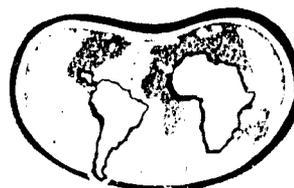


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# **THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)**

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REPORT OF  
THE EXTERNAL EVALUATION PANEL OF  
THE BEAN/COWPEA CRSP FOR FY 89

January 1990

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## TABLE OF ACRONYMS

|         |   |           |   |
|---------|---|-----------|---|
| AAAS    | American Association for the Advancement of Science   | INIFAP    | Instituto Nacional de Investigaciones Forestales y Agropecuarias (National Institute of Forestry and Agricultural Investigations)                           |
| A.I.D.  | Agency for International Development  | INTSORMIL | Sorghum/Millet CRSP   |
| AGR     | Agriculture   | IPM       | Integrated Pest Management  |
| ALS     | Angular Leaf Spot   | IPRC      | Insect Pathology Resource Center  |
| AMMI    | Additive Main Effects and Multiple Interaction Effects Analysis   | IR        | Institutional Representative  |
| ANTH    | Anthraxnose   | IRA       | Institut de la Recherche Agronomique (Institute of Agronomic Research)  |
| ARS     | Agriculture Research Station  | IRRI      | International Rice Research Institute   |
| BCMV    | Bean Common Mosaic Virus  | ISRA      | Institut Sénégalais de Recherches Agricoles (Senegalese Institute of Agricultural Research)   |
| BGMV    | Bean Golden Mosaic Virus (BGHV/BZ, Brazil; BGMV/GA, Guatemala)  | LDC       | Less Developed Country  |
| BIFAD   | Board for International Food and Agricultural Development   | ME        | Management Entity   |
| BOSTID  | Board on Science and Technology for International Development   | MNR       | Ministry of Natural Resources   |
| BNF     | Biological Nitrogen Fixation  | MO        | Management Office   |
| BOD     | Board of Directors  | MOU       | Memorandum of Understanding   |
| BTI     | Boyce Thompson Institute  | MSTAT     | Microcomputer Statistical and Data Management Package   |
| CATIE   | Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Center for Investigation and Teaching) | MSU       | Michigan State University   |
| CBB     | Common Bacterial Blight   | NARS      | National Agricultural Research System   |
| CESDA   | Centro Sur de Desarrollo Agropecuario (South Center for Agricultural Development)                                     | NAS       | National Academy of Science   |
| CGIAR   | Consultative Group on International Agricultural Research   | NCRE      | National Cereals Research and Extension Project   |
| CIAT    | Centro Internacional de Agricultura Tropical (International Center of Tropical Agriculture)                           | NIFTAL    | Nitrogen Fixation by Tropical Agricultural Legumes  |
| CNPAF   | Centro Nacional de Pesquisa de Arroz e Feijao (National Center of Investigation for Rice and Beans)                   | PCCMCA    | Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios (Central American Cooperative Program for the Improvement of Food Crops) |
| CRSP    | Collaborative Research Support Program  | PI        | Principal Investigator  |
| CSRS    | Cooperative State Research Service  | PMV       | Peanut Mottle Virus   |
| DR      | Dominican Republic  | PSTC      | Program in Science and Technology Cooperation   |
| EAP     | Escuela Agrícola Panamericana (Pan-American Agricultural School)  | RFLP      | Restriction Fragment Length Polymorphism  |
| EEP     | External Evaluation Panel   | RIISP     | Research Initiative: Insects of Stored Pulses   |
| EMBRAPA | Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Investigations)                    | RH        | Relative Humidity   |
| EPACE   | The Ceara State Agricultural Extension Service  | SADCC     | Southern African Development Coordinating Committee   |
| FAO     | Food and Agricultural Organization of the United Nations  | S&T       | Science and Technology  |
| FY      | Fiscal Year   | SEA       | Secretaría de Estado de Agricultura (Secretary of State for Agriculture)  |
| HC      | Host Country  | SUA       | Sokoine University of Agriculture   |
| HTC     | Hard to Cook  | TC        | Technical Committee   |
| IARC    | International Agricultural Research Centers   | UCR       | University of California-Riverside  |
| IBPGR   | International Board of Plant Genetic Resources  | UFL       | University of Florida   |
| IBSNAT  | International Benchmark Site Network for Agro-Technology Transfer   | UGA       | University of Georgia   |
| ICTA    | Instituto de Ciencias y Tecnología Agrícola (Institute of Agricultural Science and Technology)                        | UMN       | University of Minnesota   |
| IITA    | International Institute of Tropical Agriculture   | UNL       | University of Nebraska-Lincoln  |
| INCAP   | Instituto de Nutrición de Centroamérica y Panamá (Institute of Nutrition of Central America and Panama)               | UPLB      | University of the Philippines-Los Baños   |
| INIAP   | Instituto Nacional de Investigaciones Agropecuarias (National Institute of Agricultural Investigations)               | UPR       | University of Puerto Rico   |
|         |   | U.S.      | United States   |
|         |   | USAID     | U.S. Agency for International Development   |
|         |   | USDA      | U.S. Department of Agriculture  |
|         |   | UWI       | University of Wisconsin   |
|         |   | WB        | Web Blight  |
|         |   | WHO       | World Health Organization   |
|         |   | WID       | Women in Development  |
|         |   | WSU       | Washington State University   |
|         |   | YSA       | Yield System Analysis   |

REPORT OF  
THE EXTERNAL EVALUATION PANEL OF  
THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM  
FOR FY 89

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 89 activities, the first year of the second extension.

Evaluations were based on site visits to the campuses of participating U.S. institutions (eleven universities and one private, non-profit, research organization), project annual reports and discussions with the CRSP Management Office/Management Entity (MO/ME), Principal Investigators and the Agency for International Development (A.I.D.) Project Manager.

A. The FY 89 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. Rachie. 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, retires in 1990. The current members and their affiliations are given in Attachment C.

3. 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 89, there were thirteen projects for review (beans--nine and cowpeas--four). The thirteen remaining projects are located in eleven Host Countries (including INCAP, a regional institution located in Guatemala) and are conducted by eleven U.S. lead institutions.

The Bean/Cowpea CRSP projects are developed and executed by Principal Investigators (PIs) in collaborating U.S. and HC institutions. Oversight and participation in approval of plans and budgets are made by the Technical Committee (TC), 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, who 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 89 EEP Review: Sequence of Events

The following are events which comprised the FY 89 EEP review process.

1. A Scope of Work (see Attachment A) was developed by the Chair of the EEP and the Program Director, 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, 1989. The Scope of Work also served as a guide for EEP reviews of individual projects.
2. A schedule of EEP site visits to U.S. lead institutions was executed between September 1, 1989 and January 10, 1990. All participating institutions were visited by one or more EEP members--usually by two members.
3. EEP members Gray, McBreen, Rachie, Robins and Siedler were assigned three or four projects or special topics for intensive review and preparation of discussion drafts prior to the annual EEP meeting in Orlando, Florida, January 21-26, 1990. EEP members were assigned projects to which they had made site visits during the year.
4. Draft reviews of individual projects and special topics were discussed at the Orlando meeting. Final project and topic evaluations were made during the discussions.
5. The fiscal and administrative review was made from a site visit to MSU and from data/information supplied by the MO. Discussions of CRSP operations and procedures, status of activities and related matters were held with various MSU officials (ME and the MO), with PIs during site visits and 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 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

For the FY 89 review, thirteen projects were evaluated with regard to progress, funding/fiscal management, planning, status and prospects. One project--Ecuador/UMN--is just getting underway and several are in transition--Malawi/MSU and Mexico/MSU (changes in U.S. PI and adjustments in programs). Seven projects are rated 1-Highly Satisfactory, two are rated 2-Satisfactory and four are rated 3-Satisfactory but CRSP officials may wish to consider orderly phaseout. 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). Women in Development (WID) is separate from the MO and is funded as a half-time position.

Prior EEP evaluations of projects have concentrated on the HC components. EEP site visits have been made to all collaborating HC country institutions and EEP observations have been revealing and rewarding. Culling and adjustments have occurred; several projects were terminated; several were consolidated and/or reorganized; most were cited for satisfactory to outstanding progress. The result is that, with one possible exception, the Bean/Cowpea CRSP is now made up of solid, productive projects that reflect the best in collaborative research arrangements. During the first years of operation, the MO established a program management early-warning/surveillance system to ensure that program and administrative problems were attended to promptly. Currently the CRSP is in a comfortable position; there are no troubled projects at this time.

Satisfied with the status of HC activities, it was concluded that the EEP might appropriately shift its attention during 1989 to CRSP operations at U.S. lead institutions. With this in mind, the MO arranged for EEP site visits to all U.S. institutions during the year. These visits re-confirmed the high degree of interest and commitment by the lead institutions to the Bean/Cowpea CRSP and corroborated the view that when afforded structured, well-managed, potentially rewarding research and educational opportunities, U.S. institutions can become enthusiastic, important contributors to international development.

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: Highly Satisfactory

### SPECIAL COMMENTS:

Socioeconomic Case Study: The MO with help from A.I.D./S&T/AGR arranged for an impact study of cowpea activities in Senegal ("Impact Study of the Bean/Cowpea CRSP for Senegal" by L. A. Schwartz, J. A. Sterns and J. F. Oehmke, November 30, 1989). Using rate of return analysis, the study found " . . . benefits quantifiable in dollars results in an estimated rate of return of 63 percent. . . . This is an extremely positive rate of return and reflects well on the economic value of the project." Bean/Cowpea CRSP authorities are cited and congratulated for removing uncertainty and conjecture associated with the benefits of CRSP activities to nations. This is the first time that rate of return analysis--an accepted way of estimating the benefits of research projects--has been used by the Bean/Cowpea CRSP. It may be the only instance for any CRSP.

Allocation of Funds in Support of Research on Major Constraints: Not since the five-year review in 1986 have the PIs, TC and EEP made intensive reviews of progress made by the CRSP and others toward ameliorating major constraints to bean and cowpea production. Similar intensive reviews should be held prior to the end of the current extension period.

