republic. The research on dominant lethals may provide the basis for a new approach for the control of geminiviruses and other viruses. Simulation of research on the development of a bean transformation system using biolistic approaches may have considerable impact on future development of beans. Once transgenic beans are available with resistance to geminiviruses, it is expected that this technology could be applied to cultivars for many regions and that these resistant cultivars will have a significant impact on bean yields in Latin America (potentially increasing yields by 10-20 percent).

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

The project has made a major effort in the training of women in biotechnology and, this past year, nine women have received training on this project. Only two men have received training.

2. Other social and/or food science issues

In the field trip to the Dominican Republic, Ms. Martinez discussed the growing of beans which were developed by transformation technology with several individuals at various levels, e.g., seedsmen, experimental station workers, growers and administrators. There was not a concern as long as the transgenic plants were better than current beans.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

Since starting work on molecular characters of bean common mosaic potyvirus (an RNA virus), virus isolates have been received from Dr. M. Silbernagel (Tanzania/WSU CRSP project) and Dr. J. Kelly (Mexico/MSU CRSP project). Also, Dr. Roy French, USDA scientist at the University of Nebraska, has been very helpful. Efforts on RFLPs of the common blight pathogen involved Dr. M. Pastor-Corrales, bean pathologist from CIAT. He supplied the isolates for the study and a paper will be published jointly with him and his technician M. Otoya.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

1. The EEP review for FY 89 gave this project high marks.
2. No information on audits

B. Adequacy of Funding by CRSP Participants

1. From A.I.D.

A.I.D. funds provide less than 30 percent of the resources dedicated to this work. The plans, therefore, seem more ambitious than the budget.

2. From Host Country

No funds are available for HC activities. The DR/UNL project has provided some assistance through the HC PI in evaluating materials, collecting samples, etc.

3. From U.S. university

The University has provided, from its own resources and those of others, very substantial assistance to this project.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

Lack of HC funds has resulted in a research program in which very little responsibility has been associated with the HC. Funding level by the CRSP has been extremely low for the expected output in the area of molecular biology research and training.

D. Adequacy of Current Policies and Procedures

Last November, a three-person CRSP review panel visited the geminivirus team at the University of Wisconsin and reviewed all aspects of the project. The project received the highest rating, along with several other projects, by the EEP.

E. Activity Toward Buy-Ins and/or Other Funding

Recently a trip to Costa Rica was made to discuss geminivirus research with people at CATIE, the Universidad de Costa Rica and the USAID Mission. It is hoped that Costa Rica will become a HC in the next extension period. Additional funding for this project was obtained from the following sources in FY 90: Hatch (support for half-time specialists, \$10,000), University of Wisconsin Graduate School (three months of a visiting scientist, \$5,000), State funds (one research assistantship, \$12,500, and one half-time specialist, \$10,000), USAID Scholarship from Costa Rica (one research assistantship, \$12,000), PSTC/USDA Grant (for visiting scientists and trainee, \$39,000), CNPQ from Brazil (one trainee, about \$6,000) and

World Bank (one research assistantship, \$18,000). It is also important to note that Agracetus, Inc. donated all the time and resources for sequencing the component A of BDMV and for the particle gun experiments with the viral-cloned DNAs and they have made a major commitment to bean transformation (estimated contribution over \$20,000). This is a total of \$132,500 in direct costs or \$190,800 including indirect costs. The CRSP budget for last year was about \$78,000 for direct and indirect.

III. PLANNING

A. Review of the FY 90 Workplan

Work seems to have gone very much as planned. Collaboration with Agracetus, Inc. was more extensive (and productive) than anticipated.

B. Plans for FY 91

All seems to be in order.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

The Global Plan addresses the need to improve the living conditions of small farm producers in LDCs and to increase the availability of low-cost nutritious foodstuffs for rural and urban poor in LDCs. These efforts involve the collaboration of scientists from Brazil, the Dominican Republic, CIAT, Agracetus, Inc., the University of Puerto Rico, the University of Nebraska and the University of Wisconsin-Madison. The focus of the project is on the molecular characterization of the geminiviral pathogens causing diseases of bean. From the sequence data, it is evidence that two different strains of BGMV occur in Latin America and that other bean-infecting geminiviruses are present in Colombia and Mexico. This would indicate that breeding programs for resistance need to be continued for these different strains and geminiviruses. The general geminiviral DNA probe has been used to detect geminiviruses in weeds and other plants, e.g., tomatoes. The isolate-specific probes for the different geminiviruses can be used to determine if weeds are a main source of inoculum. This information can then be used in designing better control strategies.

Major effort will be devoted to using recombinant DNA technology to develop beans resistant to BGMV. Considerable progress was made when it was found that the full-length clones of the four geminiviral isolates were infectious. This will allow studies on genome function and the development of virus-derived schemes for creation of transgenic beans. Additionally, Agracetus, Inc. is developing a bean transformation using modification of the soybean technology which they have developed. If successful, these methods could dramatically increase the availability of adapted bean lines with resistance to a major constraint to production in Latin America.

Through the efforts of the CRSP, PSTC, CIAT, CESDA-Dominican Republic, Agracetus, Inc., UPR, UNL and UWI, the largest research program devoted to basic studies on this bean golden mosaic viral complex has been organized and will lead to new understandings of this disease and improvements in disease control.

B. Balance Between Research and Training

If funds for Dr. Robert L. Gilbertson, an Assistant Scientist, are assigned to training, then 60 percent of the direct costs of the CRSP are for training. The project has never had an adequate training component and other resources have been sought. Thus for FY 90, funds for three M.S. students, three trainees and one visiting scientist were obtained from other sources.

The training program for FY 90 was essentially as expected in FY 89 except Ms. Maria Rojas joined our program from Costa Rica.

C. Balance of Domestic vs. Overseas Activities

Because of the highly technical nature of the research, which involves techniques associated with molecular biology and special resources, the major research effort has been at the University of Wisconsin and Agracetus, Inc. This year more effort was devoted to collecting field samples in the DR than in the past; and it is expected that additional experiments on whitefly transmission of geminiviruses in weeds to beans can be undertaken in the coming year. The field research for the evaluation of germplasm is conducted in the DR in cooperation with UNL and UPR.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Drs. Maxwell and Gilbertson and Ing. Teresa Martinez visited the Dominican Republic in February to collect samples and arrange for future research. In April, Ing. Freddy Saladin, HC PI, visited the University of Wisconsin and plans were discussed for future research and budgets. Since funds for a HC budget have not been available, only minimal effort has been devoted to this process. The project serves as the major research project on bean-infecting geminiviruses for Latin America and thus research priorities are decided by the team which includes CIAT personnel. In July, Dr. James Beaver, Dr. Morales (CIAT), Dr. Silbernagel (Washington State University) and Dr. Pastor-Corrales (CIAT) visited UWI to discuss future research. These visits have provided opportunities for the international scientists to interact directly with the geminivirus team and scientists from Agracetus, Inc.

**E. Relative Contribution of Collaborating Institutions and Individuals
Toward Accomplishment of Objectives**

**1. USAID/CRSP, University of Wisconsin, and HC contributions to
budget**

USAID/CRSP:

Direct costs (Funds for assistant scientist, supplies, and travel)	\$53,884
Indirect costs	<u>\$23,709</u>
TOTAL	\$77,593

U.S. University of Wisconsin:

Specialist	\$10,000
Research Assistant	\$12,500
Graduate School	<u>\$5,000</u>
TOTAL	\$27,500

Salary for Drs. Maxwell and Ahlquist provided by the University of Wisconsin and are part of the matching funds (\$18,877). Other sources of funds are discussed elsewhere.

HC:

HC funds were used for support of HC PI and Ms. Aridia Figueroa (about 5-10 percent of their time was devoted to CRSP activities for this project).

2. Other funding

Funds spent at UWI-Madison (direct costs):

Hatch (used for a half-time specialist)	\$10,000
PSTC/USAID (used for support of trainee, supplies and travel)	\$36,000
CIAT (used for support for Ms. M. Otoyá, CIAT for 3 months)	\$6,000
USAID Scholarship from Costa Rica (M.S. graduate student)	\$12,000
CNPQ, Brazil (trainee from Brazil)	\$ 6,000
World Bank-Indonesia program	\$18,000
Gift funds (travel)	<u>\$ 2,000</u>
TOTAL	\$90,000

Estimate of funds provided by Agracetus, Inc.

Scientists at Agracetus sequenced BDMV component A and provided the primers needed for sequencing component B. They also provided the resources that were used to show that viral clones from four isolates were infectious.

Estimated value \$20,000

Importance of these funds: Non-CRSP funds provide about 65 percent of the financial resources needed to achieve the current level of training and research activities. The contribution of Agracetus, Inc. cannot be over emphasized. Without their help, it would not have been known that the viral clones were infectious and a considerable effort (one-two years) may have been devoted to this activity rather than four months.

Also, Agracetus, Inc. has started an effort to transform beans with the coat protein gene from BGMV-GA.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

Visits to USAID Mission personnel have been made during trips to the Dominican Republic and provided for a useful exchange of information.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

It is quite obvious that this activity has been highly cost-effective.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

Dr. Maxwell has been appointed to serve on the College's International Agricultural Program Committee and his CRSP project activities will be featured in the International Ag Newsletter from UWI-Madison. Ag Administration and Departmental faculty have been very understanding of Dr. Maxwell's need to devote time to this CRSP project. Because he is Departmental Chair, this has caused some stress on other faculty and office staff.

2. Integration with domestic and international commodity research programs

Dr. Maxwell had approved a new Hatch project on "Development of Transgenic *Phaseolus vulgaris* Plants With Resistance to Geminiviruses" and he also contributed to the preparation of the new W-150 regional project on "Genetics and Breeding Beans for Improved Disease Resistance and Yield."

Internationally, Dr. Maxwell was appointed to the newly formed Steering Committee of the Advanced Bean Research Network in September 1990 at an international workshop at CIAT, Cali, Colombia. He will be representing the CRSP Technical Committee.

3. Internal project management and institutional management support

Dr. Maxwell does all the administrative management of the project and Drs. Gilbertson, Ahlquist and Maxwell have formulated research direction policies. Dr. Gilbertson has been the day-to-day advisor for the research on BCMV, Xcp and PCR (polymerase chain reaction) technologies.

Dr. K. Shapiro, Director of International Programs for the College, was recently assigned the position of Institutional Representative. He has been extremely supportive and has provided some administrative personnel to help with paperwork associated with USAID trainees. He also visited the research facilities and discussed the CRSP research program in considerable detail.

4. Student/professor interactions

Dr. Maxwell has had a challenging year as "mentor" to so many Latin and U.S. women students. He devotes as much time as he can to their special education and social needs. An undergraduate student, Ms. Amy O. Loniello, supported by the CRSP, won a research award scholarship for her research proposal on characterization of bean calico mosaic geminivirus and she also received the first D. J. Hagedorn Fellowship in Plant Pathology. (Dr. Hagedorn started his Bean/Cowpea CRSP project in Brazil in 1982 and he established a scholarship fund when he retired.)

I. Other Comments

Dr. Maxwell will resign as Departmental Chair on June 30, 1991 so that he can devote more time to the research and training activities associated with this CRSP project.

Much of the success of this project has been the result of Dr. Robert L. Gilbertson's efforts. He departed October 1, 1990 for UCD and he will be a Co-PI on the Malawi CRSP project. The UWI team will miss him in many ways.

V. PUBLICATIONS AND PRESENTATIONS

An impressive record of three publications in print and three more in press along with nine presentations documents the productivity of this activity.

VI. OVERALL RATING: 1--Highly Satisfactory

A. General Strengths

Beyond question, this project is the premiere effort on bean geminiviruses in the world. The U.S. laboratory with its ties to other public and private laboratories is a cutting-edge enterprise.

B. General Weaknesses

The project could profit from some funding for HC and other linkages. So far, these have been "bootlegged" through the UWI project or by use of other resources. Funds for training would also be helpful.

C. Recommendations

Increase funds during the coming year(s) to permit more aggressive international ties and for training of developing country personnel.

A substantial increase should be provided in the five-year extension to ensure adequate work in Latin America.

·VII. FIVE-YEAR EXTENSION PROPOSAL

The EEP commends the project for past efforts and strongly supports continuation with substantially enhanced funding in the five-year extension of the CRSP. Host Country collaboration and a significant training budget are notable needs to more fully capitalize on the UWI efforts. A.I.D., the MO and UWI need to begin now to prepare for movement of transgenic plant materials that will be generated in this project within the next grant period.

FY 90 EEP REVIEW

ECUADOR • UNIVERSITY OF MINNESOTA • GRAHAM

Improving the Productivity of Phaseolus Beans Under Conditions of Low-Input Agriculture Through Genetic Selection of Host Cultivars and Rhizobium Strains for Enhanced Symbiotic Efficiency

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

This is the only significant effort on biological nitrogen fixation in beans in the CRSP and probably the most comprehensive and advanced anywhere. As such, it is truly a core effort to address one of the most important dimensions of low-input agriculture in the tropics.

The main thrusts of the research to date in the HC have been establishment of baseline data on soils and microbial populations, inoculation studies with various strains of *Rhizobia* and varietal evaluations for nitrogen fixing and other characteristics. In the U.S., efforts have concentrated on traits affecting nodulation, response of cultivars to low levels of soil phosphorus and of *Rhizobium* strains to soil acidity and development of methods for identification of bean rhizobia.

2. Research results disseminated and in use in the HC and U.S.

This project has only been underway since May 1989. No results obtained to date have been disseminated in HC or U.S.

3. Other research-related results

Host Country

- a. A baseline study has been initiated on soil properties in three regions of bean production in Ecuador. In Imbaburra province 65 percent of soils tested proved deficient in zinc, 71 percent deficient in manganese, and more than 30 percent either iron or nitrogen deficient. Data on the extent to which foliar fertilization is used to control these micro-element limitations is conflicting, and will need to be resolved. Micronutrient fertility trials will also need to be undertaken as confirmation of the importance of these constraints to symbiotically grown plants. Soil analysis for the Chimborazo and Loja regions is still in progress.

- b. Six high organic matter soils were collected and tested for their suitability as legume inoculant carriers. Only one soil, from Lago Agrio, had an organic matter content greater than 30 percent. This will be further tested and compared to sterile filter mud as an inoculant carrier.
- c. Three inoculation studies have been undertaken. At Ibarra and Chaltura, 12 strains of *R. leguminosarum* bv *phaseoli* from the UMR collection were evaluated. There was a strong response to N-fertilization and *Rhizobium* inoculation in each experiment, with biological yield increased 38 percent with N-fertilization at Chaltura, and 40 percent at Ibarra. CIAT152 and UMR1632 were the best strains tested, each giving biological yields similar to, or greater than, the +N treatment. These strains differed somewhat in nodulation pattern with CIAT151 showing limited primary root nodulation, but heavy nodulation on secondary roots, while UMR1632 tended to more uniform nodule distribution. Reasons for this difference will be evaluated. While biological yield responded strongly to inoculation, yield differences between inoculated and uninoculated treatments were not significant. This suggests either low N harvest index in the Ecuadorian variety used in these trials or severe disease problems late in the growth cycle. Both points are being studied. In a third trial using N15, even uninoculated control plants were reasonably nodulated (presumably through infection by native soil strains), and there was no response to inoculation. Even so, nitrogen fixation rates were significant with the percent of plant nitrogen derived from fixation estimated at from 31.74 to 41.44 percent.
- d. MPN counts of soil rhizobia were taken for 22 soils in the Imbaburra region. Counts averaged more than 10,000 rhizobia per gram of soil, a level at which competition between inoculant strains and those already in the soil is to be expected. *Rhizobium* strain isolations have been made from each region of bean production and will be used to determine the relative efficiency of the native soil strains. This will determine the need for studies on host variety restriction of nodulation in *Phaseolus* beans.
- e. Eighty varieties selected from CIAT's 1989 IBYAN and EP nurseries for Ecuadorian grain type, high yield and disease resistance, as well as varieties identified in various studies as active in nitrogen fixation, are being multiplied in Ecuador prior to field testing. A further 60 varieties, which combine high yield with a long vegetative phase but rapid reproductive development, have been requested from CIAT.

U.S.

- a. Studies to evaluate cultivar variation in traits affecting nodule formation and development have been continued. In the FY 89 report, differences in speed of nodulation among 80 cultivars of *Phaseolus vulgaris* were evaluated. Eight cultivars selected from this study were inoculated with *Rhizobium* then grown for 3-25 days prior to the determination of number of infection sites, nodule number and mass and plant dry weight. A modified haemotoxylin strain was used to determine infection sites per root. Cultivars differed significantly in number of nodule initials produced per plant, in the percentage of infections giving rise to nodules, and in the rate at which nodule mass increased. The latter trait appears closely correlated to shoot growth rate. Cultivar variation in this trait could be of considerable significance as Piha and Munns (1987) have reported that one reason for the weaker nitrogen fixation found in beans is their poor early shoot development. It appears from this data that a number of traits contributing to early initiation of nitrogen fixation have been identified and could be tested for in routine screenings. Studies to evaluate a wider range of cultivars and to initiate crosses between them are underway.
- b. Eighty varieties of beans have been evaluated for tolerance to low levels of soil P. Phosphate-charged aluminum/sand mixtures were used to control phosphate availability, with three levels of P supply (30, 8 and 1.4 μM P) tested. All plants were dependent on *Rhizobium* for nitrogen supply. Cultivar variation in growth at 1.4 μM was evident, with the Ecuadorian cultivar E838 apparently particularly tolerant to low soil P levels. Studies to detail cultivar differences in response have been planted, as have studies on the response of efficient and inefficient cultivars to mycorrhizal infection.
- c. Studies on the response of bean rhizobia to acidity have continued. Acid-shock proteins have been identified following the exposure of *Rhizobium* cells to acid pH and, in one case at least, are affected by phosphorus levels in the cell. Exposure to acid conditions has been shown to cause reduced extracellular polysaccharide production and at least partial breakdown in the synthesis of cell wall components. Cells exposed to acidity modify cell metabolism to reduce acid loading, with glucose metabolism markedly reduced at acid pH. Studies to determine whether acid-shocked cells switch to the utilization of amino compounds as a means of generating ammonium for the control of cytoplasmic acidity are underway.
- d. Since most bean soils in the Imbaburra region seem to contain abundant rhizobia, experiments have been undertaken to develop a dot blot method for the identification of bean rhizobia. This will be of importance in studies on competition for nodulation sites in Ecuador but will also have value in determining which strains should be used in restriction

studies with cultivars of *Phaseolus vulgaris*. In an initial study with nodules from Ecuador, the most frequent serological reactions were with antisera to strains 413.2 and CIAT676 (57 and 48 percent of nodules), respectively. If this is confirmed in subsequent evaluations, one or other of these strains will be used to identify cultivars of bean which are limited in their ability to nodulate with the predominant soil strains and so more likely to respond to inoculation.

4. Changes in national production in Host Country

Since this project was only initiated in 1989, it is too early for it to have had effects on statistics of national production or to have documented how research results address the needs of women/small scale farmers.

B. Institutional Development and Training

INIAP is in the process of receiving independence from the Ministry of Agriculture. This is likely to happen in 1991 and is expected to result in budget increases for INIAP researchers in Ecuador. Talks have been held with INIAP management over development of a national bean program and with the HC PI over the possibilities of collaboration with other centers/universities for bean research in Loja.

Ing. Consuelo Estevez will complete her M.S. degree in November 1990 and return to Ecuador as HC PI. Ing. Gustavo Bernal has recently initiated English language classes at Minnesota and is working part-time on his M.S. research project. Two "egresados" from the national university are completing undergraduate thesis research with funding provided by the project, and two additional students have been identified. A difficulty at the moment is in the identification of suitable students for graduate training in the fields of plant breeding, soil fertility and agronomy. This is the reason emphasis has been given to attracting undergraduate students in this area.

The age of this project (18 months) means that institutional development and training of HC personnel has only just begun. On the other hand, the project is perhaps slightly ahead of schedule in identifying personnel for training, and in their progress.

In addition to HC personnel, a number of other students are receiving at least partial support from this project. These include Ms. Martha Chaverra (Colombia), Ms. Sharon Aarons (Jamaica), Mr. Patrick Jjemba (Uganda) and Ms. Kathy Draeger (U.S.). It is anticipated that by the end of this extension period two Third World students will have completed Ph.D.s and two completed M.S. degrees. Ms. Draeger and Ing. Bernal should be within one year of completing M.S. degrees.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives
2. Original time estimates for completion
3. Progress in relation to proposed schedule

Again, given the short time this project has been in operation, it is difficult for it to have strayed very far from the initial guidelines and log frame. The research appears to be on schedule in the U.S. but slightly delayed in the HC through the difficulty associated with the naming of the post-doctoral fellow. With the return of Ing. Estevez to Ecuador in November, we anticipate that opportunities for collaboration with other centers in areas where INIAP does not have research personnel will open up and more than make up for this delay. Contacts have already been established with Dr. Rogelio Lepiz, the CIAT bean agronomist in Ecuador, and should facilitate research.

4. Relationship to other research

This is the only project in the CRSP with a major emphasis on nitrogen fixation and one of few to emphasize large-seeded grain types. INIAP has a relatively small research program, with little emphasis to date on varietal development, so this project represents a major force for varietal improvement in this country. INIAP is also limited in funding for training and so will be markedly strengthened by the training activities proposed.

At the international level, the U.S. PI is one of very few scientists working on enhancement of nitrogen fixation in beans, and the person who first identified Puebla 152 as superior in nitrogen-fixing ability. Many of the strains of *Rhizobium* currently recommended for beans also derive from the U.S. laboratory. The only serious research on similar lines is that being conducted by CIAT, and both PIs maintain open communications with Dr. Kipe-Nolt. Since much of the CIAT research is for other grain types and adaptation conditions, it is a source of promising lines, complementary to this program, and the project is careful to involve CIAT personnel (Drs. Rogelio Lepiz in Ecuador and Judy Kipe-Nolt in Cali) in project planning. Both U.S. and HC PIs are aware of the need for regionalization of the research focus in this project.

5. Contribution of lines of research to HC, U.S. and globally

Biological nitrogen fixation is a means of maintaining plant growth and development without the need for expensive (and in Third World countries, often unavailable) fertilizer nitrogen. It is also a way to reduce production costs and better regulate the fluxes of nitrogen in soil and ground water. All of these are important factors in a world where the oil and natural gas supply needed for fertilizer production is precarious and environmental pollution an ever-increasing problem. Because of these points the research undertaken in this project is likely to contribute significantly to bean improvement in both the HC and U.S. and should lead the way to advances with other crop legumes.

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

WID issues *per se* have not been a major focus of the program at this time; greater emphasis in the short-term having been given to the initiation of biological research activities and training. Budget also has been a limiting factor, though WID issues will form part of the study to be initiated by Ms. Kathryn Draeger in Ecuador in January (Ms. Draeger is a MacArthur Fellow whose course work includes both biological and sociological components). While WID issues have not been stressed, it should be pointed out that the HC PI from November will be female, and that five of the six graduate students involved in this project to date have also been female. The participation of Dr. Ferguson in the project in FY 91 will be of considerable help in better defining WID issues in Ecuador.

2. Other social and/or food science issues

The project can build on the previous activities of the Cornell group in Ecuador but will have to use considerable diplomacy in so doing. It is apparent from conversations with INIAP management that this group left ruffled feathers in Ecuador and for this reason social and culinary issues have been down-played to date. Again, even were this not so, budget limitations and the range of activities being initiated would have limited the emphasis given this area.

Because of his contacts with the Mexico CRSP project, the U.S. PI has maintained strong contact with this group and is working in collaboration with Mr. Javier Castellanos in the field testing of some high nitrogen-fixing lines. He has also collaborated with the molecular genetics group at Cuernava, this research leading to the identification of acid-tolerant strains identified by the PI as members of a unique sub-species of bean rhizobia, favored by their acid-tolerance but limited in their competitive ability with Mexican bean cultivars.

Linkage with the Tanzania project has also been strong. The U.S. PI visited Tanzania in September to participate in the SADDAC/SUA/WSU meeting and to discuss aspects of BNF research with Dr. Susan Nchimbi. The HC PI also visited WSU to discuss breeding strategies associated with root rot and to collect bean differentials and promising root rot-resistant lines.

Through Dr. D. Hubbell, the project has received support from faculty members at the University of Florida. Dr. Mary Collins participated in the evaluation of peat sources for possible use as legume inoculants, Dr. F. Sylvia will visit Ecuador shortly to examine the diversity of mycorrhizal fungi in bean soils. Neither activity was a charge on the project budget.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews: None reported

B. Adequacy of Funding by CRSP Participants

This project received one of the lowest levels of funding of any of the Bean/Cowpea CRSP projects in FY 90, significantly limiting the scope of initiatives and the rate at which different activities could be undertaken. Budgetary restrictions severely limit the salary of the post-doctoral fellow in Ecuador and are likely to shorten the time he will stay with the project.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

Current financial reporting in Ecuador limits the turnover of receipts and the availability of funds for HC purchases. This is being overcome by maintaining significant funds in the hands of the post-doctoral fellow.

D. Adequacy of Current Policies and Procedures: No problems

E. Activity Toward Buy-Ins and/or Other Funding

A buy-in for bean research in Egypt is being negotiated. Areas where buy-ins could have value in Ecuador include the development of an inoculant industry capability in that country for grain and pasture legumes and in institution building related to agronomic education. To date, USAID/Quito has not responded to either initiative.

III. PLANNING

A. Review of the FY 90 Work Plan

Delays in recruitment of the post-doc for duty in the HC and the late completion of the degree by the new HC PI created some delays in implementing HC activities.

B. Plans for FY 91

All seems to be in order. Progress according to plan depends on completion of greenhouse facilities now under construction.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

Activities undertaken in this project are all directly related to specific constraints identified in the global plan and address major problem areas for bean production in Ecuador, other areas of Latin America and the U.S.

B. Balance Between Research and Training

In that most of the research in both the U.S. and HC constituted part of a graduate degree program, or will be included in such a program (i.e., the work done by Ing. Bernal), it is difficult to separate these components. A 50:50 division is estimated, with most of the research costs associated with the activities of Drs. Hubbell and Henson. Even a considerable part of their work involved training of "egresados" and lecturing at INIAP and in local universities.

C. Balance of Domestic vs. Overseas Activities

Because of the delay in naming Dr. Henson as post-doctoral fellow, because Ing. Estevez has been delayed in the completion of her M.S. thesis and because it has taken some time to develop procedures for the new project in Ecuador, activities currently are stronger in the U.S. than in the HC. Balance will be restored in the new financial year, with none of these points likely to be a constraint.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Collaboration has been excellent. The U.S. PI discussed plans of research and budget proposals with INIAP management and Ing. Estevez prior to their implementation, met in June with Ing. Cevallos (Director General, INIAP) and his staff to determine activities and budget for the extension document, and together with Ing. Estevez held a review meeting to evaluate progress and decide future research strategies and collaborative activities in December. Included in this meeting was a discussion of social and food science needs in the project. The presence of Ing. Estevez in the U.S. during this period has been a big plus. Not only did it facilitate decision making, it enabled her to see some of the bottlenecks in both institutions and in the CRSP and made her aware of the responsibilities of both collaborating parties.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

U.S. and HC institution support of the research activities were as stated in the budget and mainly constituted support for salary of project PIs. At the University of Minnesota Miss Draeger and Miss Chaverra received funding from the work study program, Mr. Jjemba was separately funded through the Uganda project, and Ms. Aarons was supported through a grant from the University experiment station. As mentioned above, the University of Florida supported visits to Ecuador from Drs. Collins and Sylvia.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

Mr. Peters, formerly the USAID project officer in Quito, is trained in the field of nitrogen fixation and so had taken some interest in the project. He was instrumental in solving visa problems but was not involved in direct project activities. The new ADO, Mr. Alverson, has been on the job only a short time but has expressed interest and support for the work.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

This project is too new to have achieved significant institutionalization in either HC or U.S. institution, but in the U.S. has been effective in drawing together faculty members from different departments and disciplines. Dr. Gene Allen has been strongly supportive of project activities and, as Vice President for Agriculture, certainly has the position for institutionalization of the project. Similar integration both within INIAP and with other institutions is expected once Ing. Estevez returns to Ecuador.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

While no awards for international activities have come from UMN, the U.S. PI has been a member of the Technical Advisory Committee during FY 90 and has been invited to make keynote speeches at the Xth Anniversary Celebration of the Molecular Genetics Group in Cuernavaca (January 1991) and at the XIIIth North American Rhizobium meetings at Banff (August 1991).

2. Integration with domestic and international commodity research programs

The PI has close and effective ties with CIAT scientists and works closely with other BNF laboratories.

3. Internal project management and institutional management support: Appears to be quite adequate

4. Student/professor interactions

Student/professor interactions have been excellent. The diversity of nationalities involved (Australian, Colombian, Ecuadorian, Jamaican, Ugandan and U.S.) has facilitated interaction and made for a tight and coherent group.

V. PUBLICATIONS AND PRESENTATIONS

Three refereed publications in print and two in press show good productivity. There were two major presentations in addition to those internal to the CRSP.

VI. OVERALL RATING: 1--Highly Satisfactory

A. General Strengths

This "new" project has gotten off to a good start, given the usual start-up problems and a skimpy budget. Dr. Graham's laboratory and program are world-class.

B. General Weaknesses

Inadequate resources and general weakness of HC infrastructure are notable.

C. Recommendations

Supplement funding as much as possible and provide a substantial increase in the next project extension.

VII. FIVE-YEAR EXTENSION PROPOSAL

The EEP commends this project for the rapid and excellent start-up it has made and strongly supports its continuation, with substantially enhanced funding, in the five-year extension.

FY 90 EEP REVIEW

GUATEMALA • CORNELL UNIVERSITY • WALLACE

Agronomic, Sociological and Genetic Aspects of Bean Yield and Adaptation

I. PROGRESS DURING FY 90

This project will be phased out at the end of the FY 91 fiscal year (9/30/91); but the PIs have requested an extension of funding for the HC to allow completion of data collection/analysis from the second season planting--until December 1991.

Site visits were not carried out in FY 90 either to the U.S. or HC projects; and nearly half of the report (5-1/2 pages) involves discussion of Wallace's "Yield System Analysis" (YSA) and "Additive Main-effects Multiplicative Interaction effects analysis" (AMMI statistical analysis). However, these processes and their potential impact have been treated at some length in previous EEP reports. Moreover, it is difficult to determine whether any 1989/91-derived data contributes significantly to the current report.

This review, for the reasons given above, will focus on those results and conclusions that appear to add new dimensions to the project's hypotheses or contribute confirmatory evidence to prior results.

A. Specific Research Contributions

The specific goals are to improve the genotypic capability for bean production on U.S. farms and on small farms of Guatemala and other developing countries. It will accomplish this by developing breeding strategies which identify superior genotypes, improve the efficiency of selecting for higher yields within segregating populations, and investigate the genetics of adaptation and yield expression.

1. Research in progress in the HC and U.S.

Extensive experience and previous research have shown that the elucidation of genotype x environment (G x E) interactions are key to bean adaptation and performance across the wide range of conditions under which beans are grown. Several years of studies have been carried out on beans grown under four contrasting environments:

<u>New York Greenhouse</u>	<u>Guatemala</u>
Summer: 15.5 hours and 28°C	Lowlands: 13.5 hours and 29°C
Winter: 10 hours	Highlands: 13.5 hours and 19°C

From these observations have come the following conclusions:

- a. Bean photoperiod response is controlled by one gene.

- b. Control of days to flowering under long days (15.5 hours) or low temperature appears controlled by one or two genes.
- c. Earlier flowering of a genotype is more readily detected at higher than at lower temperatures, however, the 15.5-hour versus 10-hour daylength had the second-largest effect on days to flower.
- d. The effective use of YSA and AMI require recording data across environments on:
 - days to flowering
 - days to maturity
 - total biomass
 - grain yield

Measurements are taken on each genotype (progeny of a single F_2 plant) grown at each of the three environments (omitting the 10-hour wintertime greenhouse in New York). However, a third elevation environment in Guatemala (intermediate/13.5h/24°C) was included in 1990 and 1991 plantings, although it has little effect on flowering compared with lower and higher elevations.

2. Research results disseminated and in use in the HC and U.S.
 - a. Improved cultivars, inoculants, etc.: Two black and one red bean varieties have been developed and released in the HC; and a highly promising line was developed in New York.
 - b. Evidence of extent of use to date: Both Guatemala and New York use YSA in breeding for yield. Moreover, participants in the U.S. and Canada Cooperative Dry Bean Nursery are collecting data for YSA.
3. Other research-related results
 - a. Guatemala: A high-yielding red bean variety, tolerant of golden mosaic (BGMV) and adapted to the humid lowlands up to 1200 m in elevation has been released as "DorICTA." It represents the first commercial bean released for the tropical lowlands.

A small-seeded black bean resistant to BGMV is in on-farm trials in the lowlands and marginal sites. It is an indeterminate bush and resistant to lodging. Another black bean, Negro Cuyuta, is determinate, matures uniformly, tolerates high temperatures and is being tested under mechanization (higher population densities) in the lowlands (however, not tolerant of BGMV).

Guatemalan farmers are increasingly planting two or more monocrops rather than long-duration multicropped beans. Recent ICTA breeding lines are proving much superior to the standard variety, Texel, for this purpose.

- b. New York: Among new breeding materials, one line shows exceptional potential with a yielding advantage of 30 to 40 percent above the recommended variety. However, it must be commercially acceptable for canning before release (late 1990).

4. Changes in national production in Host Country

BGMV has, as in other Central American countries, become a major deterrent to bean production. In order to compensate, some Guatemalan farmers are growing an off-season crop to help stabilize production, currently estimated at 3.2 million hundredweight.

B. Institutional Development and Training

In March 1990, Ing. R. Rodriguez became the Principal Investigator. However, three former bean researchers (Masaya, Aldana and Monterroso) have left the program for other opportunities. The project has no continuing training activities except for English language capability, in which all of the present five bean researchers are participating.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives
2. Original time estimates for completion
3. Progress in relation to proposed schedule

The project has been successful in meeting most of the objectives of the log frame during the past nine years. The numerous processes and traits that interact to produce yield are conceptualized as being integrated into four highly integrated components. YSA has been developed and used to measure the four components of yield for each cultivar in yield trials. The AMMI model has also been shown useful for quantifying the genotype x environment interaction for each cultivar or genotype and for the effect for each environment.

4. Relationship to other research

The research has helped strengthen the Guatemala black bean breeding effort and has contributed to increasing the flow of new improved germplasm for both the lowlands and highlands; as well as varietal improvement in New York. In particular, the HC program has been effective in producing improved breeding materials and varieties for off-season plantings and more stressful growing conditions.

5. Contribution of lines of research to HC, U.S. and globally

ICTA participates in a network for sharing methodology and breeding materials with Mexico, the Caribbean and Central American countries. ICTA also collaborates with CIAT on improving disease resistance in the region.