In this review, the EEP supports the recommendation of the TC to begin orderly phaseout of several bean and cowpea projects. This circumstance prompts a review of current allocation of CRSP resources with regard to constraints. Therefore, at the conclusion of the regular evaluation of projects, training, WID and fiscal and administrative management, the EEP made a preliminary, cursory review of the allocation of funds by constraint areas. This review revealed the following distribution of funds (in thousands)\*:

| <u>BEANS</u>                       | <u>COWPEAS</u>                      |
|------------------------------------|-------------------------------------|
| <u>Disease/Pathology</u>           | <u>Diseases</u>                     |
| \$210 DR/UNL--Caribbean            | Senegal--West Africa                |
| 73 DR/UWI--Caribbean               |                                     |
| 141 Honduras--Caribbean            |                                     |
| 182 Malawi--East Africa            |                                     |
| 195 Tanzania--East/Southern Africa |                                     |
| <br><u>Insects</u>                 | <br><u>Insect Control</u>           |
| Tanzania--East/Southern Africa     | Senegal--West Africa                |
|                                    | \$189 Brazil--South America         |
| <br><u>Stress/Water/Heat</u>       | <br><u>Stress/Water/Heat</u>        |
| \$132 Mexico--Central America      | \$221 Senegal--West Africa          |
| 105 Guatemala--Central America     |                                     |
| Malawi--East Africa                |                                     |
| Tanzania--East/Southern Africa     |                                     |
| <br><u>Social/Economics</u>        | <br><u>Social/Economics</u>         |
| Malawi--East Africa                | Cameroon--Central/West Africa       |
| Tanzania--East/Southern Africa     |                                     |
| <br><u>Utilization</u>             | <br><u>Utilization</u>              |
| \$212 INCAP--Central America       | \$143 Nigeria--West Africa          |
| <br><u>Nitrogen Fixation</u>       | <br><u>Storage</u>                  |
| Mexico--Central America            | \$176 Cameroon--Central/West Africa |
| \$125 Ecuador--South America       | Senegal--West Africa                |
| Tanzania--East/Southern Africa     |                                     |

\*Project's total FY 90 budget, not including one-time supplements, reported under main constraint area only.

With regard to beans, the funding has been, and currently is, mainly concentrated on diseases and principally in the Western Hemisphere--Central and South America and the Caribbean. The general view of the EEP is that this has been appropriate, given the importance of beans in the region and the prevalence and seriousness of diseases; however, the EEP notes, for example, the progress that has been made in developing disease-resistant bean cultivars, especially for BCMV. Given progress in control of diseases by the CRSP and others, it may be possible to consider shifts of resources as they may become available to other areas, e.g., to utilization and companion socioeconomic research in the next extension period.

In the case of cowpeas, the CRSP is down to four projects and all except one are rather narrow, specialized projects. This is hardly a significant global effort. It is now time for the CRSP to re-assess its cowpea program (and its bean program also) with special regard to CRSP capabilities, global needs and opportunities and other international and national programs.

The EEP notes that A.I.D. is a major contributor to IARC-sponsored international bean (CIAT) and cowpea (IITA) improvement programs and the sponsor of the Bean/Cowpea CRSP. It is important that these programs be complementary and supplementary with minimal duplication. With respect to CRSP bean and cowpea programs in Africa, CRSP authorities should be fully aware of the A.I.D. Africa Bureau's plans and programs to improve national agricultural research system (NARS) on that continent (see EEP Special Comments on this matter in the EEP report for FY 88, page 4).

Performances of U.S. Participating Institutions: During 1989-90, EEP members, usually two-person teams, made site visit reviews of all U.S. lead institutions. Reports of these reviews are on file in the CRSP Management Office. At the Annual Meeting of the EEP, each institution was again reviewed, with special regard to such matters as: financial, administrative and logistical support for the CRSP/PI; staffing of the CRSP activity, including assignment of graduate assistants/research fellows; location of the CRSP in the academic structure; financial accounting, including internal and external audits; reporting and responsiveness to requests; participation in CRSP affairs/meetings and the status of CRSP activities as evaluated by the EEP. Slow financial reporting (University of California-Riverside) and unresponsive subcontract administration (Cornell University) were the only performance shortcomings noted.

For FY 89, the performances of all thirteen lead institutions are rated Satisfactory.

Overall Assessment/Comments on the Bean/Cowpea CRSP: The EEP reviewed briefly the Global Plan of the CRSP and current bean and cowpea projects, with special regard to coverage of constraints and related activities, such as training and WID.

It is clear that there are major gaps in coverage of existing constraints by the CRSP. This is not unexpected due to the nature and size/scope of the CRSP. Within its limited funding, the CRSP has done quite well in its coverage of constraints with beans, but less so with cowpeas.

A major shortcoming of the CRSP is the general lack of companion socioeconomic research; and there is a clear deficiency in utilization research.

The CRSP has concentrated on production and WID, as identified in the original constraints assessment. For the activities it has undertaken (i.e., its current portfolio), the CRSP has done a fine job.

Sources of Funding for the Bean/Cowpea CRSP: More and more, the various projects of the Bean/Cowpea CRSP are receiving funds from various sources which extend and strengthen research and training activities. The nature, amount and impact of funding from all sources should be reported. The EEP recommends that funding over and above that by A.I.D. and participating institutions (U.S. and HC) be reported each year in annual reports with accompanying comments as to the uses and impact of such additional funding.

### III. PROGRAM EVALUATION: TRAINING AND WOMEN IN DEVELOPMENT

#### A. Program Evaluation: Training

Short-term training and undergraduate- and graduate-level degree programs have consumed sizeable amounts of funding over the life of the CRSP. With CRSP funding cuts, several projects have essentially dropped training from budgetary consideration. Others have accessed funds from other sources and have thus sustained viable training components.

Of the thirteen projects, ten reported some level of training activities and/or plans in their FY 89 annual reports. These plans varied from fairly specific strategic approaches for the building of institutional capability to merely an accounting of numbers of people in training. The three remaining projects reported no training plans. In one case (Mexico/Harpstead) no training was planned; in another (Guatemala/Wallace) the training element was not described although a graduate student is funded 100 percent on the project; finally, the third project (INCAP/Swanson) included no training plan but noted that approximately 3/4 of the project budget was spent on training.

There is sufficient variation in quality among the training reports of the individual CRSP projects to convince the EEP that there is not a general understanding of the need for project training plans in the CRSP. It is, in fact, not exactly clear that the CRSP as a whole, or the MO, has internalized the need for project, regional and/or CRSP-wide training plans.

In response to the EEP review for FY 88, the MO initiated a CRSP alumni survey to ". . . get an overall evaluation of CRSP training and to ascertain the extent to which that training was sufficiently useful to the graduates' professional needs." Results from the survey are preliminary, with only a 36 percent return, and a follow-up letter to non-respondents is planned. However, the preliminary results include information that would be helpful in the formulation of project, regional and CRSP-wide training plans.

While the implementation of the alumni survey will do much to fill the void of quantitative and qualitative information on past CRSP training activities, there appears to have been no change in the ongoing collection and analysis of training data. The report by the MO of FY 89 CRSP training is perhaps even less enlightening than it has been in the past. Ongoing analysis of training seems to stress gender and very minimal quantitative information. For example, the report's table lists trainees completing their programs during the year but fails to note which CRSP projects sponsored the trainees.

Unfortunately, although the preliminary report of the alumni survey is well done and appears to be comprehensive, the FY 89 CRSP training report fails to make a connection between the survey and the development of CRSP training plans. While such plans are important to all of the CRSP projects, they are particularly important to new start-ups where the training element is crucial to the development of professional and institutional linkages as well as Host Country institutional development.

A CRSP-wide training plan could provide the policies and strategies to insure that newer projects receive CRSP funding or are assisted in accessing other funding for these important activities. Such a plan could also provide strategies for dealing with turnover issues in ongoing projects.

The EEP, once again, encourages the development and use of training plans at project, regional and CRSP-wide levels. We also encourage a more comprehensive, ongoing collection and analysis of training data.

## B. Women in Development

Dr. Anne Ferguson is the coordinator of the WID Program on a half-time basis. Dr. Ferguson serves as liaison to the Technical Committee, and she is an ex-officio member of the Technical Committee. In this capacity, the Technical Committee recommends close association with one or two specific projects to develop the WID component. She serves as coordinator, resource person and liaison for all the WID-related activities. Other functions of Dr. Ferguson include aiding in long- and short-term training programs via encouraging project leaders to incorporate WID components and by encouraging females to enter training programs. Finally, Dr. Ferguson represents the CRSP at various professional meetings as a participant and by making appropriate presentations at various times and places.

### 1. Specific Contributions

#### Cameroon/Purdue Project

Dr. Ferguson contributes to WID activities in this project. Participation by Dr. Ferguson in the planning of this project allowed for considerations of WID. As a result, Jane Wolfson on the Purdue campus is interacting as the WID representative, and she maintains contacts with the WID counterpart in the HC.

#### INCAP/WSU Project

An anthropologist from the University of Washington (J. Hogg) has recently worked with this project studying patterns of malnutrition in Guatemala. The conclusions of this study indicated malnutrition is caused by numerous factors, not solely food intake. Among these are sanitation, health practices and various environmental factors. The publication status of this study was not indicated.

The activities at INCAP have a major involvement with WID and other socioeconomic issues in the Central American sector.

#### Malawi/MSU Project

Dr. Ferguson, who is essentially the coordinator of the WID activities in the CRSP, is also associated with this project. She is currently on a half-time appointment in Malawi and half-time with WID. Her duties to the CRSP regarding WID and socioeconomic issues interact with numerous projects.

A longitudinal socio-cultural study was conducted in Northern Malawi by Dr. P. W. Barnes-McConnell. Additional studies of bean production practices in the Dedza Hills area of the central region were carried out by Dr. Ferguson. Using information derived from these studies, a bean breeding strategy was developed which would be suitable for use in Malawi and other areas of Africa where farmers plant mixtures of beans. A paper describing this breeding strategy was presented at the Annual Meeting of the American Association for the Advancement of Science (AAAS) in January 1989, as well as at the CRSP Annual Bean Improvement Workshop at Sokoine University in Tanzania. A working counterpart to Dr. Ferguson is now available in Malawi. Therefore, she will be able to spend additional time interacting with other projects.

An annotated bibliography on Malawi women in agriculture has been completed.

#### Nigeria/UGA Project

In the utilization project, there is an inherent component addressing WID issues directed toward reducing the labor by women for preparing food. This program has had a long history of strong interactions, and it includes instructing women in preparation, technology, etc.

#### Senegal/UCR Project

This project has been engaged in preparing and distributing mini-kits to assist in the use of CRSP-generated, improved germplasm and technologies. Dr. Ferguson is working with Dr. A. E. Hall to assess the reasons for the slow acceptance.

#### Tanzania/WSU Project

Small-scale farmers and women have been a consideration in this project from its initiation. Socioeconomic studies have provided data on the role of women in bean production and utilization. Some strong interactions have occurred owing to the participation of Dr. Jean Due. Dr. Ferguson has maintained contact with Dr. Due, who has generated numerous publications on the socioeconomic aspects in Tanzania and Africa in general. This work was an identification of socioeconomic issues related to bean production. The upcoming plans are to develop an integrated team approach between HC and U.S. counterparts in this area.

## 2. Training Programs

There are considerable WID aspects incorporated in a number of training programs associated with specific projects. However, a comprehensive and strategic plan regarding the training program should be developed. Training is an important component of the CRSP which includes degree and short-term programs. Not only do these establish linkages, but they are important in the institutional development in the HC. In 1989, twenty-two students received advanced degrees, twelve received Ph.D. degrees (seven males and five females) and ten

received Masters degrees (four females and six males). Three students (two males and one female) completed their Bachelors degree. In addition, seven researchers participated in various short-term training opportunities.

At the present time, there are sixty-four students (thirty-four males and thirty females) currently enrolled in degree programs. Overall, it appears that the percentage of women in training programs approximates nearly 50 percent.

It should also be noted that although the utilization component consists of less than 20 percent of the total budget, it has a large training component which involves a goodly number of females. Although the training program is very effective, it would still appear to need some planning in regard to specific needs, etc.

3. Progress Achieved in Relation to Objectives Stated in the Log Frame

Progress appears to be satisfactory, in spite of the limited resources. Dr. Ferguson has done an outstanding job.

4. Funding/Fiscal Management

Since the area of audit/project and management reviews has been incorporated into various projects, it is managed via the project.

In general, there is inadequate funding to accomplish objectives. However, various projects have developed leveraging procedures to have anthropologists, sociologists and economists become involved.

5. Planning

a. Review of FY 89 Work Plan

WID and training efforts are planned within the specific projects. However, several proposals have been put forth by Dr. Ferguson to expand activities. One involves seed handling and multiplication. It is hoped that this type of approach is integrated into all projects involving variety introduction. The second proposal concerns increasing social science research to assess the social and economic impact of various project technologies. Specifically, Dr. Ferguson was asked to identify key projects for WID consideration. These consisted of the Brazil/BTI project on fungal pathogens for control of cowpea pests and Senegal/UCR on cowpea improvement.

b. Plans for FY 90

In addition to initiating the studies cited above, plans for FY 90 include the following:

Malawi: Investigate small farmer seed handling and planting practices and determine farmers' perceptions and management of plant pathogens.

Senegal: Socioeconomic studies are anticipated to begin on cowpea storage methods, cooking and consumption.

Tanzania: Develop interaction with Tuskegee's Farmer Outreach Program. A team approach to the socioeconomic sector is being developed using two Host Country participants (Nchimbi and Mollel) and Lorna Butler, an anthropologist at WSU.

6. Status in FY 89

a. Appropriateness of Activities to Goals of Global Plan

This program is very appropriate to the Global Plan.

b. Balance Between Research and Training

It appears that the balance is good, but it is difficult to assess the difference between research and training in some of the areas, particularly those in the Host Country.

Balance of domestic versus overseas activities with respect to program constraints appears to be very good.

c. Level of Collaboration/Cooperation Between U.S. and Host Country Institutions and Personnel

The WID Program and training program are designed to accomplish just those objectives. Therefore, the WID and training area are basically a collaborative effort between the U.S. and Host Country.

d. Relative Contributions of Collaborating Institutions and Individuals Toward Accomplishments of Objectives

These appear to be very good, in spite of the low level of resources available from the project itself. Attempts by several projects to develop socioeconomic components using their institutional capabilities is commendable.

e. Cost Effectiveness

Cost effectiveness is exceptional based on the relatively low level of resources and the level of output which is occurring.

f. Evidence of Institutionalization in the Host Country

It appears that this is going well.

7. Publications and Presentations in FY 89

At least two refereed publications, one non-refereed publication and four presentations were made in the WID area. In addition, two panels were organized at the 1989 AAAS Annual Meeting.

## 8. Overall Rating

The WID Program appears to be going very well. Efforts to leverage the limited funding in this area through institutions may alleviate the drain on the available resources within the projects.

### a. General Strengths

The general strengths include the ability to interact with numerous projects and develop WID programs within those projects.

### b. General Weaknesses

The general weaknesses are primarily associated with the training programs in that there is a lack of an overall plan and specific plans within the projects. However, they are moving in the direction of attempting to assess the training program via surveys, etc.

## 9. Recommendations

In general, this program is rated Very Satisfactory.

#### 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. While the staff has performed superbly in conducting basic administrative operations, funding availabilities have restricted the ability of the Management Entity to monitor CRSP research and fiscal operations for which it has ultimate responsibility. See Attachment D for a brief report of highlights of the Management Office operations during FY 89.

EEP members, including the Chairperson, visited the Bean/Cowpea 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.

Rating: Outstanding

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 U.S. institutions, data provided by the MO, and discussions with the MO and A.I.D. officials.

| <u>Category</u> | <u>Rating and Recommendation</u>   |
|-----------------|--|
| 1               | Highly Satisfactory  |
| 2               | Satisfactory   |
| 3               | Satisfactory, but CRSP officials may wish to consider major adjustments or orderly phaseout<br>OR<br>Project in transition |
| 4               | Unsatisfactory, CRSP officials may wish to consider orderly phaseout   |

B. Summary of Ratings

Category 1: Highly Satisfactory  
Cameroon/Purdue  
Dominican Republic/UNL  
Dominican Republic/UWI  
Honduras/UPR  
Mexico/MSU  
Senegal/UCR  
Tanzania/WSU

Category 2: Satisfactory  
Ecuador/UMN  
Malawi/MSU

Category 3: Satisfactory, but CRSP officials may wish to consider orderly phaseout  
Brazil/BTI  
Guatemala/Cornell  
INCAP/WSU  
Nigeria/UGA

Category 4: None

## 1989 EXTERNAL EVALUATION PANEL SCOPE OF WORK

I. PROGRESS DURING 1989

- A. Specific research contributions in 1989 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.

- B. Institutional development and training, i.e., strengthening Host Country bean and/or cowpea research and improvement systems.
  - 1. Cite the changes since 1988.
  - 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 C4 above.

## II. FUNDING/FISCAL MANAGEMENT IN 1989

- 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 1989 work plan during 1989.  
Adjustments/changes/additions/ deletions--ME notified? TC?
- B. Plans for 1990.
  - 1. Research in Host Country and U.S.
  - 2. Expected changes/additions/deletions from 1989 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 1989

- A. Appropriateness of activities to goals of Global Plan.
- B. Balance between research and training.
  - 1. Give expenditures for research and training in 1989.
  - 2. Relate these expenditures to research and training plans for 1989, made in 1988.
- 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 1989.
    - b. Preparation of budgets for 1989.
    - c. Decisions regarding training CRSP personnel in 1989.
    - d. Decisions regarding publications/presentations in 1989.

- 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 1989 budget. Note whether the HC and U 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 1989

VI. OVERALL RATING

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

SUGGESTED CHECKLIST FOR EEP EVALUATION VISITS TO  
BEAN/COWPEA CRSP PARTICIPATING UNIVERSITIES

I. References

- A. Grant Document No. DAN-1310-G-SS-6008-00
- B. Guidelines for Collaborative Research Support Programs
- C. 1989 EEP Scope of Work

II. Background

The EEP has devoted most of its attention in recent years to the HC components of the CRSP. It is now timely for the EEP to make up-to-date assessments of institutional commitments/support to the CRSP, administrative management/arrangements for conduct of CRSP programs, adherence to grant requirements, and inputs to collaborative CRSP programs (research and related training and institutional development).

III. Suggested Evaluation Checklist

A. Institutional interest, support and arrangements

1. Where in the university's structure is the Bean/Cowpea CRSP project located?
2. Who is the PI? Give the PI's rank and position
3. What university resources are being allocated to the CRSP? What have been the university's inputs?
4. How do university administrators and scientists regard the Bean/Cowpea CRSP?
5. Who is the Institutional Representative? Active?
6. Are CRSP research activities integral elements of the university's research program. Explain/give examples.

B. Adherence to A.I.D./BIFAD and Grant Document Guidelines

1. Is a copy of the MOU with the HC available? Is the PI aware of its provisions?
2. Is a copy of the sub-grant document available? Are administrators and the PI knowledgeable as to its provisions?
3. How much and what is the nature of the university's matching contribution?
4. Determine if accounting, auditing and record keeping are in accordance with the provisions of the Grant Document. (See Mandatory Standard Provisions for U.S., Non-Governmental Grantees).
5. What inventory and property control procedures are in place in the university and the HC for CRSP property?
6. With regard to achievement of objectives, what does the PI think of the policies and procedures of the Bean/Cowpea CRSP and the university re budgeting? Reporting? Procurement? Travel? Training? Help or hindrance? Suggestions for improvement.

### C. CRSP Research

1. Does the program have an up-to-date Logistical Framework Matrix? What is your estimate of its value/usefulness?
2. Are detailed work plans (calendars of operation) and budgets available? Are budgets related to work plans? Give evidence of collaboration with the HC in preparation of work plans and budgets.
3. Check the work plan against the Log-Frame.
4. What are the PI's estimates of the value of the research to the HC and to the U.S.?
5. What is the PI's judgment of the progress of the research program? Where is the research with regard to achievement of Log-Frame objectives? How long has the research been underway and how much more time is needed re achievement of objectives?
6. What are the PI's views on the strong points and weak features of the CRSP program. Are there irrelevant, marginal activities? With regard to improvement of collaborative research activities, what are the views of the PI with regard to the TC and EEP? Recommendations for improvement.
7. What have been the major contributions of this CRSP project's activity?
8. Has the research performance been adequate or inadequate?
9. Has the PI had interaction with other Bean/Cowpea CRSP projects? With IARCs? With other CRSPs (e.g., INTSORMIL, TropSoils, or other)? Suggestions.
10. PI's suggestions re securing greater complementary social science research.

### D. Training and Institutional Development

1. Is there a CRSP project training plan? How does the training plan relate to the HC country's (including other donors) training plans?
2. Describe how trainees are selected?
3. What future training inputs by the CRSP are required?
4. What kinds of training have been provided by the CRSP?
5. What is the PI's estimate of the CRSP's contribution to building and/or strengthening the research capacity of the collaborating HC institution? What is the PI's estimate of the research capacity of the collaborating HC institution?

### E. Publications

1. What are the policies and procedures with regard to publication of CRSP research? What support is provided by the university? By the ME?
2. Cite the publication record in the past year. Since the CRSP was organized? Collaborative authorship of publications?
3. University support for CRSP publications.

**F. WID**

1. Cite what is being done to strengthen the roles of women in research re production, processing and food preparation.
2. Give WID changes over the life of the CRSP activity.
3. What suggestions does the PI have with regard to WID activities?

**G. Overall Assessment**

Give a summary assessment of the university's commitment and contribution to the achievement of the CRSP's objectives--current and prospective (i.e., unsatisfactory, satisfactory or highly satisfactory) and a summary status of the CRSP project and its prospects.

**H. Recommendations**

## FY 89 EEP REVIEW

## BRAZIL/BOYCE THOMPSON INSTITUTE/ROBERTS

*Insect Pathogens in Cowpea Pest Management Systems for Developing Nations*

## I. PROGRESS

Insect pests are major constraints to the production of cowpeas and beans in many Latin American, African and Asian nations with large populations of subsistence farmers, including poverty-stricken northeastern and northern Brazil. Insect pathogens are being examined in Brazil and the United States as cowpea pest management tools compatible (integrated) with other insect control practices. They are particularly attractive for use in cowpea insect pest control because they are likely to be safer than most chemical insecticides and they can be produced within cowpea-producing nations without expenditure of hard currency. Both basic and applied studies are underway in Brazil and the U.S. Survey for diseased insects in Brazil has provided more than 280 fungal isolates for further investigations. Collaborative research projects have been established with scientists at the Brazilian Research Center for Rice and Beans (CNPAP) and with several other groups within Brazil. These activities have generated data and concurrently increased the awareness of Brazilian scientists of insect diseases. In late FY 89, CNPAF instituted an integrated pest management (IPM) program. The Bean/Cowpea CRSP microbial control/insect pathology project, at CNPAF's invitation, has become an integral part of this program. Institutionalization of the CRSP microbial control project into the Latin American agriculture community is well underway. Approximately 130 Brazilians have received training in Brazil in annual week-long courses on microbial control and cowpea and bean entomology. Five Brazilian students have participated in Brazilian and U.S. university Masters degree programs in insect pathology. One U.S. student is conducting Ph.D. research in Brazil on phenomena that will increase our understanding of the epizootiology of insect diseases in Brazil and the U.S.