D. Evidence of Biological/Social Sciences Integration

Responsibility for social sciences and WID research has been transferred to ICTA.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

1. Both ICTA and Cornell participate in the IBSNAT network which now collects data for YSA and AMMI.
2. The USDA W-150 regional bean project supports analysis of the Cooperative Dry Bean trials (U.S. and Canada). YSA is being used by one Canadian and four U.S. bean breeding programs (including New York).
3. Collaboration has been initiated with biotechnologists at Cornell and CIAT to characterize any molecular genetic associations with the genotypes for adaptation.

II. FUNDING/FISCAL MANAGEMENT

Continuing devaluation of the Guatemalan Quetzal has reduced dollar expenditures by ICTA. However, funding is requested to allow ICTA to complete collection of data on flowering time, maturity, biomass and yield for the second season 1991 (to be completed by December 1991).

III. PLANNING: Not applicable

IV. STATUS

A. Appropriateness to Global Plan

Satisfactory--The YSA and AMMI should be applicable to crop breeding everywhere.

B. Balance Between Research and Training

1. Cornell allocated 28 percent of the \$52,394 budget for a Ph.D. candidate from Costa Rica.
2. About 4 percent of the \$47,000 budgeted for ICTA was allocated to English and computation training.
3. A Ph.D. candidate from Botswana performed the G x z analysis for this report at no cost to the CRSP.

C. Balance of Domestic vs. Overseas Activities: Satisfactory

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions: Generally satisfactory.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

The Cornell contribution was \$38,208 and the ICTA contribution was \$20,500. In addition, CIAT-funded training of Ms. Seja Mmopi facilitated data collection in New York, plus analysis and interpretation of all data.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy
USAID/Guatemala is supportive but not actively involved.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding
The project has been cost effective in terms of its program and scope.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

Cornell recognizes and encourages internationalization of staff activities.

2. Integration with domestic and international commodity research programs

CRSP research is fully integrated into ongoing breeding programs both in New York and Guatemala.

3. Internal project management and institutional management support: Generally satisfactory

4. Student/professor interactions

The project has conducted its research and other activities through student/professor interaction.

I. Other Comments

Guatemala is very interested in a continuing project particularly concerned with breeding for insect resistance and to initiate collaboration with Dr. Maxwell (UWI) on BGMV (preferably under the aegis of the Bean/Cowpea CRSP).

V. PUBLICATIONS AND PRESENTATIONS

Seven publications/presentations were submitted in 1989: one in Spanish and six in English. Three of the English papers included the HC PI as a co-author.

VI. OVERALL RATING: 2--Satisfactory

The project terminates on 9/30/91. This reviewer recommends the EEP consider favorably the request to extend funding for three months to ICTA to allow completing the evaluation of the second season 1991 plantings.

FY 90 EEP REVIEW

HONDURAS • UNIVERSITY OF PUERTO RICO • BEAVER

Improvement of Bean Production in Honduras Through Breeding for Multiple Disease Resistance

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

The focus of the project is to develop stable, high-yielding small red bean lines with multiple disease resistance (MDR) for Honduras conditions. Such lines must be early (65 to 70 days maturity), drought resistant, and possess acceptable cooking quality to meet local acceptability standards. The principal diseases (seedborne) are bean common mosaic virus (BCMV), common blight (CB), rust, and anthracnose (ANTH). More recently--the last two years--bean golden mosaic virus (BGMV) has begun to spread with devastating effect and will receive major attention in the future. Secondary problems include web blight (WB), stored grain pests, leaf hoppers (*Empoasca* sp.), whiteflies (vector for BGMV), and foliage feeders (*Apion* sp. borer).

Complicating the improvement process is the need to incorporate earliness, erectness, drought tolerance and seed quality requirements. Seed quality necessitates a small red bean that cooks without releasing its nutritive components since beans are normally cooked only once a week (to conserve fuel), then deliquified and stored without refrigeration for daily use. This unique attribute of the small red bean merits further attention. Its stability under room temperature storage following cooking could have wide-ranging implications in both bean- and cowpea-consuming populations since fuel for cooking and lack of refrigeration are serious constraints to bean utilization. Earliness and erectness help the plant escape drought and diseases, compete with weeds and ease harvesting.

Current research activities in the project in both Honduras and PR include:

- a. Breeding for multiple disease resistance to BCMV, CB, ANTH, rust and WB
- b. Initiating a major effort to breed for BGMV resistance in addition to the above
- c. Rust virulence and yield losses
- d. Yield losses from CB, ANTH and BGMV

- e. Molecular studies on rust and BGMV in collaboration with DR, UNL and UWI
 - f. Drought and heat tolerance studies
 - g. Physiological indicators of maturity and drought/heat tolerances
2. Research results disseminated and in use in the HC and U.S.

The prior release of the new varieties, Catrachita and RAB50 (an escape), have been widely distributed through the Ministry of Natural Resources (MNR). It has not yet been possible to quantify the impact of these releases on commercial production.

Resistance to BCMV (both "I" and "bc3" genes) has been developed in small red bean breeding lines HND43-40 and EAP12-88; and moderate resistance to CB has been found in EAP10-88 and UPR64-1. Also, BAC6 reduces the seed transmission of CB. Small red seeded lines have been developed to obtain non-specific rust resistance to highly virulent Honduran races of rust. More recently, two small red lines, DOR364 and DOR391, have been found to carry moderate levels of resistance to BGMV; and DOR364 is currently considered for imminent release to help stem the spread of this deadly virus.

Some very interesting and potentially promising genetic studies are underway on wide (interspecific) crossing of *Phaseolus vulgaris* (common bean) with *P. acutifolius* (tepary or desert bean). The latter carries an exceptionally high level of resistance to CB plus earliness and heat/drought tolerance. This development may also extend the adaptation range of beans to the lower elevations.

Supporting genetic and molecular studies underway in collaboration with the Dominican Republic/University of Wisconsin CRSP project are aimed at characterizing the prevailing races of rust utilizing restriction fragment length polymorphism (RFLP) analysis. The seven virulence isolates being studied will provide invaluable information on selecting parental stocks for crossing and in predicting yield losses.

Yield loss studies on the effects of the major diseases in Honduras clearly show the potential devastation in susceptible varieties:

- Anthracnose = up to 60% loss
- Common Blight = up to 44% loss
- Rust = up to 40% loss
- BGMV = up to 100% loss

Stored grain pests (e.g., bruchids) may cause losses up to 20 percent or more after harvest. Local studies show that storage with ashes, sand, ground limestone or botanicals can reduce this

loss. Best is ashes (See Purdue report). A second approach is to breed for resistance by incorporating the amino acid, arcelin. The HC PI has a major study on arcelin supported by other funding sources. Another investigation is the systematic collection of Honduran land races of beans (IBPGR).

Other closely related research includes genetic studies on combining ability using a diallel cross (for an M.S. thesis); maintaining genetic diversity in breeding lines with different selection procedures; five separate subprojects on nitrogen fixation in beans with support from NIFTAL, USAID/PSTC, BOSTID/NAS and USDA/CSRS-BNF; and collaborative regional yield testing with CIAT and PROFRIJOL (Swiss support). The Escuela Agricola Panamericana (EAP) has contributed promising lines (recently 8) for inclusion in these trials.

Research results have been summarized in four manuscripts accepted by refereed journals; and in seven presentations at the annual meeting of the regional (Central America and Caribbean) PCCMCA. In addition the EAP has been requested to participate closely with the MNR in preparing farmer/user bulletins, pamphlets and handouts.

3. Other research-related results

a. Germplasm conservation and use: Improved lines from the project have been distributed to bean researchers in the U.S., CIAT, El Salvador, Haiti, the Philippines, and the Caribbean. Moreover, the Seed Bank is augmenting its stock of germplasm from IBPGR, CIAT and systematic collecting (in Honduras). Currently, about 500+ collections are being grown out for "rejuvenation," seed increase and evaluation in this Primera season.

b. Seed production: In 1989 the Seed Production Unit of EAP produced and sold more than 10 tons of high quality seeds of Catrachita and other Zamorano varieties to the National Seed Program of the Honduras Ministry of Natural Resources and directly to farmers and private seed producers.

In the current season (Primera 1990) about the same level of seed production of DOR364 is being grown at EAP, anticipating an early release by the MNR.

c. Impact of other CRSP technologies: The project is handicapped by the lack of accurate national production statistics and socio-economic studies. However, very few CRSP or otherwise supported projects have made such an excellent start in developing and disseminating technology. One of the project's associates, Mr. David Erazo, currently is pursuing his M.S. degree in social sciences at the Universidad Nacional Autonoma de Honduras (UNAH) and is supported by an assistantship from this project. He will supervise and evaluate on-farm trials when he completes his studies. His thesis topic is on the impact of technology on small-scale farmers.

- d. Impact on production/consumption of beans/cowpeas: The project impact is not yet quantifiable for the reasons mentioned above.

4. Changes in national production in Host Country

National consumption of beans in Honduras is approximately 58,000 tons, of which only 60 percent or 36,000 tons was produced in the country on 62,200 ha in 1987-88. Production over the past decade has not changed appreciably despite the 3.5 percent population rate of growth and the urgent need to increase per capita protein intake.

Production of beans in Honduras occurs principally in four areas-- in the "Departimentos" of: Paraiso 31 percent, Olanche 25 percent, Yoro/Colon 12 percent, and Occidente 32 percent--and between precipitation levels of 500-1000 mm/annum.

B. Institutional Development and Training

Locating the Bean/Cowpea CRSP project at the EAP at Zamorano was the only satisfactory option for developing an effective national bean improvement program in Honduras. However, the EAP has established excellent cooperation and working relationships with the Secretaria de Ministerios de Recursos Naturales. Under this working arrangement, Mr. Jose Jimenez, Director of the National Bean Program at Danli, consults closely with EAP scientists on at least a weekly basis "in season." In addition he has assigned an MNP staff member, Sra. Sonia Fortrin, full time to the EAP, where she participates directly in bean breeding activities.

It is worth noting that INTSORMIL has also established a project at the EAP and assigned Dr. Dan Meckenstock, Sorghum Breeder from Texas A&M University, to that project. Dr. Meckenstock has also been named as CRSP overall project coordinator, with as yet undefined responsibilities.

C. Progress Achieved in Relation to Log Frame

1. In general, excellent--A highly effective and productive bean breeding program achieved "take-off." However, considerably more needs to be done in terms of: pyramiding disease resistance genes; improving drought and heat tolerance; dealing with the unexpected spread of BGMV; release of new MDRs; and assessing the socio-economic impact of the new technology. We estimate that an additional ten years will be required.
2. Multiple disease resistant small red breeding lines have been developed with resistance to one or more of the following diseases--BCMV, CB, rust and anthracnose--and with good agronomic characters.
3. A new line, DOR364, with partial resistance to BGMV (delayed symptom expression) and other *desiderata*-like growth habit and grain quality, is being increased for release in late 1990 or early 1991.

4. The project collaborates with several other bean programs and activities in the region and elsewhere.
5. This CRSP is one of the strongest HC-based efforts, is at the "take-off" stage, and has few, if any, observable weaknesses.

D. Evidence of Biological/Social Sciences Integration

One of the program's collaborators, Mr. David Erazo, is being trained in socio-economics research at a Honduran university (UNAH). He is expected to supervise and analyze on-farm research designed to study technology adoption by farmers.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

Highly satisfactory—Collaboration includes CIAT; PROFRIJOL (regional); DR/UNL and DR/UWI CRSP projects; CGIAR/FAO; USAID/PSTC; USDA/CSRS/BNF; BOSTID/NAS; and a NIFTAL project on BNF.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

Mr. Jaime Hernandez Vega conducted an internal audit at EAP during the previous extension period (1985) and several recommendations were adopted. No external audits have been made by the EEP or MO.

The current practice in the HC is to send monthly statements and copies of fiscal transactions to the University of Puerto Rico (UPR). Reimbursements are made to EAP and are handled on a monthly basis via accounts receivable sent on to UPR. The secretary in charge of the CRSP accounting activities at EAP appears to be very knowledgeable and dedicated. Reimbursed funds are sent directly to EAP with Dr. J. C. Rosas (HC PI) authorized to use them. There are no overhead charges involved in EAP handling of funds.

Procurement is handled through the Agriculture Experiment Station at the UPR. The purchased items are inventoried by assigning a property number to them and identified via the original purchase order requisition number. Mr. Hernandez Vega and Dr. James Beaver of the University of Puerto Rico are responsible for the financial accounting and reporting.

Overall, the fiscal management appears very adequate, with some room for improvement in preparing more timely fiscal reports by EAP to allow for more rapid reimbursements. There appears to be excellent control; funds move rapidly through EAP to the project with very good cooperation at all fiscal management levels.

B. Adequacy of Funding by CRSP Participants

1. From A.I.D.

Although the funding has been satisfactory, the anticipated increase in on-farm testing of varieties and the addition of BGMV as a major constraint in bean production will stress the A.I.D. budget. A Mission buy-in is being pursued.

2. From Host Country

There is good support from EAP and good cooperation from MNR.

3. From U.S. university

UPR and UNL have demonstrated their support.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

No major problems were found.

D. Adequacy of Current Policies and Procedures

Generally satisfactory—Minor issues are involved with the promptness of submission of expenditures to UPR for reimbursement and these are being addressed.

III. PLANNING

A. Review of the FY 90 Workplan

The only significant change is the addition of investigations on BGMV, a potentially devastating disease in the region. BGMV was initially observed to be spreading into Honduras in 1987-88.

B. Plans for FY 91

Pyramiding of resistance genes will be continued. Increased attention will be given to rust as well as mounting a new thrust on BGMV (See above). Evaluation of wide crosses (common bean x tepary bean) and others will be conducted.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

- 1. Disease resistance in small red beans is important throughout Central America and the Caribbean.**
- 2. A better understanding of the inheritance of disease resistance and agronomic traits will result in the adoption of more efficient selection methods. In particular, a better understanding of Honduran highly virulent rust races should lead to more efficient strategies for controlling this disease.**

3. Early maturity, erectness, drought/heat tolerance and extended reproductive period are desirable traits pursued in many bean improvement programs.

4. U.S. agriculture is likely to benefit by this project as bean production in the U.S. is threatened by many of the same diseases. Screening for these diseases is often faster in the tropics as infections are usually severe and more predictable, and two or more field crops can be grown in a year.

B. Balance Between Research and Training: Adequate

C. Balance of Domestic vs. Overseas Activities: Highly satisfactory

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Excellent working relationship has been established. Workplans and budgets are prepared jointly each year; and close consultation occurs throughout the year through visitations.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

Exceptionally close and productive partnerships have been established, particularly between UPR/UNL and UPR/EAP. Moreover, the project has coupled key expertise and facilities in the Dominican Republic and at UWI. The UPR is a particularly advantageous U.S. location because of its tropical location and similar language/culture background to Central America.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

There has recently been a turn-around in USAID interest and involvement in this CRSP. Credit for this dramatic change in attitude is attributable to the efforts of the two project PIs and new enlightened program officers in the USAID Mission.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

Highly cost effective as the project leverages resources and expertise of several U.S. and HC institutions.

H. Institutionalization of HC/U.S. Components

Further to I.B. above, it now appears more likely than ever for the present national research arrangement to continue indefinitely.

V. PUBLICATIONS AND PRESENTATIONS

The publication/presentation record is impressive. Several papers have been submitted to refereed journals and at least seven presentations on the CRSP program have been made at regional meetings. At present the CRSP is collaborating with the MNR (at the latter's request) on farmer/user's bulletins and pamphlets in Spanish.

VI. OVERALL RATING: 1--Highly Satisfactory**A. General Strengths**

1. This is an impressive project focused on alleviating the primary deterrents to bean production in Honduras. The project's strategies and execution are of the highest order, reflecting the capabilities, experience and dedication of the PIs and their associates. Excellent progress has been made towards defined goals and several advances are "in the pipeline."
2. Regional situation: The project is ideally located in the region with similar interests, culture and language backgrounds. Therefore, collaboration between both the HC and U.S. institutions is excellent. Moreover, they share a direct concern for agricultural problems of the region.
3. The EAP is a strong private institution with a long history of training national leaders and professionals in the region. It has excellent leadership and maintains a well-managed institution with virtually all the facilities required for research.
4. The project has direct linkages to the DR/UNL and DR/UWI projects through the UPR PI. This connection greatly expands access to resources and expertise in addressing the more complex issues in breeding for resistance/tolerance to more intractable problems like rust, BGMV and heat/drought.

B. General Weaknesses

1. The project lacks facilities and personnel to expand and extend testing of the new technology throughout the present and potential bean-growing regions of Honduras, especially at the on-farm level. Support for this activity, tied with increasingly important socio-economic capabilities and WID concerns, would amply justify additional CRSP support and/or a USAID Mission buy-in.
2. The EAP (institution) needs to expand its irrigation facilities as unusual and extended dry periods such as the present (Summer '90) risk serious losses of experimental materials. Moreover, it would allow bean and other breeding programs to advance a third field generation in a twelve-month period. A crop drier is also needed to allow expeditious harvest during rainy periods and accelerate the cropping turnover.

C. Recommendations

The FY 90 review is based on a visit to Honduras by two EEP members (Rachie and Siedler) August 6-9, 1990 and perusal of the project's FY 90 Annual Report, its FY 92-97 five-year extension proposal, and other materials.

The present reviewers found the HC (EAP) bean research to be of the highest order and on the verge of making several critical improve-

ments. Solutions to several major disease problems are being developed; however, a new (two years) potentially devastating disease (BGMV) has begun to spread in the country and must receive the project's best efforts to control it. This emerging problem will require the immediate attention of the project's PIs at EAP, UPR and UNL. In addition other virus experts and research institutions should be consulted, especially UWI (Maxwell), CIAT and others.