## A. Specific Research Contributions

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

This is the only CRSP project actively working on field insect pests of beans or cowpeas. Although currently focused on cowpeas, the findings and approaches would be applicable to beans and other legumes where the problems are similar.

## a. Research in Host Country

- (1) Germplasm collection and storage--Fourteen fungal isolates were accessioned and stored with the acquisition of a second liquid nitrogen storage tank. The Brazilian entomopathic fungi accessions now total 280.

- (2) Screening/characterization of fungal isolates--Primary efforts are on finding the best isolates of *Beauvaria bassiana* and *Metarhizium anisopliae* for the control of the cowpea curculio (*Chalcodermus bimaculatus*). *B. bassiana* was generally more virulent than *M. anisopliae*; seventeen *B. b.* and nine *M. a.* isolates were screened against the weevil larvae. Best was *Beauvaria* isolate CP7 which will be used in future field trials.
- (3) Improvement of insect rearing methods--New methodology was developed for rearing the chrysomelid beetles *Cerotoma arcuata* and *Diabrotica speciosa* through eight consecutive generations without loss of vigor.

Since the unidentified entomopathic nematode was so highly effective in weevil larvae control, it is suggested that this microorganism be studied and tested as a control agent.

- (4) Trials with *bassiana* and *Metarhizium*--Both fungi survived under a wide range of soil moisture levels although *bassiana* is more susceptible to high moisture levels (@ 60 percent saturation). Consistent control of the weevil (30 to 50 percent) can be achieved using the CRSP technology.
- (5) Control of leafhoppers with *Z. radican*--Control of *Empoasca kraemeri* with *Zoophthora radican* by applying dry mycelium to the foliage was not successful in Pitombeira, Ceara. Responsibility for poor appressoria penetration of the host may be high constant temperatures, insufficient dews and a complexity of scavengers/predators (ants, nematodes, etc.). Future work with this fungi may be shifted to beans where environmental conditions may be more favorable to *Z. radican*.
- (6) Control of leafhoppers with *Hirsutella*--This fungi is a natural pathogen of *E. kraemeri* in northeastern Brazil, but incidence of infected leafhoppers peaked at 3.9 percent in 1989 trials. The reasons are believed to be due to heavy rains from April to June last year which effectively washed off and reduced infestation from 10 in 1988 to 1.3 to 1.5 nymphs per trifoliolate in 1989. However, *Hirsutella* sp. has a higher developmental temperature threshold than *Z. radican* and therefore is better suited to the warm tropics.
- (7) Control of chrysomelids with *Beauvaria* and *Metarhizium*--Fungal conidia in aqueous suspension sprayed on the lower stems and soil were highly effective in causing mortality of *Elasmopalpus lignosellus* and *Cerotoma arcuata* larvae. Two strains of *B. bassiana* and two of *M. anisopliae* caused greater than 85 percent mortality of the beetles, but *Beauvaria* is more effective than *Metarhizium*. Strain CP5 caused 56-70 percent mortality.

The great advantage of these two fungi is their wide host range so that control of both the chrysomelids and *Chalcodermis* weevil can be integrated in the same treatment.

b. Research in the U.S.

- (1) Fungal control of *Diabrotica* larvae--In the U.S., *Diabrotica* is a major pest of corn with \$100 million spent annually on control (pesticides) of the larvae which feed on corn roots. In Brazil, *Diabrotica* adults also feed on bean and cowpea foliage. The high treatment rate of *M. anisopliae* ARSEF 925 (E9) was more effective than the *Beauvaria* treatments, but overall infection rates of emerged rootworm adults was lower (3.9 percent) than in 1988.
- (2) Bioassay of *Metarhizium* against white grubs--White grubs or scarab beetles and Japanese beetles feed on the roots of virtually all crops in the Third World. Mortality of white grubs occurred much quicker and reached higher proportions when exposed to soils inoculated with dry mycelium compared with conidia, and particularly at low temperatures and low moisture. This unexpected result suggests further study.
- (3) Optimizing production of dry mycelium--Losses of inoculum were observed during the processing of dry mycelium resulting in damaging and lysing of cells. It is not yet known whether this occurs during dehydration, milling or other procedures, and further studies will be made in 1990.
- (4) Infection process in *Z. radicans*--A major problem of this otherwise desirable entomopathogen is weak infection of its leafhopper host. The nature of the infection process was studied at the basic level. Conidial germination, appressorial formation and secondary sporulation in *Z. radicans* occurs independent of DNA replication and nuclear division. Formation of secondary conidia and capilliconidia was also independent of nuclear division but was totally inhibited by drugs blocking RNA or protein synthesis. This aspect will be studied further in 1990.

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

- a. Publications and reviews totalled 32 in 1989.
- b. In FY 89 fourteen strains of entomopathic fungi were added to the IPRC/Brazil germplasm collection, which now totals 283 isolates. More than ninety-five isolates were sent out to at least seven universities and government laboratories.

- c. A methodology for the continuous laboratory rearing of *Cerotoma arcuata* was developed and has been adopted by EMBRAPA scientists to study *B. thuringiensis*.
  - d. A methodology for producing and formulating entomopathogenic fungi is expected to receive worldwide adoption for developing and using these pest control agents.
  - e. Findings on *Diabrotica* will be widely used both in the U.S. and South America as it is a serious pest in both regions.
3. Other research-related results

a. Germplasm conservation and use

Since 1981 the project has cataloged 283 isolates of entomopathic fungi. Nearly 100 of these were sent out on request.

b. CRSP technology used in the HC and other LDCs

Methods for mass culture and formulation of entomopathic fungi can be readily used in developing countries for experimental purposes and could be modified for mass production at the cottage industry or grower-cooperative level.

c. CRSP technology for worldwide use

See above. Also, a spray application chamber designed for uniform topical application of test insects with aqueous suspensions of fungal conidia was constructed at both BTI and IPRC/Brazil. At present five of these chambers are in use or under construction. A second methodology for similarly treating small delicate insects (aphids, leafhoppers) with a constantly rotating field of sporulating mycelium has been developed and is currently in use in both the U.S. and HC.

d. Other project impact

A low-cost, low-technology method for biological control of *Chalcoedermis* weevils, the principal pest of cowpeas in Brazil, has been developed. This method consistently produces 30-50 percent control of weevil larvae. This method in concert with CRSP-recommended cultural and mechanical control would increase overall effectiveness. This methodology is enthusiastically received by EPACE entomologists.

e. Needs of small farmers and women

The research has focused directly on low-cost, uncomplicated technology designed for low-resource farmers and consumers of both sexes.

The role of women in agriculture was studied in 1989 by a CNPAF economist, Dr. Sonia Teixeira, and a CRSP Ph.D. student, Ms. Sandra Galaini-Wraight.

4. Changes in national production of cowpeas in Brazil

Small-scale farmers' trials conducted in subsistence-level fields indicate that the technology for controlling *Chalcodermis* weevil may be useful. Large-scale trials and economic-viability studies are planned for 1990.

B. Institutional Development and Training

The project continues to have a considerable impact on the Latin American scientific and technical community. The project has trained 130 agronomists in five short courses (one to two weeks) and four undergraduate interns (one month to one year). Training in FY 89 short courses included ten female and eleven male participants. Four Brazilian graduate students were trained to the M.S. level at Brazilian universities and two graduate students are in Ph.D. training. One of the two Ph.D. students, two of five M.S. students, three of four student interns, and approximately half of the 110 agronomists trained in short courses are women; and a project-trained research associate, Dr. Eliane D. Quintela (also a woman), has been promoted as a bean entomologist and designated HC PI of the project.

1. Changes since FY 88

A new CNPAF administration was installed in 1989 with Dr. Homero Aidar as a Chief. The former CRSP HC PI, Dr. José Emilson Cardoso, became Deputy Chief. The new administration is exceptionally cooperative and desirous of the CRSP's continuing the project on microbiological insect control. The project is now an integral part of a new CNPAF IPM group, and project laboratory space was doubled in FY 89.

2. Over the life of project

No comment

3. In prospect

The CNPAF recognizes the importance of insect pathology and has included such a unit in the new (1989) IPM group. The missing link is a Ph.D. in insect pathology, which will be filled by Mr. Bonifacio Magalhaes, an EMBRAPA staff member, currently undergoing this training at Cornell. This will be accomplished by the end of the extension period, prior to which it is important to maintain a CRSP presence at CNPAF.

4. Project training targets

Mr. Luis Leite completed an M.S. in Brazil in 1989 and will continue collaboration with the CRSP on bean research. Two interns (B.S.) are receiving on-the-job training at CNPAF

(supported by Brazil), and Mr. Bonifacio Magalhaes (also mainly supported by Brazil) will continue his Ph.D. studies at Cornell.

In 1990 a one-week course on microbial control will be taught mainly to scientists from outside Brazil and Brazilian scientists from the cowpea-growing areas.

C. Progress Achieved in Relation to the Log Frame

1. Satisfactory on all four project purposes

- a. Reduce cowpea pest losses through biological control agents--viz. *Zoophthora* vs. *Empoasca* leafhoppers and with other fungi for control of soil-inhaling stages of beetles
- b. Establish a permanent insect pathology resource base at CNPAF--well advanced
- c. Train Latin American scientists in insect pathology--both short- and long-term training highly successful
- d. Create a database on cowpea insects and pathogens--considerable literature produced by the project and other information is being compiled

2. An additional and important global contribution (not included in the log frame) is the collection, cataloging and preservation of entomopathic fungi germplasm (283 accessions).

D. Evidence of Biological/Social Sciences Integration

No comment

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

Domestic linkages (Brazil) are extensive and highly effective, particularly with Brazilian universities (Lavras and Sao Paulo at Piracicaba) and with a state research station (EPACE in Ceara). International linkages include: CIAT in Colombia, CATIE in Costa Rica, University of Tamil Nadu (India), and IRRI and UPLB in the Philippines.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

No audit as yet but project welcomes. Project expenditures are consistently well documented.

B. Adequacy of Funding by CRSP Participants

1. A.I.D.--Marginally adequate; some expenses have been held over to FY 90.

2. Host Country--Brazil is in a severe financial crunch, but EMBRAPA's commitment remains firm and is being strengthened (estimated at US\$46,000 for FY 89).
3. U.S. Institution--BTI has provided substantial support from the project's inception through commitment of the PI's time, staff, resources and facilities.