Finally, the reviewers concur with last year's findings in UPR: "The advantages in UPR/EAP with regard to outstanding institutional resources, geographic location, transportation, operating costs, and cultural/language features should be exploited to the full benefit of the program and all concerned." If possible, additional emphasis and funds should be allocated to the UPR to make the most of a clear program advantage in the region.

VII. FIVE-YEAR EXTENSION PROPOSAL

The EEP heartily concurred with the comments of the TC on the general excellence and progress being made and the urgent need to continue support for the extension period (1992-97) with increased emphasis on rust studies. However, the EEP does not believe this project should be restricted to working on two or three diseases when these and other pathogens may be primary deterrents to national production. Moreover, the HC researchers may be obliged, by virtue of strong local pressures, to allocate more than nominal efforts and resources on a rapidly spreading, potentially devastating hazard like BGMV.

The flow of improved technology from the project is accelerating. Therefore, continuing support for ongoing program activities is essential and will return handsome dividends in terms of the national (HC) impact, as well as providing expanded credibility for the CRSP.

The development of optimal research strategies for the extension period and future technology impact assessment will not be possible without reliable baseline information and production statistics. Therefore, appropriate agencies in the HC should be encouraged (with CRSP support, if necessary) to determine current production trends on bean production including yields, consumption, imports and exports as well as production practices, post-harvest handling, storage and marketing.

FY 90 EEP REVIEW

INCAP • WASHINGTON STATE UNIVERSITY • SWANSON

Improvement of Dry Bean Nutritional Quality and Acceptability

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

The research focus of this project has been on evaluation of the protein digestibility and protein quality of dry beans (*Phaseolus*) and in the elucidation of the mechanism and causes of the hard-to-cook phenomenon. The overall goal is to improve the nutritional value and acceptability of beans. There has been a close association with the breeding program at MSU (Hosfield) throughout this project. Protein digestibility was evaluated in a number of protein fractions from *Phaseolus vulgaris* using *in vitro* techniques. Removal of the carbohydrate moiety of glycoproteins improved digestibility. Protein digestibility of a number of different cultivars was assessed in canned Navy beans using *in vitro* assays. Some variation was noted but this variability appears to be associated with growing conditions rather than cultivars.

Studies using genetic varieties obtained from CIAT have shown that the pest resistance factor, arcelin, is destroyed by heat processing. Animal studies confirmed this.

One of the major constraints on bean utilization is the long cooking time required. This is exacerbated by beans which acquire the hard-to-cook characteristic. Research has continued to determine factors and procedures which influence cooking times as well as nutritional quality. In affiliated studies, various cooking methods were evaluated for efficiency in cooking beans in Rwanda, Africa, households and several procedures were found to be superior to traditional methods.

Research has continued to delineate the factors causing the hard-to-cook phenomenon and technologies to prevent it. Coating beans with edible oil films appears to decrease the rate of development of hard-to-cook beans stored under conditions accelerating the acquisition of this characteristic. Soluble fiber content of cotyledons appears to be correlated with the hard-to-cook characteristic, whereas insoluble fiber content showed no differences.

2. Research results disseminated and in use in the HC and U.S.

a. Technical papers, reports and bulletins produced and released for public use:

- (1) Organized a symposium and presented a number of reports on processing, food value and health benefits of beans at the 1990 Institute of Food Technologists annual meeting, Anaheim, California
- (2) Presented information on "The Dry Bean—Its Many Food Values" at the customer workshop of Agripac Inc., Los Angeles
- (3) Presented research results to the Dry Bean Research Committee at the 1990 National Food Processors Association meeting, San Francisco, California
- (4) Presented results at the Ninth Annual SUA/CRSP Bean Research Workshop, Morogoro, Tanzania
- (5) Three presentations made on bean research results in Guatemala and one in El Salvador by INCAP personnel

b. Evidence of extent of use to date: No evidence of extent of use was reported. However, the use of the Mattson bean cooker to evaluate cookability continues in both the U.S. and HC as well as other CRSP HCs (e.g., Tanzania).

3. Other research-related results

- a. Germlasm conservation and use: A number of accessions (African, CIAT) were evaluated for cookability and digestibility.
- b. Seed production (or other materials): Two hundred thirty-one F₂ populations of red beans were grown for architecture and consumer acceptance evaluation. A number of other varieties were also evaluated for nutritional quality.
- c. Impact of other CRSP technology: Some 25 Mattson bean cooker devices have been distributed to various investigators.
- d. Impact on production/consumption of beans/cowpeas: It is anticipated that the development of the "haybasket" cooker will be adopted by users.
- e. Needs of small-scale farmers and women: The development of easier cooking varieties, systems for higher cooking efficiencies, increased nutritional values (digestibility, etc.) is specifically targeted for increased utilization by small-scale farmers, higher overall market demand and alleviation of time and energy demands of household preparers.

4. Changes in national production in Host Country

No definitive assessments have been made to date.

B. Institutional Development and Training

1. Changes since FY 89

Four students are currently being trained at INCAP. Close collaboration continues between INCAP and Washington State University/Michigan State University.

2. Over life of project

Training over the life of this project appears substantial with WSU, MSU, INCAP and CIAT plus the University of São Paulo also contributing.

3. In prospect

It is expected that three Ph.D. and four M.S. trainees (five at WSU and two at MSU) will complete their degrees by the end of FY 92. Two additional Ph.D. trainees will complete their degrees after FY 92.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

The goals are relatively long term. It appears that progress is being made. This project has been underway for nine years.

2. Original time estimates for completion

Estimated to be 10-15 years to accomplish goals

3. Progress in relation to proposed schedule

This project is to be phased out by 1992. A new project is being developed to supplant this one, presumably with similar utilization objectives and building upon the results of this research. Overall, many of the objectives have been accomplished and a new project will require an estimated additional five years to achieve the goals.

4. Relationship to other research

Considerable bean research programs have been existent for many years at the participating institutions (WSU, MSU, INCAP). Therefore, bean research independent of the CRSP has been a long-term commitment by these institutions. Utilization research is particularly important to establish bean quality indices for breeders. There has been close collaboration on utilization technologies which have broad application with the cowpea projects and variety testing for utilization qualities have involved CIAT.

5. Contribution of lines of research to HC, U.S. and globally

The development of indices of bean quality with respect to utilization will impact both bean breeders and consumer acceptance at local and global levels. Specifically, increased digestibility, acceptable appearance, enhanced cookability characteristics are objectives of this project and all are constraints regarding bean utilization. In addition, the strong collaborative research efforts and the training program will enhance the probability of overcoming these constraints. A strong interaction between bean breeding programs and this project has been developed.

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

Utilization research is particularly directed toward WID issues. Nutritional quality and ease of cooking address the household, much of which involve women. The training program has extensively involved women.

2. Other social and/or food science issues

This project has paid particular attention to integrate bean variety development to overcome utilization constraints.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCS and Other External Groups

Strong collaborative efforts have involved the Tanzania/WSU CRSP project, Malawi/MSU-UCD CRSP project, the University of Sao Paulo, ICRISAT (legume quality), IITA (cowpea quality) and a number of non-U.S. universities.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews: None reported; none anticipated; apparently none have been requested.

B. Adequacy of Funding by CRSP Participants

Although reported to be adequate in FY 89, a reduction in funding for FY 91 will impede research progress, training programs and publication output.

1. From A.I.D.

Appears adequate at present.

2. From Host Country

No significant problems reported. Plans are underway to develop a proposal on nutrient bioavailability among a number of CRSP HC institutions.

3. From U.S. university

Most universities are experiencing budget constrictions. Therefore, the contributions of the U.S. institutions to overall bean research may present future difficulties regarding leveraging of this CRSP project.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.: No severe problems are apparent.

D. Adequacy of Current Policies and Procedures: Satisfactory

E. Activity Toward Buy-Ins and/or Other Funding

U.S.-industry funding is being pursued. A proposal is being planned for inter-HC collaboration as noted in II.B.2. There has been no attempt for a USAID/Guatemala buy-in.

III. PLANNING

A. Review of the FY 90 Workplan: Satisfactory--No significant changes were made.

B. Plans for FY 91

1. As is the practice in this project, yearly planning was coordinated with INCAP at the 1990 annual meeting of the Institute of Food Technology, Anaheim, California. No significant changes in plans were made.

2. Current plans for FY 91 are satisfactory and will continue on cookability and nutrient quality and coordinating utilization qualities with the bean breeding program at MSU.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

Very appropriate to global plan--Nutritional quality and consumer acceptance are inherent components of utilization projects.

B. Balance Between Research and Training: Satisfactory

1. No specific breakdowns between research and training can be made. However, it is estimated that there is about a 3:2 ratio of funds expended between research and training.

2. Relationship of the expenditures in FY 90 to FY 89

Appears that more funds were allocated to research than training in FY 90 and is responsive to FY 89 EEP review

C. Balance of Domestic vs. Overseas Activities

Appears to be satisfactory—INCAP has focused on application of research to consumer acceptance issues and socio-economic evaluations. WSU/MSU have primarily focused on basic studies on digestibility and cookability and in support of development of bean varieties with enhanced utilization qualities.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Primarily accomplished by PIs at June 1989 and 1990 annual meeting of Institute of Food Technologists; also via telephone contact and at PIs' meeting at MSU and via contacts at other research meetings

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

1. HC reported \$32,075 via salaries of INCAP investigators; U.S. reported \$55,391 via in-kind contributions.
2. Other contributions by HC: None reported
3. Other contributions by U.S.: Support included research assistantship (and tuition), travel to scientific meetings including Ninth Annual SUA/CRSP Bean Workshop at Morogoro, Tanzania
4. Cost effectiveness: Appears to be satisfactory from both HC and U.S.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy: Little or none is occurring.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

Satisfactory—Although not itemized, considerable leveraging is occurring at the U.S. institutions.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

WSU has a long term commitment to bean research (a major crop in the state of Washington). In addition, a number of researchers were invited to present their research at various non-U.S. institutions and write book chapters. One PI presented a paper on legume utilization at an international symposium. Researchers at INCAP are internationally recognized for bean research.

2. Integration with domestic and international commodity research programs

Satisfactory—There are strong commitments to bean research by WSU, MSU and INCAP.

3. Internal project management and institutional management support: Satisfactory

4. Student/professor interactions: Very good

I. Other Comments

The EEP agrees with the overall assessment of this project by the TC regarding questions on lack of focus. The constraints on bean utilization regarding legume quality indices of cookability, nutritional quality (digestibility, protein quality, anti-nutritional factors) are critical to increased bean production and use. Therefore, although phase-out is being accomplished, a new project should address these issues. Objectives should include close collaboration with variety development efforts to insure legume quality from a utilization standpoint.

V. PUBLICATIONS AND PRESENTATIONS

This project has had an excellent record of publication and presentation output.

VI. OVERALL RATING: 2--Satisfactory

A. General Strengths

The quality of the researchers involved is excellent. The issues of cookability, nutritional quality/safety are critical to enhanced bean usage in the HC, U.S. and globally. The development of the interaction of this utilization project with the bean breeding program at MSU is a major contribution and should be promoted as vital to overall bean breeding program success.

B. General Weaknesses

Although the research is critical to the success of the Bean/Cowpea CRSP objectives, there has been a lack of focus on the overall objectives. The role of INCAP has been hard to assess. On-time and comprehensive reporting has been a problem.

VII. FIVE-YEAR EXTENSION PROPOSAL

This project will be phased out. New projects concerned with bean utilization are being solicited.

FY 90 EEP REVIEW

MALAWI • MICHIGAN STATE UNIVERSITY • ISLEIB/ADAMS

Improvement and Host Pathogen Co-Adaptation in Malawi, a Secondary Center of Diversity

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

The focus of this project has been to study the genetic diversity and speciation of the common bean and to use this information to develop improved cultivars for production in the U.S. and Malawi. The knowledge obtained to date is ready for application to breeding programs. Malawi beans have a broad range of genetic diversity (Mesoamerican and Andean) and therefore are excellent sources for evaluation of characteristics, breeding potential and development of more productive heterogeneous mixes.

The genetic diversity of various Malawian landraces has been characterized including their allozyme, protein and mitochondrial DNA differences.

The agronomic performance, racial variability to anthracnose, maize intercropping performance and angular leaf spot resistance were investigated in various Malawian beans.

A total of 650 Malawian landraces were analyzed for their seed storage protein types; 49 percent had the T-phaseolin pattern and less than 3 percent the H-phaseolin pattern. Seed sizes were also studied with respect to seed storage protein patterns. Investigation of the hard-to-cook phenomenon indicated that phytic acid hydrolysis via phytase may be causal to this defect although pectin methyl esterase activity may also play a role.

A major activity of this project has been the evaluation of the socio-economic constraints associated with bean production and utilization. A socio-economic survey has been completed in the southern region of Malawi during this past year. This completes a study of all the Malawi regions. This last study surveyed 350 farmers and demonstrated that beans are important as a food and cash crop, ranking first in providing income for most of the households surveyed and ranking second to maize as the most important food crop. Major production constraints are caused by diseases, pests, drought, lack of seed and suitable varieties, available land, and technological support via extension. Bush beans were preferred over climbing varieties with Chimbamba and Kaulesi being most desirable based on their marketability,

tolerance to disease and culinary characteristics. A majority of the households were headed by women. A limited number of bean varieties were grown compared to the other regions.

The information from the socio-economic studies is critical to defining the research objectives necessary to overcome the constraints limiting bean production in Malawi.

2. Research results disseminated and in use in the HC and U.S.

Over 1200 accessions of Malawian germplasm plus several non-Malawian germplasm were evaluated for angular leaf spot (ALS) resistance traits. Approximately 33 percent showed resistance and another 22 percent partial resistance. Studies with various pathogen isolates confirmed the variations in virulence noted earlier and the need to develop germplasm with broad resistance characteristics. Three varieties were found to have broad resistance characteristics to ALS.

Yield trials have been conducted at seven sites and seed yields generally varied with genotypes. CIAT lines were also evaluated and found to be high yielders with good resistance to disease and will be further evaluated regarding their potential for use in further breeding experiments.

Adaptation trials have shown promising attributes and selections will be made from the most promising varieties. However, these are small seeded and this characteristic may limit their acceptance by farmers.

Agronomic trials using maize intercropping as well as drought resistance trials have recently been initiated in the HC to evaluate fertilizer effects on selected varieties and to select for drought resistance respectively.

3. Other research-related results

- a. Germplasm conservation and use: Germplasm from local (Malawi) varieties and a number of other accessions are screened at Bunda College. Bunda now has the largest collection of *Phaseolus* germplasm in eastern and southern Africa. Screening activities include: yield, adaptation, disease resistance, agronomic response and drought resistance.
- b. Seed production (or other materials): If progress continues, it is expected that from two to five varieties will be released during the next project period.
- c. Impact of other CRSP technology:
- d. Impact on production/consumption of beans/cowpeas: It is too early in the development of this project to have an impact assessment. However, the baseline studies are in place.

- e. Needs of small-scale farmers and women: A major thrust of this project has been to assess socio-economic constraints in bean production and utilization by small-scale farmers. A particular focus of this thrust has been the integral role of women in bean production, use and acceptance. The research is geared to respond to the constraints identified in the socio-economic studies.

4. Changes in national production in Host Country

This project is in its early phase and no changes could be claimed to be attributed to CRSP technology adoption. It is anticipated that there will be reportable changes in the next few years.

B. Institutional Development and Training

During FY 90 the University of California-Davis became the new U.S. lead institution, replacing Michigan State University. Dr. Paul Gepts is now the U.S. PI. The social science component remains under the Co-PI direction of Dr. Anne Ferguson at MSU. Unfortunately, Dr. Chiyenda, the Chair of Crop Production at Bunda, passed away. The CRSP will miss his strong support for the project.

Development of a strong bean research team at Bunda College is occurring. At the present time, two students are pursuing M.S. degrees at Bunda College with completion dates scheduled for late 1992. CRSP-supported training of Malawians has been crucial to the development of this institutional capability and includes: the HC PI, Dr. A. B. C. Mkandawire (Ph.D.); Dr. M. Mafuleka (Ph.D.); Mr. H. Mloza-Banda (M.S.); and Mr. J. Bokosi (M.S.). Mr. Bokosi is currently pursuing a Ph.D. in plant breeding. Additional researchers trained via other resources have helped strengthen the overall bean research capabilities. Further training of personnel in key areas is planned in the extension proposal. Overall, institutional development and training is proceeding satisfactorily.

C. Progress Achieved in Relation to Log Frame

This project has been ongoing since 1982. The original objective, the characterization of genetic diversity in Malawian beans was essentially completed by 1988. Subsequently, the goals focused on disease resistance with emphasis on angular leaf spot and anthracnose, management of bean diseases by farmers, development of plant breeding strategies and development of bean breeding programs at Bunda.

Although reasonable progress in relation to the log frame has been made, progress was slowed by the change in the U.S. PI and lead institution during this past year as well as the change of the PI at Bunda College from Dr. Msuku to Dr. A. B. C. Mkandawire.

Other difficulties cited as impeding the progress of this project towards goals included the unexpected loss of the CRSP vehicle and the slow start-up in training M.S. students at Bunda College, which delayed their role in the development of studies on farmer perception and management of bean diseases.

The CRSP research program is viewed as a component of the Malawi National Bean Improvement Program, which has the same overall thrust of improving bean production by small-scale farmers in Malawi. Strong collaboration has developed between the Rockefeller Food-Legume Improvement Project, the CJAT/SADCC Bean Program and the CRSP project in Tanzania. Interaction between maize and bean projects is also occurring.