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

The level of funding is marginally adequate particularly during the present implementation phase which is crucial to validating the laboratory and small-scale trials.

D. Adequacy of Current Policies and Procedures

Present procedure, though cumbersome (one-month average), works reasonably well.

### III. PLANNING

A. Review of FY 89 Work Plan

The FY 89 research plan was closely adhered to except that it was not possible to carry out Brazilian field trials of *Beauvaria* and *Metarhizium* against chrysomelid beetles for lack of natural field populations of these pests. Second, the Brazilian budgetary crunch precluded the planned socioeconomic studies of cowpea production by the EMBRAPA social scientist, Dr. Sonia Teixeira.

B. Plans for FY 90

1. Host Country--Research will continue along lines previously followed, with primary emphasis on field trials:
  - a. *Beauvaria* and *Metarhizium* against *Chalcodermus* weevils--This will be conducted in northeastern Brazil (Ceara) in collaboration with EPACE and at CNPAF (to assure success).
  - b. *Z. radicans* against *Empoasca* leafhoppers--This fungus did not work well in northeastern Brazil but may be highly appropriate for beans in central and southern Brazil.
  - c. Socioeconomic/women in development research--Dr. Sonia M. Teixeira will do some work on cowpeas and beans "piggy-backed" on a small-scale rice agriculture study (partly backed by IRRI).
2. Major HC laboratory work activities will be in support of field trials.
  - a. Collection and screening of new pathogen isolates to continue
  - b. Efficacy of entomopathic fungi for control of first instar larvae of chrysomelid beetles (*Beauvaria* and *Metarhizium*)

- c. Effects of temperature on *Z. radicans* infection of *E. kraemeri* leafhoppers
  - d. Control of storage weevil *Callosobruchus bimaculatus* with *Beauvaria* and *Metarhizium*
3. United States--Research will continue along the following lines:
- a. Control of *Diabrotica* (corn rootworm) with *Beauvaria* and *Metarhizium*--will include fungus and herbicide compatibility
  - b. DNA probes to be developed for the detection of entomopathic fungi--These will be much more effective, are less expensive and quicker than current isoenzyme analysis and isoelectric focusing methods.
  - c. Infection of insect cuticle by entomopathic fungi to sort out problems of *Z. radicans* vs. *E. kraemeri*
  - d. Optimization of production and storage of dry mycelium to include *Z. radicans*, *M. anisopliae* and *Nomuraea rileyi*

4. Expected changes from FY 89

a. Research activities

The only substantive changes from FY 89 are the addition of the storage weevil studies and deletion of the field trials of *Beauvaria* and *Metarhizium* against chrysomelid larvae in Brazil as an extension of the U.S. work.

b. Personnel changes

Promotion of former HC PI Dr. José Emilson Cardoso to Assistant Director of CNPAF and Dr. Eliane D. Quintela to HC PI will have an important impact on the project. Other changes will tend to increase EMBRAPA staffing support for the CRSP, thereby reducing by two the technicians on the CRSP payroll. However, three additional field helpers will be added in Goiania for at least six months in 1990. These changes are generally positive in the long term.

c. Administrative changes

The new CNPAF administration in 1989 initiated a restructuring of the program to include an IPM group which includes an established unit for insect pathology. This is a very positive development for the CRSP.

#### IV. STATUS

A. Appropriateness of Activities to Goals of the Global Plan

This is the only project fully committed to plant-feeding insects in the Bean/Cowpea CRSP. Since insects are the primary constraint to

cowpea (and often to bean) production on a regional and global basis, this is the most likely approach to develop completely safe, long-term and scale-neutral control of insect pests in cowpeas.

**B. Balance Between Research and Training**

Exceptionally well balanced with a particularly strong training program

**C. Balance of Domestic vs. Overseas Activities**

Excellent--Considerably more than half of A.I.D.-provided funds were expended in Brazil.

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

The project enjoys a very high level of collaborative effort between Brazil and BTI.

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

Commitments of each institution and individual to the project are at a high level and essentially equal.

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

The USAID Mission is represented by only one person, a non-agriculturist whose responsibilities are numerous but who is very cooperative.

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

This project is highly cost effective considering the number of organizations and individuals involved, training carried out, linkages formed and the potential multiplicative impact of the technology being developed.

Field research has been carried out in close collaboration with EMBRAPA staff and stations and with state agricultural staff in Goias, Acre, Amazonas and others.

**H. Institutionalization of HC Component**

The project is strongly entrenched in Brazil and an insect pathology unit has been permanently established with the IPM group at CNPAF. The former Chefe of CNPAF, Dr. A. Blumenschein, and his successor, Dr. H. Aidar, are strong advocates of the project and have supported it enthusiastically from start-up.

## V. PUBLICATIONS AND PRESENTATIONS

A total of thirty-two research papers, reviews, abstracts and presentations were prepared for publication or presented in FY 89. This list includes thirteen research papers, reviews, abstracts and presentations with U.S. first authors and nineteen papers with HC first authors. Of these, at least seventeen papers were jointly authored by Brazilian and U.S. researchers.

## VI. OVERALL RATING: 3—Satisfactory, but CRSP officials may wish to consider orderly phaseout

This project has been highly successful on two counts: training and institutionalization in the HC. The more basic and supportive biological investigations have made considerable progress in understanding and managing selected entomopathic fungi and target insect pests. However, these gains have been offset by the failure in transferring a useful technology to the field. The EEP is particularly concerned about the project's apparent reluctance and/or inability to successfully carry out field trials in the major cowpea-growing region of northeastern Brazil. Undoubtedly, the lack of interest and involvement in field trials has also deterred the project from gaining experience and developing techniques in field applications.

The prospects for a practical cowpea pest control strategy using entomopathic fungi remains doubtful based on research progress to date. Another consideration is the appropriateness of Brazil as a continuing HC in view of the excellent institutionalization of PMC/insect pathogens and comparatively high-level research competence and infrastructure. For these reasons the EEP concurs with the TC on recommending that this project requires some major adjustments in orientation and directional strategies.

## FY 89 EEP REVIEW

### CAMEROON/PURDUE UNIVERSITY/MURDOCK

#### *Preservation of Post Harvest Cowpeas by Subsistence Farmers in Cameroon*

## I. PROGRESS

### A. Specific Research Contributions

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

The Purdue/IRA-Cameroon project was initiated on March 1, (1987) to focus on problems of insect-caused losses of cowpeas in storage, a major constraint to the availability and use of cowpeas in developing countries. The strategy adopted is to devise implementable storage technologies to reduce losses to insect pests and to enhance these technologies through short-, mid- and long-term research. The training strategy is to assist IRA-Cameroon in building a research team capable of addressing storage and other problems of cowpea production and utilization over the long term.

The current year (FY 89) is only the second year of the project--considering a seven-month startup--but impressive progress has already been made. This includes a clearer definition of the roles played by women and men in cowpea production and storage practices in northern Cameroon, including evidence that among low-resource farmers, women are more often responsible than men for cowpea storage, inter-cropped cowpeas, and generally growing the crop for household consumption. Nearly all families interviewed used cowpea leaves as a vegetable and had definite varietal preferences for this purpose.

#### a. Identification of constraints

The first order of project activity was to identify the major constraints to cowpea utilization in Cameroon. These were identified as:

- (1) Inadequate knowledge of storage methods and insect infestation in northern Cameroon
- (2) Lack of simple technologies for storing cowpeas after harvest to minimize losses to storage pests
- (3) Inadequate availability of cowpea cultivars with pod and seed resistance to storage insect pests
- (4) The presence of a potentially serious virus problem in northern Cameroon
- (5) Need for general information on cowpea pest management in northern Cameroon

- b. Constraint #1--Information on cowpea production and storage was considerably expanded from a survey in northern Cameroon carried out by Dr. Jane Wolfson in January 1989. She conducted a survey of 112 households (131 interviews) gathering information on household demographics, cowpea agronomic practices, cowpea storage practices, importance of cowpeas to the producer, farmer perceptions of losses in storage and utilization of cowpeas by the household. A preliminary evaluation of the data may be briefly summarized as follows:
- (1) Women consider cowpeas more important than men do; but it ranks second or third overall in importance. Moreover, women tended to use different cultural practices than men (e.g., more intercropping--with peanuts or sorghum--and traditional storage methods).
  - (2) Consumption of cowpea leaves, either green or dry, was very important in influencing the selection of varieties grown. Moreover, the aftermath or (cowpea hay) was an important livestock feed.
  - (3) Storage methods were highly diverse. Cowpeas were stored: (a) in pod or seeds; (b) in granaries/"dankis"; (c) combined with ash, insecticides, herbs (biological), salt, oil or nothing. All samples exhibited some insect damage ranging from 0.8 to 71 percent of the seeds.
  - (4) Both *Bruchidius atrolineatus* and *Callosobruchus maculatus* were found on pods, but *B. atrolineatus* accounted for most of the eggs. However, *C. maculatus* emerged first.
  - (5) Price of cowpeas fluctuates very widely from CFA100 (per cup) in February to CFA350 in August.
- c. Constraint #2--The project is developing a series of simple, applicable technologies appropriate to developing country farmers:
- (1) Solar disinfection is an elegantly simple method for using solar radiation to kill seed-borne pests prior to storage. Laboratory tests have shown that all stages of *C. maculatus* are killed by five-minute exposure to 65°C or 57°C for one hour.

The prototype heater consists of two layers of plastic sheets (75 x 100 cm)--black below (on which cowpeas are placed) and clear above (to capture the radiation). A recent improvement is to insulate the lower layer from the ground with an insulating "mattress" of threshed pods. The heaters work well early in the season, easily attaining 60°C temperatures; but later in the year (December/January), only about 50°C is reached--inadequate to kill the bruchids.

Reviewer's note: Temperatures above 60°C for extended periods may affect seed germinability, and perhaps nutritional qualities. These aspects need study as soon as possible. However, later studies showed that temperatures up to 85°C for short periods do not affect cowpea seed viability (of some cultivars).

- (2) Ash storage is widely used in northern Cameroon and is an effective deterrent to bruchid infestation. Project studies have shown that untreated cowpea seeds are completely destroyed after four to five months of storage. However, mixing of the seeds with one-half to one volume of ash reduces damage to negligible proportions.
  - (3) Storage of cowpeas with botanicals is generally less effective than with ash. Some treatments like mint leaf powder, mazayvrick flower powder, calandra bark powder, red pepper powder, neem leaf powder and an unidentified yellow root powder were largely ineffective. However, a coating of oil such as neem oil or shea nut oil (*Butyrospermum parkii*) is quite effective for preventing bruchid eggs from hatching. Since shea nut oil is widely used in cooking, it is unlikely to be toxic as neem oil may be. The amount of oil used was 1 volume to 450 volumes of seeds.
  - (4) K-Othrine, a synthetic pyrethroid, effectively controls storage pests safely and cheaply (about \$.25 for 50 to 100 kg), but may not always be widely available or of satisfactory quality.
  - (5) Storage of cowpea pods in native dankis (or granaries) is currently under study and will be reported later.
- d. Constraint #3--Lack of resistant varieties--both pod and seed resistances--is being investigated. Several hundred landraces were collected by IRA to identify pod and seed resistant strains. Several good pod resistant types reduce damage to as little as 5 percent of that of naked seed. Two local resistant lines allowed no insects to emerge from their pods.

Field infestation screening to determine egg-laying preference by *B. atrolineatus* and *C. maculatus* were found unreliable as egg counts were both inaccurate and misidentified.

- e. Constraint #5--Studies have been initiated to obtain general information on cowpea pest management in northern Cameroon and include observations on varietal types, cultural practices and pest management recommendations. There is also a need to update this information. This has included collaboration with IITA trials at Maroua, Sanguere and Ngaoundere representing three different ecologies. However, data have not yet been analyzed and summarized.

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

The project has not yet disseminated any research results. However, there are plans to prepare and distribute bulletins and materials on the solar heater, storage in ash, drum and bag storage with insecticide, and identification of pod and seed resistant varieties.

3. Other research-related results

a. Germplasm conservation and use

The RIISP collection of *Vigna* sp. germplasm has increased to 487 accessions including ninety-five new accessions of *V. unguiculata* subsp. *dekindtiana*, sixty-five *V. luteola*, eighteen *V. oblongifolia*, fifty-five *V. racemosa* and seventy-three *V. vexillata*. Samples of some of these were shared with the Universities of Minnesota, Gembloux (Belgium) and Khon Kaen (Thailand).

b. Seed production and distribution

The project disseminates information through IRA on information about strains that perform well and also seed stocks and guidance to Projet Semencier, the seed-producing agency in the country. Demand for seeds is increasing steadily, but the spread of viruses in the north poses a serious problem to supply disease-free seeds. Currently, three varieties have been released (by IRA) and others are in an advanced testing stage.

c. Impact of CRSP-produced technology

Very little impact at present

d. Other project impact

No impact as yet

e. Needs of small farmers and women

Continuing surveys and contacts with farmers focus attention on these groups. New technology being developed is designed to impact mainly on these groups.

4. Changes in national production of cowpeas in Cameroon

No data available

B. Institutional Development and Training

1. Changes since FY 88

The following changes have occurred during the past year:

- a. The expatriate scientist will be discontinued on January 31, 1990.
- b. The project will be continued for at least one more year in conjunction with Phase II of NCRE with responsibility for cowpea work.
- c. IRA has identified a young plant breeder, Mr. Boukar Ousman, to work closely with Dr. Laurie Kitch at Garoua under a French grant for three years.
- d. Mr. Endondo Chevalier will complete an M.S. degree in agronomy at Purdue University with his major professor, Dr. Herb Ohm, and will return to Cameroon by September 1, 1990.

2. Over the life of the project

The objective of the project is to build a three-scientist team to work on all aspects of cowpea improvement. At present this appears to be:

Plant breeder: B. Ousman  
 Agronomist: E. Chevalier  
 Entomologist: G. Ntoukam

3. In prospect

The need is to provide Ph.D. training for Mr. Ntoukam and Masters training for Mr. Ousman.

4. Project training targets

No comment

C. Progress Achieved in Relation to the Log Frame

1. This project has been engaged in research for two years plus seven months start-up.
2. The original time estimate for achieving the objectives as specified by the log frame was three years; goals should be fully realized in five to seven years.
3. Time remaining to achieve objectives is within log frame estimates.
4. Relation of research work to research in the HC or other countries, including IARCs--Work on simple, implemental technologies is not duplicated elsewhere. However, there is some overlap with the UCR work on drum storage and K-Othrine treatment (collaborating) and with IITA work on pod and seed resistance (cooperating). Also, the project is collaborating with the Boyce Thompson Institute on oil treatment of seeds.

5. Likely contributions to lines of research to the HC, the U.S. and amelioration of global constraints
  - a. To the HC, a trained research team and a variety of effective technologies
  - b. To the U.S., a cowpea and *Vigna* sp. germplasm, alternate technologies for storage insect monitoring and control and new concepts about storage pest management
  - c. Toward amelioration of global needs
    - (1) Technologies developed are applicable to all pulses--as all species are attacked by bruchids. In particular, the solar heater and ash treatments are widely applicable.
    - (2) New approaches to grain and seed storage research are widely applicable.

D. Evidence of Biological/Social Sciences Integration

1. The Purdue campus has a WID representative (Dr. Jane Wolfson) in continuing contact with the WID officer in Yaounde.
2. Considerable project resources were devoted to household surveys in the cowpea growing areas. These focus on the enormous complexities of the social and economic factors affecting cowpea production, storage and utilization--in which women are often the prime movers.

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

Information and materials are shared with the following institutions and individuals: IITA Grain Legume Improvement Program led by Dr. S. R. Singh; consortium of Italian universities led by Professor Luigi Monti of Naples; other CRSP projects--Senegal/UCR and Brazil/BTI; CIAT Bean Program and Dr. R. Kirkby in East Africa; other universities--Minnesota (Dr. Nevin Young), Auburn (Dr. O. Chamblis and Dr. Narendra Singh), Khon Kaen in Thailand (Dr. P. Suriyatantratong); and with Purdue's special grant on cowpea genetic engineering.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

No audit to date--A mid-term NCRE project review identified a management problem in Cameroon which was resolved by phasing out the expatriate scientist. An audit has not been requested but would be welcome.

## B. Adequacy of Funding by CRSP Participants

1. A.I.D.--Funding is not adequate, particularly for training, data analysis and inflationary salary increases. Possibilities for a USAID Mission buy-in were discussed by the U.S. PI in September 1989.
2. Host Country--Funding is subject to a severe national economic crisis, but IRA has somehow increased project support.
3. U.S. institution--Funding is adequate to match A.I.D. funding and could even be increased.

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

There have been excessive delays of several months in replenishment of funds owing to distances involved, monetary conversions and procedures used. This situation has improved following discussions between administrators from both institutions.

## D. Adequacy of Current Policies and Procedures

Management is expected to be much improved following the visit of the U.S. PI and administrative assistant (Ms. Katy Ibrahim) to Cameroon in FY 89.

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

The possibility of the USAID Mission to Cameroon providing some funds was discussed by the U.S. PI and others during a visit to Cameroon in September 1989.

## III. PLANNING

### A. Review of the FY 89 Work Plan

The FY 89 plan developed in the spring of 1988 has been followed within limits possible. There have been no material changes.

### B. Plans for FY 90

1. Plans for the cropping year 1990 and storage 1990-91 will be developed at the annual planning meeting at Purdue, April 1990.
2. Phaseout of the expatriate scientist on January 31, 1990 will be compensated by increasing Purdue staff assignments in Cameroon to include an extended stay of up to six months by Dr. Laurie Kitch, a one-month visit by Dr. Wolfson in March, and a visit by the U.S. PI during the storage season. The extended stay may be covered by a USAID Mission buy-in or other mechanism.

#### IV. STATUS

##### A. Appropriateness of Activities to Goals of the Global Plan

The goals are on target. Several storage technologies will continue to be explored, and the project is in an excellent position to translate biotechnological improvements on cowpeas into practical use. Most of the technologies being developed should apply equally well to common beans and other pulses.

##### B. Balance Between Research and Training

###### 1. Expenditures for research and training

Research: \$225,434      Training: \$ 20,701

###### 2. Expenditures are close to FY 88 projections.

##### C. Balance of Domestic vs. Overseas Activities

Balance is about right--practical research is done in Cameroon with support and foundation-laying work done at Purdue.

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

###### 1. Description of the process/procedures:

- a. Research planning for FY 90--Mr. Ntoukam and Dr. Ta'Ama of IRA met for approximately one month at Purdue (March 1989) preparing detailed plans.
- b. Budget for FY 90 was tied very closely to the collaborative work plan.
- c. Training issues were discussed, but limited funding precludes new initiatives. Mutually desired is Ph.D. training for Mr. Ntoukam and M.S. training for Mr. Ousman.
- d. Potential publications discussed include work on solar heaters, cowpea research by Dr. Ta'Ama over the past several years, and other works in the future.

##### E. Relative Contributions of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

Each institution is contributing equally toward the accomplishment of mutual objectives.

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

Interest in this CRSP has been high and support level is good. Mission buy-in has supported the assignment of an expatriate scientist, the transition from pest management (UGA) to cowpea storage research; and, hopefully, in-country activities in FY 90.

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

Considered high, measured by the developing momentum in both the U.S. and HC

**H. Institutionalization of HC Component**

IRA is committed to support a three-scientist team for cowpea improvement, two of whom will require further training.

1. Faculty recognition for international activities--Purdue is internationalizing its curriculum and outward-looking posture.
2. Integration of state and international research--Cowpeas are not grown in Indiana, but the plant is an excellent model for basic and biotechnical research.
3. Internal project and institutional management is excellent and benefits from a strong International Programs in Agriculture at Purdue.
4. Student-professor interactions are satisfactory, but only one student, Mr. E. Chevalier, is presently involved (in Agronomy).

**V. PUBLICATIONS AND PRESENTATIONS**

M. Ta'Ama. 1989. Highlights of Five Years of Cowpea Research in Cameroon. Special Publication.

Three additional publications are in preparation.

**VI. OVERALL RATING: 1--Highly Satisfactory**

**A. General Strengths**

1. The project is exceptionally well-focused.
2. Technological innovations are elegantly simple and highly practical for low-resource farmers.

**B. General Weaknesses**

Further development in cowpea improvement in Cameroon may be constrained by the spread of viruses, which is beyond the mandate of this project.

**C. Recommendations**

At least one to two more years will be required to complete the mechanical aspects of cowpea storage. However, investigations into pod and seed resistance are ongoing and could easily require an additional four to five years.

Heat treatment for bruchid infestation appears to be a highly effective and practical technology, unless it reduces seed germinability and viability or detrimentally affects the nutritional qualities of the grain (excessive drying may affect seed hardness and the protein component). This aspect needs study before any recommendations are made. Another concern is to determine how insect damage affects seed viability in different varieties. Moreover, the research should monitor seed moisture content at harvest, solar heating and after storage.

The EEP suggests trials on solar heating disinfestation of whole pods immediately after harvest since much of the crop is stored in pod for several weeks before threshing. Another interesting prospect is the use of high, but sub-lethal, temperatures (e.g., high 70s°C) to eliminate seed-borne viruses and other pathogens.

At least four or five Bean/Cowpea CRSP projects are involved in seed storage. If this level of participation is justified, then some coordination should be encouraged. It is suggested that the Cameroon/Purdue project, because of its primary responsibility for cowpea seed storage, be designated as coordinator and "clearinghouse" for these activities.

As a relatively new project, the Cameroon/Purdue project is in the very beginning stages of its focus on Host Country institutional development and training. The project has what appears to be a simple but viable long-term training plan which will be essential to the eventual institutionalization of the project's research efforts in Cameroon. The EEP encourages the Bean/Cowpea CRSP to support these training efforts through a combination of CRSP and other funds and, in general, proposes that relatively new projects be recognized as having different training and institutional needs than may be the case for long-established projects.