Particular joint, cooperative efforts are evolving between the socio-economic components of the Tanzania and Malawi projects headed by Drs. Butler and Ferguson, respectively. This research project is designed to aid in alleviating the anticipated shortfall of bean production in Malawi and provide fundamental information and germplasm pools for bean breeding in the U.S. Information obtained, technology developed, socio-economic constraints elucidated, and genetic diversity will undoubtedly aid in alleviating global constraints regarding bean production and utilization.

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

One of the strong points of this project has been the involvement of a social science thrust since its inception. This research has focused on the role of women in small-scale farmer households and the information obtained is being used to forward the bean production research component of this project. In addition, the information obtained may have some regional application potential particularly for the Tanzanian project.

2. Other social and/or food science issues

Consumer and marketing research capability is currently being developed under the leadership of Dr. M. Mafuleka, a recent recipient of the Ph.D. in Food Technology. The hard-to-cook phenomenon is a global constraint to bean utilization because of fuel shortages in most if not all developing countries. Close cooperation is envisioned to occur with the Tanzanian food science efforts on hard-to-cook beans via the Dr. Butler/Dr. Ferguson conduit.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCS and Other External Groups

It is expected that further collaboration with others will be forthcoming.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

No information on previous or upcoming audits is available. However, owing to the change in U.S. institution and PI, management practices will undoubtedly be reviewed and appropriate changes made.

B. Adequacy of Funding by CRSP Participants

1. From A.I.D.

There is a general need to increase CRSP funding for this project for the following reasons:

- a. Increased activity by the research team in order to achieve objectives within the log-frame schedule
- b. Unexpected need to replace the CRSP vehicle
- c. PI airfare costs and local fuel price increases
- d. The need to cover some indirect costs for the Bunda College research activities

2. From Host Country

Apparently the HC also is having budgetary constraints which resulted in the need to obtain indirect costs for the CRSP project and to obtain CRSP help in supplementing the HC PI's salary. In general, HC matching support has been good. Bunda College has the mandate of the Malawi Ministry of Agriculture for bean research and the Ministry is supportive of the CRSP project.

3. From U.S. university

It is anticipated that the new U.S. lead institution will devote adequate matching funds to the success of this project.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

Depletion of advance funds by Bunda College has been a problem. This primarily has occurred because of delays in sending receipts to the U.S. lead institution in a timely manner. Efforts to correct this problem are underway.

D. Adequacy of Current Policies and Procedures

A designated account for CRSP-related costs has been established with more stringent controls. This will allow for more rapid submission of expenditure receipts and should alleviate some of the previous difficulties on reimbursement. Specific responsibility for this account has been assigned to the Bursar at Bunda College.

E. Activity Toward Buy-Ins and/or Other Funding

A Mission buy-in is being pursued but definite commitments will be delayed until the new Mission director establishes a priority strategy.

Support for bean research has been received from the Rockefeller Foundation and a proposal has recently been submitted for additional funding. Close cooperation between the CRSP and this organization will continue via their Grain Legume project.

III. PLANNING

A. Review of the FY 90 Workplan

The changes in the U.S. institution and PIs will undoubtedly cause some adjustments in the FY 90 workplan but no significant deviations are noticeable. The enthusiasm and competence of the new U.S. PI and the HC PI will undoubtedly enhance the rate of progress of this project.

B. Plans for FY 91

The changes in U.S. institution and personnel (PIs) have been accomplished during FY 90.

1. Research in HC and U.S.

Proceeding according to plan in the HC—Because of the emergence of the bean common mosaic virus (BCMV) as a constraint in bean production in the HC and U.S., some effort will be directed toward the characterization of BCMV in the U.S. institution preliminary to developing an effort in the HC.

2. Expected changes/additions/deletions from FY 90

No major changes are expected in FY 91.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

Very appropriate—Activities include efforts to alleviate constraints on global bean production including socio-economic and sustainable agriculture issues.

B. Balance Between Research and Training

Good—More effort was given to training HC personnel. This has resulted in the strengthening of the HC capabilities and further development of their research team. As planned, approximately 20 percent of CRSP funds were utilized to train HC personnel.

C. Balance of Domestic vs. Overseas Activities

Much of the research in FY 90 was done in the HC. This included socio-economic studies. U.S. research will become more active with the new PI and lead institution in place.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

This project has had outstanding collaboration, particularly in the socio-economic research component. The new PIs have developed an excellent relationship for continuation and expansion of collaborative efforts. Workplans and budgets are being developed in close cooperation between the U.S. and HC PIs.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

A good balance exists between the U.S. and HC institutions regarding research and training funds, with almost equal expenditures of CRSP funds. In addition, both components have contributed substantial "in kind" costs.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

Good relations have existed with the USAID Mission; however, changes in the Mission Director and Ag Development Officer will require renewed efforts to maintain and enhance these relationships.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

At present this appears to be satisfactory. The recent completion of designating the PIs and the U.S. lead institution will further increase cost effectiveness regarding research and training.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

The faculty at Bunda have developed into a highly qualified bean research team. Bunda College is supportive of this activity. The development of the M.S. program in bean research at Bunda College is also indicative of institutionalization progress. Faculty recognition for international activities will become apparent within the next few years. The participation at the 1990 SUA/CRSP Bean Research Workshop at Morogoro, Tanzania by Malawi researchers is also evidence of faculty recognition for international activities.

Since a new U.S. lead institution was assigned to this project, it is too early to assess institutionalization at UCD.

2. Integration with domestic and international commodity research programs

The CRSP research is considered part of the Malawi National Bean Improvement Program. Close coordination/integration also is occurring with the CIAT/SADCC Bean Program and the Rockefeller Foundation bean efforts. There also are collaborative studies with the national maize program.

3. Internal project management and institutional management support: Appears to be adequate

4. Student/professor interactions

A number of students at Bunda College have participated in the studies on bean production practices in southern Malawi. In addition, two M.S. degree students are currently working with faculty at Bunda and they will participate in studies on farmer perceptions and management of bean diseases.

V. PUBLICATIONS AND PRESENTATIONS: Not presented in annual report

VI. OVERALL RATING: 2—Satisfactory

A. General Strengths

The establishment of socio-economic baselines will ensure reliability of impact assessments. The capability, enthusiasm and commitment of the various participants should result in a highly successful effort.

B. General Weaknesses

Progress has been slow in developing variety releases. It is anticipated that the new leadership will accelerate progress. Procedures to insure germplasm preservation should be adopted. The fiscal constraints are slowing progress.

C. Recommendations

Satisfactory performance—It is recommended that this project continue with increased funding.

VII. FIVE-YEAR EXTENSION PROPOSAL

The EEP supports the extension of this project and concurs fully with the TC's evaluation of the five-year extension proposal. They found the extension proposal to be an excellent blend of biological, social science and field research and commended the project for its combination of fundamental and applied science.

FY 90 EEP REVIEW

MEXICO • MICHIGAN STATE UNIVERSITY • HARPSTEAD-KELLY

Improving Resistance of Environmental Stress in Beans Through Genetic Selection for Carbohydrate Partitioning and Efficiency of Biological Nitrogen Fixation

I. PROGRESS DURING FY 90

A. Specific Research Contributions

The collaborative project between INIFAP (national agricultural research program) and MSU is concentrated on bean production problems of the semiarid highlands of central Mexico and similar bean-growing areas of the U.S. The CRSP-sponsored research is carried out in Mexico—primarily at Durango and Aguascalientes—and in Michigan. The program has also collaborated with the University of Minnesota on nitrogen fixation and other institutions on bean-related topics.

1. Research in progress in the HC and U.S.

- a. Improved cultivars (HC): The primary focus of the project is genetic improvement of bean cultivars and parental stocks designed to increase and stabilize yields under the stressful conditions of the semiarid highlands of central Mexico. Rainfall is marginal and unpredictable, nights are normally cool (1800 m–2400 m above sea level), root rot occurs widely and the soils are frequently shallow with excessively high or low pH. As a consequence of these stresses, biological nitrogen fixation (BNF) is frequently reduced; but more effective, introduced *Rhizobium* strains are unable to compete with indigenous N-fixers. In addition, several potent foliar diseases are endemic to the region, chiefly rust, anthracnose, common blight and halo blight. Several virulent races of rust and anthracnose complicate development of multiple resistance strains.

Despite this complexity of problems, the HC is making excellent progress in developing improved strains combining multiple disease resistance, good adaptation to prevailing growing conditions and maturities, and desired consumer qualities (like the shiny black, pinto and "bayo" seed types). In all of these objectives, an over-arching goal is to improve drought tolerance and increase biological N-fixation (BNF) under limited moisture conditions. Screening of a wide range of genetic diversity identified a limited number of genotypes exhibiting some characteristics associated with drought tolerance. These were utilized in bi-parental and multiple crosses as the primary step in a recurrent selection plant breeding strategy. Winter nurseries on the Mexican coast (Sinaloa) were utilized to accelerate the generational advance

and allow further inter-crossing of promising segregants. Advanced generations of selected plants (families) are tested at multiple locations and under controlled environmental conditions (e.g., irrigation).

In 1990 about 2600 F₄ families were evaluated in at least three contrasting environments (Durango, Aguascalientes and Sinaloa) to eliminate 90 percent of the genotypes in each selection cycle. The remaining 10 percent were entered into multi-location replicated yield experiments to more accurately determine performance and allow selection of parental lines for the next cycle of inter-crossing. Since the procedure utilizes both irrigated and rainfed conditions for paired identical nurseries, estimates can be made on both agronomic characteristics and water use efficiency. The procedure has proven effective as the development of superior new lines is increasing every cycle. The most recent named or released strains include:

- Pinto Villa: a disease resistant pinto type with medium to large seeds
- Bayo Victoria: medium seed size, "bayo" (pinkish gray) type
- Negro Durango: medium to small, shiny black seeded type, high yielding

New, even better lines than the above are in advanced nurseries, most of which carry multiple disease resistance.

The HC program recognizes the importance of a continuing infusion of new germplasm into the program. During the past year, 60 new accessions were obtained from CIAT, 100 lines were introduced from MSU and a number of local collections were made. Among the latter were about 15 wild and weedy relatives of *Phaseolus vulgaris* from which it is hoped can be obtained new genetic materials for disease resistance and drought tolerance. A specific line recently obtained from the U.S. (Silbernagel at WSU) is reputed to have good resistance to *Fusarium*.

- b. Biological nitrogen fixation: Studies carried out in both the HC and U.S. have demonstrated differential rates of nitrogen fixation, rhizobium strain efficiency, cell sap osmotic adjustments, capacities to remobilize and translocate labeled nitrogen (¹⁵N-urea), and root growth patterns among selected genotypes in the presence of moisture stress.

Although some aspects of the BNF studies were eliminated or reduced since the recent termination of collaboration with Dr. P. Graham at the University of Minnesota, other activities are continuing. During the past year about 70 new isolates were collected mainly from the major Mexican bean-growing regions. These were evaluated in field and laboratory trials

and resulted in the identification of three new, elite isolates (C.P. 111, 99 and 78). Tests are continuing to determine whether one or more of these are superior to commercial strains of *Rhizobium*. Unfortunately, the bean/rhizobium BNF system is not as efficient as that of other legumes. However, a significant finding of this work on *Rhizobium* is that some efficient strains are better able to colonize bean roots than others under Mexican conditions.

2. Research results disseminated and in use in the HC and U.S.

- a. Improved cultivars, inoculants, etc.: Recent releases--Bayo Victoria and Pinto Villa--have gained farmer acceptance and are spreading rapidly. Other farmer varieties have "voluntarily escaped" INIFAP nurseries to become widespread in some areas.

The new black-seeded strain, Negro Durango, is very promising in regional trials and likely to be officially released during the next several months, based on current results.

The large number of drought-tolerant lines and superior N-fixing rhizobium are being advanced and tested widely both in Mexico and the U.S.

- b. Evidence of extent of use to date: Officially released varieties are under widespread distribution. Unofficial "escapes" are already extensively grown--but not recorded.

3. Other research-related results

- a. Germplasm conservation and use: An additional 15 promising wild and weedy relatives of *P. vulgaris* have been added to the 60 regional collections made in 1988-89. These together with 100 new accessions from the U.S. and 60 lines from CIAT are being evaluated and will eventually be maintained in the 8000 bean accession gene bank at Chapinigo under the supervision of Dr. F. Cardenas, Curator.
- b. Seed production (or other materials): Seeds of the recently released Bayo Victoria and Pinto Villa are being increased for widespread distribution. In addition the new black-seeded strain, Negro Durango, is being increased for imminent release during the next several months.
- c. Impact of other CRSP technology: Chemical marker studies--Isozyme characterization studies show distinct polymorphisms for 10 enzymes. However, it has not been possible to determine whether particular polymorphisms and isozyme patterns are associated with drought reactions.

Plant marker studies--Drought tolerance or avoidance is a very complex manifestation of several plant responses. Biomass partitioning, water use efficiency, nitrogen

fixation, N and C remobilization, osmotic adjustments in cell sap, photoperiod response, rooting patterns and stomatal conductance are all interactive in drought-avoidance.

Despite this complexity, considerable progress has been made on genetic improvement of beans for drought tolerance compared with both extraneous and local germplasm. As such, they are likely to become widely used beyond their present adaptive range—at least as parental stocks.

Some interesting findings are emerging from investigations on the components of drought tolerance. For example, Durango 222 was found to have significantly greater cell sap adjustments in the leaves than Bayo Madero. This means Durango 222 is able to tolerate higher levels of moisture stress before irreversible physiological changes or death occurs.

- d. Impact on production/consumption of beans/cowpeas: Not determined at present
- e. Needs of small-scale farmers and women: These studies are not included in the project.

4. Changes in national production in Host Country

Mexico is the second largest bean producer and consumer in the world. On average, beans are grown on two million hectares in 24 of 30 states in Mexico with average yields of only 335 to 350 kg/ha. The major producing states are Aguascalientes, Durango and Chihuahua where beans are the leading annual field crop. Nevertheless, total annual production is short about 100,000 to 200,000 tons of demand, a major portion of which is imported.

Annual yields vary greatly depending on rainfall and other factors. Annual precipitation in the major producing areas of Durango and Aguascalientes is only about 400 to 450 mm. However, the exceptionally heavy and late rains of 1990, combined with a high farmer price of \$0.70/kg (vs. \$0.30 in 1989), are likely to increase the 1990 production by 15 to 20 percent above the norm.

B. Institutional Development and Training

1. Changes since FY 89

Essentially, there has been no CRSP-supported training for U.S. or Host Country researchers in the past year. While other researchers in the National Legume Program are involved in training, the two junior members of the CRSP team have no access to INIFAP training scholarships. However, the CRSP is providing partial support for Ms. Mmasera Manthe from Botswana and Mr. Ahmed Jama from Somalia, both Ph.D. candidates.

2. Over life of project

The CRSP has supported degree training for two Mexican scientists over the life of the project, one at the Ph.D. level (the Host Country PI) and one at the M.S. level. Additionally, the project provided partial assistance to two scientists from Colombia pursuing M.S. degrees and provided funding for a scientist from Brazil pursuing a Ph.D. degree.

3. In prospect

There seems to be no specific training plan for the Mexico project, yet the project faces the very real possibility of a shortage of "research power." With the HC PI's appointment to be the National Coordinator of the Mexican National Legume Program and his move from the main location of CRSP activities in Durango to Aguascalientes, his time commitment to CRSP activities in Durango has already decreased. His success within the agricultural research system in Mexico will, no doubt, continue and it would behoove the project to consider ways to maintain its excellent level of research through appropriate training decisions.

The CRSP employs two excellent junior researchers at the Durango research station, both trained at the B.S. level. Since both are CRSP employees, they are not eligible for further training through regular INIFAP programs. It is important to provide assistance to these promising junior scientists who have played a significant role in the successes of the CRSP in Mexico.

Within the legume research program in Mexico, there is an impressive level of expertise involved in the bean program and, indirectly, assisting the attainment of CRSP goals. However, the vast majority of these scientists do not have a level of English language expertise to allow them to access research published in English. This has been identified as a limitation to the program in Mexico and a potential area of training.

4. Project training to be completed by end of extension period

There are no specific plans for training.

C. Progress Achieved in Relation to Log Frame

The extension proposal log frame (1989--1991) included five major research objectives:

Objective--Produce bean lines superior to standard cultivars in drought tolerance and N-fixing ability in black and pinto beans and adapted to semiarid highlands of north-central Mexico, using a recurrent selection procedure

Progress--In the development of drought tolerance, the project is working with at least three classes of beans in addition to the blacks and pintos: pink, cream and goats eye.

The Pinto Villa, which was recently introduced, has a good level of resistance to rust.

The Pinto Villa is also more resistant to anthracnose than others.

Minimal progress has been made in resistance to root rot complex since this research focus was only begun in 1989. Currently sources of resistance are being collected and beginning to be incorporated into the breeding program.

Objective—Screen rhizobial strains for efficiency of nodulation, N-fixation and competitiveness and conduct field experiments under stress

Progress—The three native rhizobium strains that are most efficient in N-fixation have been identified and isolated.

Objective—To test the value to drought tolerance of particular morphological and physiological components

Progress—Limited progress has been made in this area because of the lack of a physiologist on the team. However, a scientist who will complete his Ph.D. at MSU in 1991 will return to the bean program in Mexico and focus on this objective.

Objective—Explore the feasibility of isoenzyme markers as indicators of drought tolerance factors

Progress—Research in this area has been conducted by a post-doctoral researcher from Ghana working at MSU who seems to have made some progress in identifying electrophoretic marker loci but has not yet published any results.

Objective—To study the relationship of genotype and stress to N-partitioning

Progress—Work conducted at MSU indicates that drought-resistant and drought-susceptible genotypes exhibit different patterns of nitrogen partitioning and remobilization.

D. Evidence of Biological/Social Sciences Integration

There is little direct CRSP involvement in biological/social science research integration. However, there is a focus on the evaluation of cooking characteristics of bean varieties. Certain varieties have been less appealing to consumers, purportedly because of unacceptable cooking characteristics, and a new focus on cooking and market acceptability of new materials will help address this issue. There appears to have been no "major accomplishments" in this area and while plans for further work are evident in project extension plans, they do not appear in the new log frame.

Even with this focus, minimal social science research is being conducted as a part of national efforts. However, in his role as the national research program director, the Host Country PI has a clear

interest in the ultimate acceptance of his product among farmers and consumers. The following list of issues being addressed through the national program include a wide array of social science concerns ranging from marketing to technology transfer to economic development.

- In response to a problem of seed distribution in Mexico with the private sector limiting production and distribution of seeds because of the limited potential profit, INIFAP is beginning to produce and distribute seeds. It is unclear whether or not the market analysis has been conducted to determine what the exact causes of limited profits and the lack of private sector interest are.
- The Bank of Mexico, in its programs to provide credit to farmers, provides technical assistance/education for farmers. It has used the CRSP as a resource in determining content for that assistance/education.
- Every five years, the Government of Mexico surveys farmers to determine research needs. The survey results are incorporated into the presidential plan for development to determine very broad, basic commodity priorities for agricultural research. Currently efforts are underway to strengthen the farmers linkage to agricultural research with a set-aside from profits for research. The farmers in Mexico are highly organized, already providing potential for some success in this area.

Each of these areas represents the potential of a confounding factor for the successful dissemination of the results of the bean program in Mexico or a potential boost to that dissemination. As such, any could be a viable focus for social science research to be integrated with the biological focus of the CRSP.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

In addition to MSU and CIAT, the INIFAP bean program has linkages to the following:

1. Graduate School at Chapingo (germplasm)
2. Technical Institute at Celaya (laboratory studies)
3. Grain Legume Improvement Programme in Botswana (Ms. Manthe)
4. Mogambo Irrigation Project in Somalia (Mr. Jama)
5. U.S. linkages in place or proposed with:
 - University of California-Davis
 - University of Utah
 - Cornell University
 - University of Minnesota

6. Long-term training is carried out at several institutions both in Mexico and the U.S. At present these include:
Narro University in Mexico (2 M.S.)
University of California-Riverside (Ph.D.)

II. FUNDING/FISCAL MANAGEMENT

- A. Audit/Project Management Reviews: There have been none.

- B. Adequacy of Funding by CRSP Participants

Funding from all sources seems to have been adequate for priority research activities. However, it appears that certain equipment needs will become a priority very quickly (including a reliable project vehicle). With the HC PI's move away from the primary CRSP research site in Durango, his ability to get back and forth to the research plots will become essential to the future of the project.

- C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.: None

- D. Adequacy of Current Policies and Procedures: Adequate

- E. Activity Toward Buy-Ins and/or Other Funding

There is no evidence of interest in a Mission buy-in. However, in addition to Mexican federal government funding, CRSP funding, Swiss government funding through CIAT, and FAO assistance in the form of seed production, the bean program in Mexico is attempting to access state funding and is encouraged by the potential of some funding from the producers' association, whose involvement in research is increasing.

III. PLANNING

- A. Review of the FY 90 Workplan

No changes—Greater emphasis on bean cooking qualities will be an outcome of the establishment of a new laboratory devoted to the evaluation of existing and new strains of beans. Apparently, the growing environment also affects cooking quality and will be studied in this facility.

- B. Plans for FY 91

Minor adjustments in operational plans are anticipated for the coming year. As a consequence of the inconclusive findings on isozyme analyses associated with drought avoidance, emphasis may be shifted to DNA studies and the use of restriction fragment length polymorphism (RFLP) analysis to map dry bean drought responses. It is assumed that the active participation of Dr. J. D. Kelly beginning in 1991 will give renewed impetus to these and other collaborative activities.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

Highly satisfactory—Genetic improvement and information acquired is unique in this CRSP and complementary to other dry bean research.

B. Balance Between Research and Training

This project no longer supports long-term training for students from Mexico, and other sources of funds are available from both internal and external sources for training for INIFAP employees. Two junior scientists working directly for the CRSP do not, however, appear to be eligible for INIFAP training opportunities. It seems that a project training plan would consider use of project funds to assist these individuals as a priority over assistance to new students from other countries.

C. Balance of Domestic vs. Overseas Activities

Satisfactory—Certain activities however have been curtailed or modified as a consequence of the recent changes in leadership at MSU.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Highly satisfactory despite personnel (PI) changes at MSU—Research planning, budget preparation, training decisions and publications are done jointly at frequent meetings of the principals during the year.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

The joint program is fully integrated, effective and productive, thanks to the excellent and extensive bean research program underway and the complementary plant research expertise available in the U.S.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

No support is required; the Mission is very small.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

Highly cost effective considering the infrastructure, facilities and expertise available to the project in both institutions—The highly favorable monetary exchange rate in Mexico has been particularly advantageous in terms of field and laboratory operations.

H. Institutionalization of HC/U.S. Components

The project is fully institutionalized in both Mexico (INIFAP: Dr. Jorge Acosta is the National Legume Coordinator) and at MSU (both Drs. E. Foster and J. D. Kelly are permanent staff members of the Department of Crop and Soil Sciences at MSU). Both institutions provide excellent infrastructure support for the project. It is

particularly helpful when both PIs have a close working relationship and an understanding of the other collaborating institution. In this case, Dr. J. Acosta recently studied for his Ph.D. at MSU; and Dr. D. Harpstead has had a long involvement in Latin America and Mexico.

I. Other Comments

The present reviewers have some concerns about the project based on their recent (9/17-22/90) visit to Mexico. These require attention in future planning and include the following:

1. The widespread occurrence of the root rot complex (*Fusarium*, *Pythium*, *Rhizoctonia*, and *Sclerotinia*) was evident in all plantings observed in both Durango and Aguascalientes. It also appeared that root rot had a differential effect on genotypes; it reduced yields and could directly affect plant response to moisture and other stresses.
2. Both research plot and national mean yields are low in Mexico, ostensibly due to inadequate and poorly distributed moisture. However, other unidentified soil factors (including micronutrient availability) and root rots may be involved. Again, there appears to be an urgent need for much better root rot resistance (from all sources) and possibilities for reducing infection through cultural practices.
3. Weeds are always a major problem in cultivated fields but are particularly troublesome in abnormally wet years like 1990. Since hand labor is often unavailable at the opportune time, some means of mechanizing weed control in beans might be considered for field operations.
4. Recurrent selection has been adopted as the long-term breeding strategy in Mexico. This is an excellent choice, but future progress could be accelerated if recombination was done at an earlier stage (e.g., F_2 to F_3) rather than in the F_4 to F_6 generation. However, this will become easier in future cycles when less diverse parental lines are developed.
5. Termination of collaboration with the University of Minnesota has curtailed studies on BNF, particularly on *Rhizobium*. It is now questionable whether this component of the project should be continued.
6. The change in U.S. leadership has necessarily resulted in some reduction of supporting research on isozyme characterization, RFLP analysis and other physio-morphological studies. However, these and other activities should soon benefit from the assumption of Dr. J. D. Kelly as U.S. PI in FY 91.
7. With the Host Country PI's promotion to coordinator of Mexico's National Legume Program and the clear potential for such a talented scientist to be given more and more responsibility at a national level, it seems that the CRSP should develop contingency

plans for a decrease in the amount of time Dr. Jorge Acosta will be able to commit to the CRSP. One contingency plan would include training to insure the presence of a potential PI in the National Legume Program and further training for the junior scientists already working on the CRSP so that they might take a greater decision-making role on the project.

V. PUBLICATIONS AND PRESENTATIONS: Satisfactory

VI. OVERALL RATING: 2—Satisfactory

This project links a dynamic and productive national bean improvement program with an outstanding U.S. university. As a consequence, new technology is beginning to flow into the hands of farmers at a quickening pace. However, much remains to be done, particularly in the areas of plant diseases (e.g., root rot complex) and undetermined soil problems. Therefore a project extension for 1992-97 is an urgent priority.

A. General Strengths

1. Strong research leadership at both institutions
2. Highly productive national program capable of collaborating at virtually all scientific levels
3. Prestigious U.S. institution with a long and successful history of bean research
4. Close collaboration between the two partner institutions

B. General Weaknesses

1. Field drought tolerance studies *per se* may be confounded by undetermined soil problems like heavy infestation of root rots, plant nutrient availability and other unfavorable conditions. These factors may, in some cases (and years), supersede drought in importance and limiting yields.
2. Field experiments were extensive—impressive from a breeding standpoint but may exceed the project's capacity to properly manage them, particularly in a wet year like 1990.
3. Collaborative research in the U.S. has clearly suffered from recent changes in leadership. There appears to be very little evidence of supporting research on isozyme characterization, RFLP analysis, BNF and other physio-morphological factors during the past 18 months.
4. The project does not have an active socio-economic component to help understand the basic needs of Mexican bean farmers and monitor the impact of imminent new technology.

C. Recommendations

1. The project--both the HC and U.S. investigators--should give immediate attention to fundamental soil problems mentioned above and to separating adaptive factors from drought response.
2. The U.S. institution should establish a strong and well-defined role in supporting studies on the more intractable problems of bean production in central Mexico during the first semester 1991. It may even be advantageous to reassess the primary constraints to production in the region.
3. The HC should arrange training and other preparation for qualified back-up leadership and to assist in carrying out day-to-day activities while Dr. J. Acosta is attending to his other responsibilities as the National Legume Coordinator. We can only assume that Dr. Acosta's success within the Mexico agriculture research systems will continue and it will be more and more difficult for him to commit necessary time to the CRSP.

VII. FIVE-YEAR EXTENSION PROPOSAL

The project made good progress in terms of developing useful farm technology (new varieties). However, there is no convincing evidence that the improvements observed are attributable to increased tolerance to drought but may result from enhanced adaptation to the unique conditions of semiarid highlands and disease resistance incorporated through the breeding process.

The extension period will allow the project to focus anew on the unique production problems of the semiarid highlands; to address the bean plant responses to limited and erratic rainfall conditions, separately from soil and disease effects; and genetically enhance new germplasm for improved performance under prevailing conditions of disease--including root rots, drought, low temperatures and other undefined soil problems. The EEP was impressed with the overall scope and progress of the HC activities and highly recommend continuation of the project during the 1992-97 extension.

FY 90 EEP REVIEW

NIGERIA • UNIVERSITY OF GEORGIA • McWATTERS

*Appropriate Technology for Cowpea Preservation and Processing and
A Study of Its Socio-Economic Impact on Rural Populations in Nigeria*

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

The focus of this project has been on the development of technology for cowpea preservation and processing in the HC and assessing its adoption and impact.

Previously, mechanical milling technology was developed and two village mills were installed at different locations and are now producing product. The economics of this process and the introduction of these products is currently being assessed.

Six workshops were conducted at Nsukka, Adani, Onitsha and Okigwi involving 300 teachers, nurses and housewives. Acceptability testing of different products was also done in six village markets. High acceptance rates occurred and a recipe book developed. Household surveys of 300 families near Ogbodu-Aba indicated cost as the primary constraint to increased demand. A strong preference for dehulled cowpea splits in local dishes was observed in consumer tests involving 500 subjects.

An evaluation of the use of weaning foods containing cowpeas on the nutritional status of sixteen 4- to 6-year-old children is underway. The energy expenditure of housewives and vendors in the preparation of moin-moin and akara was significantly lessened (1.5—3 times) using cowpea flour versus traditional methods.

Process parameters for canned moin-moin have also been developed and basic information on the factors controlling the texture of moin-moin.

Studies on the development of the hard-to-cook phenomenon in cowpea have continued regarding the role of pectinase and subsequent interaction of pectin with calcium in its development.

2. Research results disseminated and in use in the HC and U.S.

- a. Technical papers, reports and bulletins produced and released for public use: Technologies developed for the production of cowpea flour and akara were presented to various members of the dry bean industry in the U.S. Interest was expressed in the potential for an akara product in the U.S.

b. Evidence of extent of use to date: Village mills have been installed in two different locations and they are producing products (cowpea meal, flour, flour blends and weaning food). Additional mills are being set up. Five thousand recipe booklets for cowpea flour containing foods have been published. There is evidence of increased use by vendors and in maternity and child rehabilitation clinics.

3. Other research-related results

- a. Germplasm conservation and use: Not applicable
- b. Seed production (or other materials): Not applicable
- c. Impact of other CRSP technology: Cross-CRSP cooperation with INTSORMIL and peanut utilization projects continues.
- d. Impact on production/consumption of beans/cowpeas: Inflation and the Nigerian government's ban on wheat imports has encouraged the use of cowpea flour in various products. The availability of suitable technology is critical to increased usage of cowpea in the Nigerian diet.
- e. Needs of small-scale farmers and women: Energy requirements for cooking and the human activities for preparing cowpea products is much reduced using dehulled splits or flour. The impact of saving fuel (firewood) on sustainable agriculture systems is apparent. The increased use (demand) of cowpea products by non-rural populations will favorably affect small-scale farmer economies and encourage small village entrepreneurship.

4. Changes in national production in Host Country

It is too early to assess the impact of the technologies developed in this project on cowpea demand.

B. Institutional Development and Training

1. Changes since FY 89

Five B.S. degree students will graduate from the HC institution in 1990. Three M.S. degree students are currently doing research on nutritional aspects of cowpeas and two are completing their degrees with theses on product development and functional properties of cowpea flour, respectively. Five Ph.D. candidates are currently working on their degrees.

2. Over life of project

The capability of the HC institution has been sufficiently developed to allow for relatively independent continuation of cowpea research. This project is currently being phased out in Nigeria.

3. In prospect

The HC institution expects that 3 Ph.D., 3 M.S., and 6 B.S. degrees will be awarded by 1992.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

Two years for this extension proposal, five years overall. This project will phase out the HC affiliation and select another HC. The overall assessment is that very satisfactory progress has been made.

2. Original time estimates for completion

Goals were expected to be achieved by 1992.

3. Progress in relation to proposed schedule: Project is on schedule

4. Relationship to other research

This project has had a strong history of linkages with other Bean/Cowpea CRSP projects and with the Peanut CRSP. See I.E. below.

5. Contribution of lines of research to HC, U.S. and globally

Cowpeas are a staple in many Latin American, African and Asiatic countries. Increased utilization will significantly impact cowpea production and marketing on a global basis.

The capability of the HC institution has been significantly enhanced to contribute to further research on cowpea utilization perhaps even on a regional basis. Technologies for utilization in the HC have been developed and are being adopted. A private funding organization (AFRICARE) is currently using the technology. The enhanced demand for cowpea will have a positive impact on HC nutrition and economy. In the U.S., the potential for an akara-type product is being assessed.

D. Evidence of Biological/Social Sciences Integration

A major focus of the research has been directed towards developing less labor intensive systems for the utilization of cowpeas and to enhance the nutritional quality of the food supply. Workshops are oriented towards teaching women ways and techniques to prepare cowpeas for consumption.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

Linkages include: IITA programs on cowpea, soybean and cassava; University of Ibadan; village women groups; and government agencies such as Imo State AFRICARE project; Silver Spoon Breakfast Service,

Enugu; Francis Foods, Nsukka; Lisabi Mills, Lagos; University of Nairobi, Kenya; University of Ghana, Legon; Noguchi Memorial Institute, Ghana; and the Agriculture University at Wageningen (Netherlands). Linkages with Sri Lanka, Thailand, Indonesia and Denmark are being developed. Efforts have been continued for further cooperation between the Peanut and INTSORMIL CRSPs.

II. FUNDING/FISCAL MANAGEMENT

- A. Audit/Project Management Reviews: None reported
- B. Adequacy of Funding by CRSP Participants: Appears to be adequate but with problems as noted in C. below.
- C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

As in other HCs, the problem of timely submission of expenditure documentation has caused problems in cash flow. The selection process for an alternate HC for this project should emphasize the need for rapid turnaround of expenditure documentation and ease of ordering and delivery of supplies in the HC.

The purchase of a vehicle is critical to the accomplishments of the HC objectives in this project prior to phasing out in Nigeria.

- D. Adequacy of Current Policies and Procedures

See comments in II.C. above. In addition, difficulties in purchasing American-made vehicles and, in some cases, equipment for HC use causes serious delays or, at times, unending "down-times."

- E. Activity Toward Buy-Ins and/or Other Funding

A proposal to the USAID Mission in Egypt for a cowpea utilization buy-in was not successful in 1990. A collaborative project on cowpea containing weaning food by the HC with the Agricultural University at Wageningen, The Netherlands, is expected to be funded by the IFS, Sweden. IITA collaborative efforts by the HC are occurring on cowpea-cassava intercropping. Funding for improvement of milling equipment has also been received from the HC university (Nsukka).

III. PLANNING

- A. Review of the FY 90 Workplan: Project is proceeding as planned.
- B. Plans for FY 91

This project is proceeding towards a planned phase-out in the HC in 1992. A new HC site is currently under active consideration and hopefully will be selected in early 1991 for a new five-year project which has been proposed.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

The goals are very appropriate. This project has a focus of increasing utilization of cowpeas on a local, regional and global basis both in developing and developed countries.

B. Balance Between Research and Training

Very good balance has been apparent with approximately a 4:1 research to training expenditure. It should be noted that considerable training costs have been absorbed via other funding sources. The research and training expenditures are very close to those planned for .FY 90.