FY 89 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

A. Specific Research Contributions

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

a. Constraint--Rust disease

Research Response--The association of leaf pubescence with nonspecific rust resistance was confirmed in field trials. It was determined that different major genes controlled the leaf pubescence in rust-resistant Jamaica Red, compared to those in PC-50. Superior pubescent selections were identified in an Alubia landrace from Argentina. It was also determined that dry bean lines differ in their resistance to rust on different soil media.

b. Constraint--Common bacterial blight (CBB)

Research Response--Pompadour bean germplasm was rated for reaction to common bacterial blight resulting in determinate plant habit being associated with increased necrotic reaction to CBB but with reduced leaf chlorosis compared to indeterminate types. Interspecific crosses of *Phaseolus vulgaris* x *P. acutifolius* were made in order to incorporate higher levels of resistance to CBB in *P. vulgaris* germplasm. In further studies of use of copper compounds in the control of CBB, the efficacy of copper-based chemicals decreased significantly at pH 7 or above.

c. Constraint--Ashy stem blight

Research Response--Three Pompadour germplasm lines showed moderate levels of resistance to ashy stem blight.

d. Constraint--Breeding improved adapted disease resistant cultivars/lines

Research Response--Breeding activities during FY 89 included the development of improved red mottled and black dry bean lines with resistance to web blight (WB) and/or common bacterial blight and tolerance to bean golden mosaic virus (BGMV). Higher yielding white seeded lines and Great Northern and Pinto lines with resistance to white mold, CBB, rust and BGMV were also developed. Basic seed of seven new improved lines was increased along with 396.5 metric tons of PC-50 to meet the entire bean seed demand in the Dominican Republic for red mottled beans.

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

Basic seed of seven lines intended for release and of the released, CRSP-developed PC-50 were increased in the DR. Three Nebraska multiple disease resistant dry bean lines were increased for release and large-scale tests on one line were begun on sixteen Nebraska farms.

Application of CRSP research to other research includes use of crosses made between red mottled beans with dense pubescence (identified in the DR) and Pinto and Great Northern beans to transfer rust resistance into the Pinto and Great Northern beans. Upright A55(CIAT) line is being used in Nebraska to develop Pinto and Great Northern beans with avoidance of white mold disease and BAC6 from Brazil is being used in Nebraska and the DR to transfer resistance to common bean blight.

Forty-five publications and/or presentations were completed during FY 89. Of those, eight were written or presented in Spanish with the remainder in English.

3. Other research related results

- a. Germplasm conservation and use--Germplasm sources of improved architecture were sent to Michigan and North Dakota and a source of leaf pubescence to a private seed firm in Idaho.
- b. International exchange--Internationally, bean lines have been sent from Nebraska and Cuba to the DR for adaptation and CBB evaluation. The DR sent bean lines to Nebraska for additional work on pubescence and rust resistance. The DR sent the entire Pompadour germplasm collection to Tanzania to determine the impact of pubescence on local rust populations. CIAT and Brazil have made extensive use of Nebraska-developed CBB-resistant germplasm.

4. Changes in national production of beans in the Dominican Republic

Estimates are that production of red mottled beans increased by 8 percent and black beans by 34 percent from 1987 to 1988.

B. Institutional Development and Training

It is extremely difficult to anticipate the extent of long-term institutionalization that can be expected of this project. Even though real technical success has been achieved in developing a competent, cooperative bean research team in the DR, the economic situation in the DR has continued to deteriorate. Ministry of Agriculture salary levels are essentially inadequate to retain staff members with advanced degrees. Without additional information on policies and priorities in the DR and the Ministry of Agriculture, it would appear that any longevity to the bean research program will require long-term assistance.

The sad state of finances for agricultural research in the DR, especially as it relates to the remuneration of scientists, is a particular blow to this project in light of the very successful training program and the resultant short-term institutional development that have come out of CRSP activities.

CRSP researchers at the University of Nebraska-Lincoln have continued their excellent record of accessing non-CRSP funds for long-term training conducted at the University of Puerto Rico to strengthen the research capabilities of DR support staff.

#### C. Progress Achieved in Relation to the Log Frame

This project has made excellent progress in relation to the log frame. The project has been in existence for nine years with an initial expectation of ten years of work required for the development and introduction of new varieties. The project is generally on schedule with an anticipated two additional years necessary to complete current research on CBB.

As is exemplified by the research results disseminated by the project during FY 89 (Section I.A.2.) and other research-related results (Section I.A.3.), research results from this project have been both supplementary and complementary to other research activities within and outside the CRSP.

#### D. Evidence of Biological/Social Sciences Integration

There is essentially no evidence of the integration of a social science research focus in the project. There appears to be an inherent assumption that new technology/strains of beans will be adopted by farmers in the DR and elsewhere. On the other hand, UNL researchers expressed real interest in the equity issues that are part of a WID concern. Their record of training of women is excellent.

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

This project is an excellent example of successful collaboration, not just between U.S. and Host Country researchers but also with other CRSP projects and outside the CRSP. Within the CRSP, linkages are especially strong with projects in Honduras, Tanzania and the Dominican Republic (UWI) project. Outside the CRSP, the project is closely linked with the USDA ARS bean research program at the Tropical Agricultural Research Station and the CIAT bean research program. Finally there is a project underway to work with results in Jamaica from research conducted in the DR.

## II. FUNDING/FISCAL MANAGEMENT

### A. Audit/Project Management Reviews

An audit conducted in 1987 focusing on the initial grant period (1981-1985) noted that CRSP funds in the DR had not been segregated

from other funds during 1981 and 1982. Action was taken by UNL in cooperation with Michigan State University (the Management Entity for the CRSP) to supply sufficient information to preclude any disallowances. Additionally, steps have been taken by the University of Puerto Rico Grants Officer to clarify procedures with his counterpart in the DR.

In October 1988, the project was randomly selected as a part of a State audit of the UNL's Grants and Contracts Office. No problems were found with the subcontract.

This year's EEP evaluation stressed visits to U.S. universities and a general look at management systems. No problems were found with the UNL fiscal and management support systems.

**B. Adequacy of Funding by CRSP Participants**

1. A.I.D.--Funding levels seem to be adequate to attain project objectives.
2. Host Country--The DR simply does not appear to be able to maintain adequate long-term support for trained scientists given the economic straits of the country. The long-term maintenance of a bean research program is, realistically, probably only possible with continued external funding.
3. U.S. Institution--As with many CRSP projects, UNL has successfully developed a symbiotic fiscal and research relationship between the CRSP and other research support.

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

In the past there have been problems surrounding the adequacy of fiscal paperwork (receipts) from the DR. This seems to have been solved through more stringent implementation of regulations and requirements at UNL.

**D. Adequacy of Current Policies and Procedures**

Appear to be adequate

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

The CRSP project has been very successful at accessing additional funding with UNL using a USDA competitive grant, local industry grants, company grants, USAID scholarships and regional research funds; the UPR using local industry support and other USAID projects; and the DR using UN, USAID (regular and PL 480), and Swiss funding.

### III. PLANNING

#### A. Review of FY 89 Work Plan

Changes in the FY 89 work plan were made in response to several "opportunities." First, the spread of whitefly and resultant BGMV threat in the DR has increased, leading to a planned increase in collaboration with UWI CRSP activities. Two additional opportunities presented themselves in the form of returning and visiting scientists. Dr. Mildred Zapata completed a Ph.D. on common bean blight and is returning to UPR where further collaboration on CBB is anticipated. Finally, UNL is currently hosting Mr. Mohamed Fouad from Egypt, a tissue culture specialist and visiting scientist who is conducting research on regeneration of *Phaseolus vulgaris* in tissue culture. The project has taken advantage of this opportunity to possibly solve a problem that has, to date, been a major barrier to success in producing transgenic plants.

Project researchers are to be complimented on their ability to reach long-term goals and still have the flexibility to address new developments and take advantage of unanticipated opportunities.

#### B. Plans for FY 90

No comment

### IV. STATUS

#### A. Appropriateness of Activities to Goals of the Global Plan

This project has made important contributions to the Global Plan and continues to do so. These contributions are not only a function of the content of the research but are also reflective of the clear commitment to collaboration of the researchers. These scientists are determined to "do good science" and to insure that the science leads to better conditions for farmers and consumers.

#### B. Balance between Research and Training

Training costs: \$14,400                  Research costs: \$130,000

While expenditure of CRSP funds is heavily skewed toward research, the project has successfully accessed other funding sources for a successful and appropriate long-term training element. Additionally, the project has included short-term training at UNL and UPR, an extremely appropriate use of CRSP funds.

The need to maintain a continuing focus on long-term training for scientists from the DR has been stressed due to the number of turnovers in the program at SEA. Additionally as with many CRSP projects, in this case basic research is being conducted at Nebraska with more applied research in the DR. Long-term training for scientists from the DR is essential to the development of their capacity to collaborate on the basic research portions of the project as well as the applied research.

C. Balance of Domestic vs. Overseas Activities

This balance has been highly appropriate. Additionally, the recognition of the goal of increasing amounts of basic research conducted in the DR by CRSP scientists predicts a continuation of that appropriateness as the collaborative relationship continues to mature.

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

This project exhibits excellent coordination at all levels and in all areas. Beyond direct U.S./HC collaboration within the project, coordinators are to be complimented on their collaboration across CRSP projects, across departments at UNL, and with CIAT.

E. Relative Contributions of Collaborating Institutions and Individual Toward Accomplishment of Objectives

U.S. contributions for FY 89 were \$66,345 in salaries and benefits. HC contributions were \$27,900 in salaries and benefits. Both U.S. and Host Country institutions provide contribution in-kind to the project including laboratory supplies, secretarial services, labor, etc. These contributions are generally made by educational, service and research institutions, especially those in the public sector, without documentation.

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

While the Mission is supportive of the project, there appears to be no particular interest in a buy-in of any kind.

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

This project is cost effective not only in relation to the potential returns from the research and graduate training but also in terms of the ability of the researchers and their respective institutions to access additional funding and in-kind contributions in support of the project.

H. Institutionalization of HC Component

Support for the CRSP and faculty recognition at UNL appear to be excellent at all levels. Additional recognition for U.S. and HC teams and individuals has included awards for research and presentations.

CRSP activities have been well integrated with other commodity research activities. Similarly there is important integration across CRSP projects.

Project management and institutional management support have been highly satisfactory.

Student/professor interactions are excellent with contact being maintained after students complete their studies.

V. PUBLICATIONS AND PRESENTATIONS

Excellent publications record; see item I.A.2

VI. OVERALL RATING: 1—Highly Satisfactory

This project's strengths are in both the quality of its research and the clear commitment to a truly collaborative approach to research.

## FY 89 EEP REVIEW

### DOMINICAN REPUBLIC/UNIVERSITY OF WISCONSIN/MAXWELL

#### *Molecular Approaches for the Control of Bean Golden Mosaic Virus*

## I. PROGRESS

Extremely impressive progress has been made by the project over the last year, with several research breakthroughs since the filing of the FY 89 annual report in September 1989. While the following review concentrates on the project as reported in the annual report, mention will be made of subsequent breakthroughs both in relation to research results and in terms of the very impressive research network which is developing as a result of this project.