C. Balance of Domestic vs. Overseas Activities

Appropriate--Both HC and U.S. participants have coordinated their activities to make the most efficient use of resources. Basic and applied research are well balanced within the two institutions.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Excellent--Plans were made in 1988 in Nigeria for 1989 through 1992. Follow-up meetings were held to refine plans through 1992.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

1. U.S. and HC Contributions to FY 90 Budget: Cost sharing contribution by the University of Georgia was 37 percent of the A.I.D. contribution to the U.S. institution. This amounted to a cash contribution of \$30,485.79 (\$22,878.53 direct plus \$7,607.26 indirect). The University of Nigeria contributed staff time of HC PI and other co-investigators on the project. All facilities of the departments of Food Science and Technology and Home Science and Nutrition and the services of the technical staff of both departments were also made available to the project at no overhead cost to the CRSP. These contributions are in-kind.

2. Other Funding

No significant other funding sources were cited in the annual report. However, general support of the CRSP activities by the participating institutions via facilities, administrative costs and cost for travel and publications are apparent.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

There is no USAID Mission in Nigeria. However, the USAID liaison at the U.S. Embassy in Lagos has been supportive.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

The cost effectiveness appears to be very good as evidenced by training and research outputs.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

Scientists from both institutions have been recognized by colleagues for their research on cowpeas via requests for their publications, participation as reviewers of scientific publications and requests for post-graduate training in cowpea utilization. The University of Georgia is considered the principal U.S. site for cowpea utilization research.

2. Integration with domestic and international commodity research programs

Linkages include IITA, Africare/Imo State Child Survival Project, private companies, and academic institutions in Ghana, the Netherlands and elsewhere. As a result, the HC institution has expanded its capacity to integrate domestic with international commodity research programs. CRSP activities are well integrated into overall research at the U.S. institution since cowpeas are an important crop in the state. The U.S. team has had extensive contact with a major processor of frozen cowpeas in Georgia and has evaluated use of a byproduct of its operation as the basis for industrial akara making. Evaluations using cowpeas provided by this company showed that satisfactory akara could be made from this cultivar. Discussions with California processors of cowpea-based foods are generating interest in akara as a possible retail or institutional food.

3. Internal project management and institutional management support

Although not without difficulties, the HC management has improved throughout this project's continuation regarding management of both research and training programs. The University of Georgia has had outstanding management.

4. Student/professor interactions

Appears to be very good in both the HC and US institutions

1. Other Comments

It appears that the HC will be capable of independently continuing cowpea utilization research and training. However, encouragement and communication with the HC team by the U.S. institution following phase out in Nigeria is highly recommended.

V. PUBLICATIONS AND PRESENTATIONS: Exceptional output

VI. OVERALL RATING: 2--Satisfactory

A. General Strengths

Commitment and research output of the U.S. institution's participants and strong participation of HC researchers.

B. General Weaknesses

Difficulties in the HC regarding management of the project and ease of accomplishing objectives owing to HC government regulations.

VII. FIVE-YEAR EXTENSION PROPOSAL

We concur with the TC's overall assessment and await the selection of the HC. As noted in our general comments, we recommend a very close association with production projects and selection of a location that has potential for regional impact. It is suggested that, as feasible, the University of Georgia continue to encourage the Nigerian utilization efforts.

FY 90 EEP REVIEW

SENEGAL • UNIVERSITY OF CALIFORNIA-RIVERSIDE • HALL

*A Program to Develop Improved Cowpea Cultivars,
Management Methods and Storage Practices for Semiarid Zones*

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

This is a comprehensive research project conducted in Senegal and in the U.S. Substantial collaboration extends to IITA and through West African networks of A.I.D. (SAFGRAD), IITA, and the French government (CILSS). There is also cooperation with the Cameroon/Purdue and Nigeria/University of Georgia CRSP projects.

The main thrusts of the project, as the title suggests, are superior cultivar identification and breeding of varieties to overcome the main cowpea diseases, insect and weed pests; and development of improved cultural and management methods and storage practices for cowpea production and preservation. The project also seeks materials with multiple disease and pest resistance and with other desirable traits such as heat and drought tolerance and nutritive and culinary qualities.

2. Research results disseminated and in use in the HC and U.S.

- a. Improved cultivars, inoculants, etc.: The ISRA team has developed an advanced line (#275) in which they have incorporated resistance to the cowpea weevil (at the seed level), bacterial blight and mosaic viruses. This line has now been subjected to four years of multi-location testing on research stations and two years of multi-location on-farm testing. The advanced line has equivalent or higher grain yields than the best available varieties over the full range of environmental conditions where cowpeas are grown in central and northern Senegal. Tests by the Food Technology Institute (ITA) in Dakar indicate that this line has grain quality that is equivalent to some local varieties (e.g., 58-57), but not as good as some less widely used varieties (e.g., Bambey 21 and CB5). Evaluations conducted in two on-farm nurseries in 1990 designed to screen for resistance to the parasitic weed, *Striga Gesnerioides*, indicate that #275 may have strong resistance to *Striga*, confirming results obtained in 1989.

Storage experiments demonstrated that K-Othrine PP2 at 50g/100kg grain can effectively store cowpea grain for more than six months, whereas Actellic and Actellic Super were

only effective for four months and that sealed drums can be effective for more than six months.

Scientific papers were published showing that measurements of carbon isotope composition may be useful in breeding cowpeas for adaptation to drought (Hall et al., 1990), classifying cowpea accessions for their tolerance to heat (Patel and Hall, 1990), showing that yield potential may be increased by selecting for higher harvest index (Kwapata and Hall, 1990b), and describing and comparing models for breeding for tolerance to heat and adaptation to drought (Hall, 1990)

- b. Evidence of extent of use to date: Evidence of extent of use of new technology is being obtained by surveys conducted by Dr. Seynabou Tall, who joined the project in 1990. She has made studies in seven villages where on-farm Mini-Kit trials have been or are being conducted. She interviewed 125 people in each village, including: five men and five women from Mini-Kit families and five cultivators of cowpeas who had not been directly involved in the Mini-Kit experiments. A complete report is not yet available, but some preliminary information is presented here. A majority of the Mini-Kit farmers (55 percent) and the non-Mini-Kit farmers (67 percent) have used chemical products to aid the storage of cowpeas, but most of them use Actellic and only a few have started to use K-Othrine (it should be noted that the project has not conducted extensive Mini-Kit tests with K-Othrine). Most farmers' wives cannot read, but they listen to agricultural programs on the radio which are presented in a local language. This indicates that a radio program to advise extension agents, farmers and farmers wives on the use of K-Othrine and sealed drums in the storage of cowpea could be beneficial and an effective means for disseminating this technology. Dr. Tall is also conducting on-farm tests of the cooking quality of the advanced line No. 275. As a consequence of two years of on-farm testing, this line is becoming adopted by farmers, and ISRA has requested the responsible agency to officially release it as a new variety in Senegal.
3. Other research-related results
- a. Germplasm conservation and use: Under funding from USDA and this project, 600 lines from IITA were propagated in a glass-house and are now being multiplied in the field at Riverside, together with 400 other accessions from the UCR collection. In cooperation with Dr. R. Hampton, Oregon State University, the seed-borne viruses present in these materials are being determined to minimize the possibility of importing new diseases into California. Drs. R. O. Hampton and P. N. Patel have established that substantial variation is present in cowpea response to different isolates of potyvirus, including representatives of both cowpea aphid-borne mosaic and blackeye cowpea mosaic viruses from Senegal and elsewhere. A set of cowpea genotypes has been developed that is useful for differentiating among and diagnosing these potyvirus isolates.

This project now has a collection of 2,500 accessions of cowpea with descriptor information on a computerized data base. Seed has been provided to the following cooperators in 1990: 500g each of seed of 328 new accessions to the USDA Plant Introduction Station in Georgia to enhance the U.S. collection; 200 accessions to the Cameroon/Purdue CRSP project for screening pod resistance to bruchids; seeds of 30 accessions to Dr. Nevin Young for his RFLP genome mapping project on cowpea, and the same accessions to Dr. Norman Weden for complementary studies of isozyme variation; cowpea seed to CRSP projects in Puerto Rico and the Dominican Republic, a Peace Corps Project in Belize, Bunda College in Malawi, El Obeid Research Station in Sudan, South Africa, a heat shock protein project at Texas Tech University, the Research Institute for Irrigation in Hungary, the International Atomic Energy Agency in Austria, and projects screening for resistance to *Lygus*, root knot nematodes, the *Fusarium solani* at the University of California. The UCR cowpea germplasm collection and data base has become a valuable resource for scientists throughout the world. Unfortunately, funding from USDA for cowpea germplasm multiplication and characterization ended on September 30, 1990. This activity is being continued at a modest level using CRSP funds.

- b. Seed production (or other materials): The project is producing breeders' seed of all varieties used in Senegal, and the advanced line #275, and assisting the ISRA seed multiplication services to produce one to two tons of disease-free foundation seed per year. Dr. Patel inspected the seed-producing fields in Senegal in 1990 and advised the new ISRA plant pathologist, Mr. Mbaye Ndiaye, concerning the inspection of fields for diseases and methods for producing disease-free seed.
- c. Impact of other CRSP technology: The farmers involved in the Mini-Kit experiments are producing the equivalent of certified seed and through the use of the improved storage techniques are making high quality seed available to farmers. They produced five tons on experimental plot and many more tons on their own fields for the 1990 season. The Mini-Kit farmers are using modified plates provided by the project to permit the seeding of cowpeas in rows using their peanut planters. During the 1990 season there were many non-Mini-Kit fields of cowpea in Senegal that had been planted with peanut planters.
- d. Impact on production/consumption of beans/cowpeas: The statistics for cowpea production are given below. They indicate that the production of cowpea as dry grain during the last three years of the project was 30 percent greater than the production during the 10 years prior to the project. Most of this increase was due to improved efficiency of production with higher yields. These statistics only consider cowpea production of dry grain. A substantial portion of the early cowpeas are consumed on the farm or sold as fresh "southern

peas." Discussions with farmers indicate that selling fresh cowpeas can be extremely profitable, and Dr. Tall has initiated studies to obtain information on this aspect of cowpea production and consumption.

- e. Needs of small-scale farmers and women: This project is developing varieties of cowpea and management methods that have greater and more stable production, while requiring only minimal inputs that are available to small-scale farmers. With one exception, the Mini-Kit farmers chosen for cooperative research have small farms. In early 1990, the project hired a Senegalese sociologist, Dr. Seynabou Tall, to study women's roles in cowpea production, storage and utilization. Dr. Tall has expertise studying the role of women in development in Senegal, and she has an established commitment to women's concerns. She will provide guidance to the project so that the technology being developed and extended will be beneficial to all members of farm families, and indirectly to the urban poor.

4. Changes in national production in Host Country
(Source: Ministry of Rural Development, Senegal)

Year	<u>Hectares Planted</u>		<u>Yield/Hectare</u>		<u>Total Production</u>	
	<u>Louga*</u>	<u>Total</u>	<u>Louga</u>	<u>Total</u>	<u>Louga</u>	<u>Total</u>
	hectares		kg/ha		tons	
1970-79	25,203	63,300	295	293	7,746	18,568
1980	28,516	54,247	370	315	10,539	17,080
1981	30,218	68,484	401	420	12,110	28,777
1982	28,627	47,930	233	276	6,671	13,245
1983	12,658	40,000	371	325	4,696	13,000
1984	8,400	53,000	-0-	302	-0-	16,000
1985	63,557	121,000	434	545	27,588	66,000
1986	53,733	117,607	451	466	24,001	54,863
1987	35,114	71,480	325	400	11,412	28,625
1988	29,067	69,121	235	251	6,820	17,320
1989	23,123	64,809	255	407	5,903	26,350

*Louga and Saint Louis regions

B Institutional Development and Training

1. Changes since FY 89

A plant pathologist, Mr. Mbaye Ndiaye, was hired by the project in May 1990 to replace the expatriate scientist, Mr. D. G. Gaikwad, who had returned to India. Dr. P. N. Patel worked with Mr. Ndiaye in Senegal in August and September 1990 to train him in methods of screening plants for resistance to bacterial blight and mosaic viruses. The field entomologist, Dr. Amadou Bal, left Senegal in May 1990 to be a professor in Niger. The project does not yet have another entomologist. Ms. Khady Diop, who obtained a B.S. in entomology at UCR and returned to Senegal on February 18, 1990,

has not yet established a research program due to health problems. The storage entomologist, Agron. Engr. Dogo Seck, left Senegal in September 1990 to begin a Ph.D. program in Belgium. The seed technologist, Agron. Engr. Famara Massaly, left Senegal in January 1990 to begin an M.S. program at Mississippi State University. The seed multiplication project is now directed by Mr. Artur Da Silva. A sociologist, Dr. Seynabou Tall, was hired by the project in January 1990. An economist, Mr. Moustapha Gaye, from the Farming Systems Department of ISRA is providing a part-time contribution to the project working with Dr. Tall. Four technicians were terminated in June 1990 in response to austerity measures taken by the Government of Senegal. At UCR, Mr. Mubarak Abdalla transferred from the M.S. to the Ph.D. program. Since July 1, 1990, the project has been providing funds for students from the Sudan: Mr. Mubarak Abdalla, Mr. Faisal Ahmed and Mr. Abdel Ismail. These students had been conducting research for the CRSP project and, in recent months, the Government of the Sudan has been unable to fund their present scholarships or extend them.

2. Over life of project: See I.B.1, 3 and 4.
3. In prospect

The extent of research on field and storage entomology will be substantially reduced due to the shortage of scientists in Senegal. For storage research this is not a problem because the project is emphasizing the extension of storage technologies developed by the project, in cooperation with the extension agencies. The agronomist, Mr. Samba Thiaw, will return to Senegal in January 1990 and will conduct some high priority research on the use of seed dressings to control hairy caterpillar. Screening breeding lines for resistance to cowpea aphid will be conducted by technicians supervised by the plant breeder or the agronomist. ISRA has promised to hire a replacement field entomologist as soon as this is possible. The cost of conducting the project in Senegal will be increased because the project is paying the salaries of the plant pathologist and the sociologist and will have to hire more temporary laborers to compensate for the technicians who were terminated due to shortages of Government funds. For FY 91, a majority of the funds for UCR will be spent on the training costs of the three Sudanese students. Support is being sought from UCR, and to date the project has obtained a tuition waiver for one quarter for one of the Sudanese students and elimination of indirect costs for these training expenses. The extreme shortage of project funds at UCR will result in a reduction in the research that can be accomplished compared with previous years.

4. Project training to be completed by end of extension period

Mr. Mbaye Ndiaye will undertake a general training course on cowpeas at IITA, Ibadan, in October and November 1990 and gain experience in the virology of cowpea diseases at Oregon State University in 1992 under informal training with Dr. R. O. Hampton. The following students are projected to complete their degrees by

the following dates: Mr. Samba Thiaw, M.S. Plant Science, December 1990; Mr. Owen Gwathmey, Ph.D. Botany, January, 1991; Ms. Claudia Petrie and Mr. Faisal Ahmed, Ph.D.s in Botany, Fall 1991; Mr. Abdel Ismail, Ph.D. Botany, Winter 1992; and Mr. Mubarak Abdalla, Ph.D. Botany (Plant Genetics), Spring 1992. Mr. Ndiaga Cisse is projected to begin a Ph.D. program in Plant Breeding in the U.S. in August 1991 if the five-year extension is granted.

C. Progress Achieved in Relation to Log Frame

1. Length of commitment to research related to these objectives

The program goal, since the project was initiated in August 1981, was to increase grain production and yield stability of cowpea grown on small farms in Senegal and other semiarid regions. For Senegal, this was achieved during the period 1985-1989 with total grain production and yield/area that were 108 percent and 28 percent, respectively, greater than the baseline period of 1970-79. The impact of the project on production in other semiarid regions is unknown and was probably negligible.

2. Original time estimates for completion

The project purpose was to develop improved cowpea varieties, management methods and storage practices for small farms in Senegal. Significant progress on the project purpose was anticipated by the end of this phase in 1992.

3. Progress in relation to proposed schedule

The project has made significant progress. Advanced breeding line #275 has resistance to cowpea weevil, bacterial blight and mosaic viruses; probably some useful resistance to *Striga*; and greater yield stability than available varieties. If this line is released by the Government of Senegal in 1991, the project will have achieved more than was planned, originally, because the resistance to *Striga* is a consequence of serendipity. Unfortunately, the agency responsible for varietal release in Senegal is inexperienced and the release may take more time than is warranted (the line is clearly superior to available material). Sowing cowpeas in rows at high densities using a modified peanut planter is proving to be effective and is being accepted by farmers. Methods for extending the improved storage techniques, involving K-Othrine treatment or sealed-drum storage, are being developed at this time. Cowpea varietal intercropping was shown to increase the stability of cowpea grain and hay production under dry infertile soil conditions on experiment stations. The next step is to evaluate cowpea varietal intercrops on farm conditions in cooperation with farmers, and this will be initiated in 1991.

4. Relationship to other research

This project conducts most of the research on cowpea in Senegal and is the national cowpea research program. SAFGRAD has designated the program as one of the leading centers for cowpea

research, with responsibility for exporting technology to other countries in Africa. The focus of the program on cowpea sole cropping and varietal intercropping complements the program of IITA which, in recent years, has begun to emphasize the intercropping of cowpea with cereals.

5. Contribution of lines of research to HC, U.S. and globally

Senegal should plan on increasing cowpea production to 100,000 tons/year by the year 2010 to meet the food needs of a population that is projected to double within 20 years. This will more than double the demand for cowpea due to shortages of other foods. The basis for achieving a four- to five-fold increase in national production within twenty years is to develop cowpea production systems that are two-to-three times more productive (yield/ha) but require only modest inputs and double the total area of cowpea under cultivation. This increased production of cowpea would enhance nitrogen fixation and improve the fertility of the soil in the Peanut Basin, contributing to the yields of millet and peanut. Continuation of the project, with progress similar to that achieved since 1985, would enable Senegal to meet the production goal of 100,000 tons/year by 2010. The project is continuing with the development of varieties for California which will help this industry to continue as a major world-wide exporter of cowpea. The basic research at UCR on methods for breeding crops with improved heat tolerance and adaptation to drought has the potential to make long-term contributions to increasing the stability of production on a global scale of several crop species in addition to both cowpeas and beans.

D. Evidence of Biological/Social Sciences Integration

Structural problems within the Government of Senegal and funding constraints have impeded the integration of the agricultural sciences research of this project with complementary research on social sciences. The secondment of the economist, Mr. Moustapha Gaye, from the Farming Systems Department in 1989 and the hiring of the sociologist and specialist in Women in Development, Dr. Seynabou Tall, in 1990 have enabled this project to initiate linkages between agricultural and social sciences research. In addition, the project has collaborated since 1989 with the Food Technology Institute (ITA) in Senegal on the evaluation of the food quality of the advanced lines and varieties.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

This project assisted the Nigeria/University of Georgia project to plan a presentation on the food processing of cowpea and *akara* which was made in Southern California in June 1990. The organization of cowpea farmers in California appreciated the presentations of Ms. Kay McWatters and the UGA team because of their potential contribution to increasing the consumption and demand for cowpeas in the U.S. and elsewhere. Discussions were held also with ITA and the USAID Mission

in Senegal to facilitate the possible establishment of a University of Georgia/ITA project on cowpea food processing in Senegal. The project contributed to the Cameroon/Purdue project by providing seed of 200 cowpea accessions for screening for pod resistance to bruchids. Purdue has provided cowpea accessions from Cameroon to this project which will be multiplied to enhance the U.S. cowpea germplasm collection. Even closer collaboration with the Purdue and Georgia projects is planned for the future because there are so few cowpea CRSP projects and efforts must be coordinated.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews: None reported

B. Adequacy of Funding by CRSP Participants

The Government of Senegal faced a budget crisis in 1990 which required the termination of many ISRA technicians (more than 300) and decreased the likelihood of their hiring new scientific staff. Fortunately, the cowpea project lost only four technicians. ISRA hired two Senegalese scientists paid by the project to keep the project operational. These are temporary positions, but one of the positions will be considered for a permanent position when and if new Government positions become authorized. The U.S. dollar fell to an all-time low, making less money available in Senegal. The Government of the Sudan defaulted on student support, necessitating the use of UCR project funds to continue the support of three Sudanese students. The Agricultural Experiment Station of the University of California has been subjected to a major budget cut since July 1, 1990, whose magnitude has not yet been determined. The external review of the project in Senegal in FY 90 necessitated the expenditure of extra costs for the travel of the Principal Investigator, which had not been included in the budget. The project is presently being conducted in California with instructions to minimize expenditures in all sectors and the project technician will be terminated in a few months if financial conditions do not improve.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

Financial reporting by ISRA has been more prompt than earlier years.

D. Adequacy of Current Policies and Procedures: Seem adequate

E. Activity Toward Buy-Ins and/or Other Funding

The USAID Mission provided ISRA with some funds to support an extension of the cowpea research to the Senegal River and to pay some of the operational expenses of socio-economic studies conducted during FY 90.

III. PLANNING

A. Review of the FY 90 Workplan: Not reported

B. Plans for FY 91: See II.B. above.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

SAFGRAD and A.I.D. have designated Senegal as a technology-producing country. This project has helped ISRA to achieve this status for cowpea, and further assistance would help ISRA achieve the goal of exporting cowpea technology to neighboring countries. The more basic research being conducted at UCR is useful to crop production research projects throughout the world.

B. Balance Between Research and Training

1. Expenditures for training in FY 90

Expenditures for training in FY 90 were \$22,890 for Senegal and \$14,070 at UCR; and on research (excluding overhead) were \$66,441 for Senegal and \$65,295 at UCR.

2. Relation to planned expenditures

Budgeted expenditures on training in FY 90 were \$32,782 for Senegal and \$-0- at UCR; and on research (excluding overhead) were \$56,375 for Senegal and \$77,965 at UCR. The differences between actual and budgeted expenses on training are due to the unexpected return of Ms. Khady Diop to Senegal and the need for the project to support the Sudanese students. This enhanced the funds available for research in Senegal and decreased the research funds available at UCR.

C. Balance of Domestic vs. Overseas Activities

Appropriate, considering the philosophy of the project which is to promote the evolution of independent, but collaborating, programs in Senegal and California with minimal long-term use of expatriates.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

The ISRA team met with Dr. A. E. Hall in Senegal in August and September 1989 to finalize the workplan and budget for FY 90. Dr. Hall and Mr. Ndiaga Cisse jointly presented the research report for the project at the PIs' meeting at MSU in May 1990. The UCR and ISRA teams met at UCR following the May meeting to evaluate the 1989 summer season research and plan the 1990 summer season research. In September 1990 Drs. Hall and Patel met with the ISRA team in Senegal, helped with the organization of the external review, finalized the workplan and budget for FY 91, and finalized planning for the five-year extension.

**E. Relative Contribution of Collaborating Institutions and Individuals
Toward Accomplishment of Objectives**

1. U.S. and HC budgetary contributions

The A.I.D. contribution to the project in FY 90 was \$230,500 with direct costs of \$93,657 for ISRA and \$85,965 for UCR. The ISRA contributions were approximately \$22,770 for the salaries of scientists, \$44,275 for the salaries of technicians, and \$95,450 for the costs at four experimental stations, giving a total of \$211,243 including indirect costs. The UCR contributions were \$26,499 for salaries and \$40,000 for the costs at two experimental stations, giving a total of \$95,051 including indirect costs.

2. Other contributions

ISRA received approximately \$8,000 from the USAID Mission to extend the research into the Senegal River region and to support costs of socio-economic studies. Two U.S. students working on the project at UCR received research assistantships from UCR totalling \$22,200. Three Sudanese students working on the project while studying for graduate degrees received a total of approximately \$45,000 for the year from the Government of the Sudan.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

The USAID Mission has been using this project as a model in its plans to assist ISRA to strengthen the other crop research programs in Senegal. Future support, however, is less certain given the Mission's "rethinking" of its strategy.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding

It would appear that the project is quite cost effective given the level of productivity from continuing tight budgets. The impact of attrition in ISRA inputs is as yet uncertain, but could be substantial.

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

The Dean, College of Agricultural and Natural Sciences at UCR, has actively supported this project.

2. Integration with domestic and international commodity research programs

The project continues to work with the cowpea farmers of California and receives funding from the Blackeye Varietal Council (\$18,500 in 1990). The cowpea germplasm obtained by the project has benefitted the cowpea breeding programs in California.

3. Internal project management and institutional management support

The Management Services Officer and her staff at UCR have continued to provide excellent administrative support for the project, but they find that it takes considerable time and the project PI has had to spend far too much time on project administration this year.

4. Student/professor interactions

The support from professors at UCR in Botany and Plant Sciences, Soil and Environmental Sciences, and Entomology for Mr. Thiaw, Mr. Abdalla, Mr. Ahmed, Mr. Ismail, Ms. Petrie, and Mr. Gwathmey has been excellent. The difficulties for Ms. Diop during her stay at UCR were due to her personal, psychological problems and, in retrospect, were not solvable despite the sincere and sensitive efforts of the PI and several personnel at UCR to provide her with assistance.

V. PUBLICATIONS AND PRESENTATIONS

The productivity of this project is documented in seventeen publications and technical reports during FY 90. Oral reports were made on at least six occasions to technical audiences.

VI. OVERALL RATING: 1--Highly Satisfactory

A. General Strengths

Major strengths include the comprehensiveness of the project, the level of both HC and U.S. contributions, the strength of the technical base undergirding the project and the extensive collaboration between the project and other cowpea and related research internationally.

B. General Weaknesses

The principal weaknesses are the insecurity of funding and the attrition in HC staff resources.

C. Recommendations

Funding should be shored-up as much as possible. Consideration should be given as to whether a utilization project should be associated in the next extension.

VII. FIVE-YEAR EXTENSION PROPOSAL

The EEP commends this project for its consistent productivity; its holistic approach to cowpea research, including collaboration with other institutions (i.e., IITA, SAFGRAD, CILSS, the Cameroon, etc.); and its training and institutional development activities in Senegal. We think the project has maximized use of resources available to it. We think it is a key element in the five-year extension and urge its inclusion.

FY 90 EEP REVIEW

TANZANIA • WASHINGTON STATE UNIVERSITY • SILBERNAGEL

Breeding Beans (Phaseolus vulgaris L.) for Disease, Insect and Stress Resistance and Determination of Socio-Economic Impact on Smallholder Farm Families

I. PROGRESS DURING FY 90

A. Specific Research Contributions

1. Research in progress in the HC and U.S.

The current focus of this project is to establish a programmatic approach to increasing the production of beans by smallholder farmers via a multi-pronged approach. This includes:

- a. Development of highly productive germplasm and agronomic practices for the environmental conditions in Tanzania
- b. Establishing which socio-economic constraints may affect bean production and mechanisms for overcoming them
- c. Developing a bean utilization component integrated within the production and socio-economic research programs to preserve the product and enhance demand.

The major effort to date has been devoted to bean production via germplasm improvement and development of monoclonal antibody (MCAB) diagnostics for BCMV. The development and use of MCAB has been primarily done in the U.S. component of this project as well as the development of BCMV-resistant germplasm via conventional and genetic engineering techniques.

The HC research in process includes: further development of multiple disease resistant lines (e.g., Kabanima backcrosses); evaluation of advanced lines with multiple disease resistance including their responses to changes in agronomic practices; further developing farmer participatory research programs and establishing more communication (outreach) systems to strengthen farmer-SUA linkages. In addition, several baselines have been and are being established regarding current bean production systems by region including bean preferences and consumption patterns for subsequent impact analysis.

2. Research results disseminated and in use in the HC and U.S.

The Ninth Annual SUA/CRSP Bean Research Workshop was an excellent vehicle for disseminating research results to other bean researchers. Extensive use of MCAB for screening for BCMV is underway in U.S. breeding and seed production programs.

TMO216 has been distributed to farmers in the Kilosa district with strong acceptance reported.

Dr. Butler has worked with SUA scientists to develop on-farm trials and to be involved with on-station trials.

3. Other research-related results

- a. Germplasm conservation and use: Germplasm accession, conservation and exchange continues. A limited number of cooking studies on bean varieties have been done in the Food Science Department at SUA as well as studies on the potential use of sprouted beans for food preparation.
- b. Seed production (or other materials): There was some seed multiplication and limited release of TMO216.
- c. Impact of other CRSP technology: Trials on the use of the inoculant NITROSUA are promising and this inoculant is being produced at SUA.
- d. Impact on production/consumption of beans/cowpeas: None to date
- e. Needs of small-scale farmers and women: The impact of the technology will be addressed following establishment of the baselines on production practices, bean preferences and consumption patterns. Production constraints are the focus of this project.

4. Changes in national production in Host Country

Germplasm releases and production practices are not far enough along to impact production in HC.

B. Institutional Development and Training

1. Changes since FY 89

Dr. S. Nchimbi has established a strong research and training program following receipt of her Ph.D. at the University of Wisconsin. Students being trained by her at SUA gave impressive papers at the SUA/CRSP workshop. One student has been admitted to MSU for a Ph.D. in agronomy. Three Ph.D. students are expected to complete their degrees with the next year or two.

2. Over life of project

To date, five Tanzanians have completed Ph.D.s and a number of undergraduate students have done research projects under CRSP auspices.

3. In prospect

The capability of SUA in the areas of food science, rural economy and agricultural education and extension have shown marked growth. Therefore the potential for an integrated programmatic approach to include socio-economic and utilization/marketing components to the program are excellent. Personnel trained under the CRSP (Dr. Mollé) in agriculture education and extension is also developing a program similar to 4-H as a technology transfer system.

4. Project training to be completed by end of extension period

Completion of the training of two additional Ph.D. candidates with M.S. degrees from SUA is planned (seed technology and entomology). If additional funds are available, three trainees (agronomist, microbiologist, anthropologist) and a non-degree technical program are envisioned.

C. Progress Achieved in Relation to Log Frame

Sources of resistance to bean diseases, breeding strategies, disease identification and field-testing techniques have been developed. These are essentially the goals planned to be achieved during this period.

Although it had been projected that resistant releases would be available by now, this goal has not been achieved. Limited release of TM0216 is underway and at least one other variety is approaching release status, with several additional varieties in the pipeline.

Progress is satisfactory to date.

D. Evidence of Biological/Social Sciences Integration

1. Attention to WID issues

Dr. Lorna Butler has been appointed (25 percent) to develop research support in this area. Particular emphasis is on participatory research by farmers in on-station research and the role of women in bean production. This area has developed nicely over the past several years.

2. Other social and/or food science issues

Although of limited nature, food science inputs have continued regarding consumer acceptability and nutritional implications.

E. Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with CRSPs, IARCs and Other External Groups

This project has developed outstanding linkages and collaborative projects. The exceptional success of the Ninth Annual SUA/CRSP Workshop in conjunction with the Second SADCC/CIAT Regional Bean Research Workshop is a prime example. It brought together production,

socio-economic and utilization researchers from the region, sponsored by numerous organizations. Many of the participants were familiar with each other's research programs and interaction among them was very apparent. This resulted in extensive cross-fertilization of ideas and developed a regional, if not global, programmatic view of a total effort regarding bean research including constraints and impacts. Strong interactions are occurring regarding the social science/WID areas between this project and the Malawi/UCD CRSP project (Dr. Anne Ferguson).

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews: None reported

B. Adequacy of Funding by CRSP Participants

1. From A.I.D.

A.I.D. funding is marginally adequate but is limiting the development of socio-economic component and caused deterioration of the utilization/marketing component.

2. From Host Country

Adequate support is being supplied by the HC in the form of personnel, experimental plots, and buildings. There appears to be a strong commitment by the institution and the government of Tanzania for bean research and user acceptance.

3. From U.S. university: None were cited.

C. Problems Regarding Funding, Budgeting, Release of Funds, Etc.

The new procurement procedures initiated in FY 89 are satisfactory.

D. Adequacy of Current Policies and Procedures

These appear to be satisfactory.

E. Activity Toward Buy-Ins and/or Other Funding

A Mission buy-in proposal has been submitted and is awaiting a decision. In addition, there is another proposal being developed to address utilization/marketing issues (Departments of Food Science, Rural Economy, Ag Engineering and Land Planning, and Ag Education and Extension).

III. PLANNING

A. Review of the FY 90 Workplan

1. Adjustments/changes/additions/deletions

No significant changes were specified.

2. FY 90 Workplan

Development of human-powered thresher was dropped; support of food science component was minimal; overall workplan appears to be adhered to.

B. Plans for FY 91

The breeding program at SUA will continue to address regional problems. The new emphasis on participatory research will have a positive impact on the program.

IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan: Very appropriate

B. Balance Between Research and Training

Very appropriate—The value of emphasizing the training component in the past is now apparent, particularly in the development of HC research programs by Dr. S. Nchimbi and Dr. N. Mollel.

C. Balance of Domestic vs. Overseas Activities

This appears to be in good balance with more basic research (e.g., BCMV work) in the U.S. and application in the HC.

D. Level of Collaboration/Cooperation Between U.S. and HC Institutions

Outstanding—Workshops held at SUA are the annual site of research planning sessions, decision-making regarding training needs and development of publication schedules, etc.

E. Relative Contribution of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

There is excellent balance between the HC and U.S. institutions and good inputs from USAID. Cost effectiveness appears high with considerable "leveraging" via cooperative projects.

F. Interest, Involvement and Support of USAID Mission and/or U.S. Embassy

Currently, decisions for further support are being delayed owing to new Mission direction.

G. Cost Effectiveness, Especially Regarding Level of Activity vs. Funding: Very good (See IV.E.).

H. Institutionalization of HC/U.S. Components

1. Faculty recognition for international activities

The CRSP-trained faculty members have been instrumental in increasing the quality and quantity of the overall faculty, leading

to further development of SUA. Supporting capabilities have improved. A new facility for Food Science has been completed.

Dr. James Teri was a Kellogg Foundation Fellow and Dr. Mtembe (Food Science) was a Fulbright Fellow at the University of Illinois.

2. Integration with domestic and international commodity research programs

The integration of a number of commodity research programs has steadily developed.

3. Internal project management and institutional management support

Overall project and institutional management support is excellent.

4. Student/professor interactions

Student/professor interactions appear excellent. The quality of Dr. Nchimbi's students' presentations at the workshop were excellent evidence of this.

V. PUBLICATIONS AND PRESENTATIONS

The workshop proceedings have been compiled and distributed to participants. Two papers have been published and one submitted to journals.

VI. OVERALL RATING: 1—Highly Satisfactory

This project has the potential to develop into a regional center of excellence in bean research (production and utilization). Progress is very good and the potential for achieving the CRSP objectives is excellent.

A. General Strengths

A strong programmatic approach to bean research encompassing production, social and economic issues has developed. CRSP-trained faculty at SUA are assuming leadership roles. The HC institution and government are strong supporters of bean research. This project has developed regional capabilities.

B. General Weaknesses

No marked weaknesses—Logistics and baseline information available are always a problem in HCs as is lack of equipment.

VII. FIVE-YEAR EXTENSION PROPOSAL

The EEP supports the extension of this project. Although the TC has concerns about the holistic approach, the EEP believes that this project has an excellent potential for development of an integrated production/utilization project with regional impacts at Sokoine. The EEP supports the continued development of a strong socio-economic component in the extension proposal.

ATTACHMENT D

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