### A. Specific Research Contributions

Research activities focusing on bean golden mosaic virus (BGMV) have become of greater and greater urgency over recent years with the growing impact of BGMV in Latin America and the Caribbean. What one researcher described as a "curiosity disease" in 1965 was clearly a major destructive force in 1989. This is true throughout the region, including the Dominican Republic.

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

- a. Constraint--Lack of resistant cultivars of beans for BGMV in the DR

Research Response--The field evaluations of germplasm for BGMV resistance continued in the DR with CIAT-supplied germplasm. Since the completion of the FY 89 annual report, researchers in the DR have identified a Pompadour-type landrace that appears to be resistant to BGMV.

- b. Constraint--Lack of understanding of the complex of geminiviruses that cause bean golden mosaic and bean dwarf diseases

Research Response--Further progress is being made in the cloning and sequencing of DNAs from BGMV isolates collected in the Caribbean and Central America. Results support the concept that two distinct strains of BGMV exist: the mechanically transmissible strain (BGMV-MT) and the non-mechanically transmissible strain (BGMV-NMT), with isolates from Central America and the Caribbean representative of the former group and isolates from Argentina and Brazil expected to be representative of the latter.

A cooperative, ongoing focus on the molecular characterization of bean dwarf mosaic virus (BDMV) has been initiated with the Agracetus Corporation of Middleton, WI.

- c. Constraint--Lack of a rapid method to identify geminiviruses that infect beans and weeds

Research Response--The molecular characterization of BGMV isolates described above allows the further development of DNA probes for detection of the two strains of BGMV described above. Progress has already been made in the development of a specific probe to detect BGMV-MT and not BGMV-NMT.

- d. Constraint--Lack of standard breeding methods to produce beans with high levels of resistance to BGMV

Research Response--The development of virus-derived resistance schemes has, until now, been stymied by inadequacy of traditional DNA introduction techniques. The annual report included mention of experiments being conducted with scientists at Agracetus using an electrical discharge particle accelerator (particle gun) for inoculation of beans with cloned-BGMV DNAs. Since the writing of the annual report, results of experiments using the particle gun technique to inoculate plants with non-mechanically transmissible plant virus have been extremely promising, and Agracetus has achieved transformation of beans with a recorder gene. Plans for FY 90 research focus on further work in this area.

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

The project's record of presentations and publications in FY 89 is impressive, with eight presentations, five articles published, one accepted but not yet published, two submitted but not yet accepted and an additional three articles in preparation. Of greater importance than the sheer numbers of presentations and publications is the development of a network of researchers with interest in the techniques and results of CRSP activities.

The researchers at UWI and their former and current Host Country counterparts at EMBRAPA in Brazil and CESDA in the DR are to be commended on their efforts to collaborate with one another and to draw in other collaborators working on bean research. Within UWI, linkages are functioning optimally between departments and projects funded by A.I.D. and World Bank. Within the CRSP, cooperation with UNL and UPR are excellent. The working relationship with CIAT is exceptional as is CIAT's acknowledgement of the impact of CRSP activities.

The project has made impressive progress in the characterization of bean geminiviruses with molecular markers and sequencing of the DNA of the geminivirus. This work has provided powerful evidence of major genetic differences between Brazilian and Central American isolates. This finding has major immediate implications for applied plant breeding as it points to the need to deal separately with these isolates that had been previously thought to be essentially

the same. The research is not only of great practical utility to breeders at CIAT and in national programs, but also it is research that CIAT could not have done on its own.<sup>1</sup>

Finally, within the immediate project network, the cooperation between researchers at UWI and Agracetus Corporation is a model example of work with the private sector.

Beyond the actual working network that has been nurtured by CRSP scientists and their colleagues, the success of the total research effort as well as the dissemination of research results is represented by work with other scientists involved in related activities. Examples include: (1) assistance to Dr. Judy Brown at the University of Arizona in identifying variation between the geminivirus she isolated from beans in Sonora, Mexico and BGMV strains and bean dwarf mosaic virus; (2) DNA probing of samples of a potential bean virus for Dr. R. Forester, extension plant pathologist at the University of Idaho; and (3) use of DNA probe technology for detection of viruses in peas and beans in Guatemala by Dr. Robert Lambe, a private consultant.

## B. Institutional Development and Training

### 1. Changes since FY 88

The change in Host Country from Brazil to the DR has essentially resulted in the project's starting over in developing HC linkages and in the area of institutional development and training.

### 2. Over life of the project

Luckily, the re-allocations of CRSP funding from Brazil to the DR did not result in an abrupt severance of linkages with Brazil. Dr. J. Faria from CNPAF, Goiania, Brazil has spent the last two years in Wisconsin working on the project with funding from the Government of Brazil and UWI's Graduate School. Dr. Faria's training in molecular virology is expected to be applied to his work for EMBRAPA upon his return to Brazil (December 1989). His impact upon the research results credited to CRSP activities is clear, with Dr. Faria credited in the FY 89 annual report as primary author on one of the presentations, two of the publications, and one of the journal articles in preparation. Of these, the presentation and publications were Brazilian while the article in preparation is expected to be published in *Virology*. Credit should be given to all those involved for the further development of a collaborative linkage between UWI and their Brazilian counterparts despite the withdrawal of A.I.D. funding.

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<sup>1</sup>Facsimile message from Dr. Douglas H. Pachico, CIAT, to Dr. Douglas Maxwell, UWI, December 5, 1989.

### 3. In prospect

As the linkage with the DR progresses, it should gain similar strength to that which has been established with Brazil. Because of the commendable collaboration between CRSP researchers at UNL and their DR counterparts, links between UNL and UWI, and an equally strong linkage with UPR, the UWI project will be able to build upon the strengths of CRSP activities in the region.

### 4. Project training targets

Ms. R. Teresa Martinez from the DR has been working on the project at UWI since June 1989. Continued funding for Ms. Martinez will come from an A.I.D./PSTC grant, not from the CRSP. There are also plans to bring Ms. Aridia Figueroa from the DR to Madison for training as a visiting scientist during the next two years.

CRSP researchers have acknowledged the importance of providing training for CESDA staff. However, CRSP funding does not seem to be available for this training, and there is some concern regarding the ability to recruit qualified candidates for training at CESDA. Without both CESDA commitment in the form of qualified personnel and CRSP commitment of funding for trainees, one questions the possibility of true HC collaboration and institutional development.

The need to further incorporate CESDA staff into the training system at UWI is accentuated by the strong involvement of undergraduate and graduate students (U.S. and international) in project research. Quality and quantity of training are extremely impressive.

## C. Progress Achieved in Relation to the Log Frame

### 1. Length of time project has been engaged in this research

Research on BGMV under the CRSP began in 1986. In 1988 the BGMV focus became its own project with the DR as its Host Country. Progress has been impressive for all outputs especially in light of recent advances. Both the possible identification of a BGMV-resistant landrace in the DR and the successful use of the particle accelerator by *Agracetus* bode well for more rapid progress than had been earlier anticipated.

2. Original time estimates for achieving objectives
3. Estimated time remaining to achieve objectives

| Objective                   | Original Time to Attain | Actual or Currently Estimated Time to Attain | Comments   |
|-----------------------------|-------------------------|--|--|
| Cloning and Sequencing      | 1989                    | Completed 1989                               | Cloning and sequencing of other viruses continues to be completed in 1990.                                 |
| Isolate Specific DNA Probes | 1989-90                 | 1989-90                                      | BGMV-BZ and BGMV-GA specific probes developed in 1989; 1990 foci are BGMV-MT and NMT and BDMV.             |
| Virus-derived resistance    | Approx. 1993            | Approx. 1993                                 | Work began in this area in FY 90. Research is on schedule and enhanced by recent developments.             |
| Germplasm Evaluation In DR  | Unknown                 | Unknown                                      | This has been very slow. However, recent developments re a possibly resistant landrace may speed progress. |

4. Relation of research work to research in the HC or other countries, including IARCs

This particular research project exemplifies the potential results of collaboration in research. Essentially, the scientists involved have developed a scientific and funding support network that includes the CRSP and its contributors at UWI, UNL, UPR and CESDA in the Dominican Republic; former CRSP collaborators at EMBRAPA, Brazil; CIAT; Agracetus; and funding through an A.I.D./PSTC project, World Bank, and USDA/CSRS as well as the UWI Graduate School. Section I.A.2., Research Results Disseminated and Currently in Use, explains in greater depth the complementarity of research within this network as well as related activities.

5. Likely contributions to lines of research to the HC, the U.S. and amelioration of global constraints

The increasing urgency surrounding BGMV among bean researchers, government agricultural agencies and farmers is a clear indication of the potential contribution of this research. BGMV is destroying bean plots at agricultural research stations in Latin America and the Caribbean. It has reached proportions that prohibit research on other bean problems. The government of the DR has prohibited the planting of beans in certain areas due to the seriousness of BGMV. Farmers have lost as much as 100 percent of their crops to the disease.

#### D. Evidence of Biological/Social Sciences Integration

##### 1. Identification/attention to relevant WID issues

The major WID focus of this project has been a highly successful one on training women scientists.

##### 2. Identification/attention to other social/food science issues

The focus of this project on genetic engineering brings a potential confounding factor to the successful dissemination of any new technology that might result from the research effort. The EEP is encouraged that this research effort will ultimately result in virus resistant beans. However, there is concern among the scientists involved, university administrators and the EEP that full consideration of the political and social implications of the introduction of genetically engineered plants in the U.S. and Host Countries has not existed.

Certainly, concern exists for the problems of development, release and multiplication of germplasm, "ownership" of germplasm, and public response to genetic engineering (whether based on logic or emotion). It is, however, unclear whether there is a concerted effort to address these problems so they relate to Third World developmental activities. Since the potential results of this particular research are related to most, if not all, of the elements of the potential political and social problems listed above, it seems appropriate for the CRSP and A.I.D. to begin to investigate these implications with a goal of avoiding problems.

#### I. FUNDING/FISCAL MANAGEMENT

##### A. Audit/Project Management Reviews

Funds are processed through the University of Wisconsin-Madison Office for Research Administration. The university audits only a sample of contracts on an annual basis and this project has never been a part of that sample. Additionally, no audit has been requested. This year's EEP review included a campus visit and a look at project and university fiscal management. All appear to be satisfactory.

##### B. Adequacy of Funding by CRSP Participants

1. A.I.D.--Both A.I.D. and U.S. university funding appear to have been adequate to date. Researchers have requested an additional \$8,000 in CRSP funds to cover increased expenditures on growth chambers, supplies, service contracts on equipment, rental charges for electron microscopy, publication of research, travel for students and salary increases. Given project success and the "matching" of last year's \$54,000 of CRSP-funded direct costs with over \$153,740 in non-CRSP funds, the request seems more than reasonable and a good investment.

2. Host Country--Limited information regarding HC contribution was made available to the EEP. All budget documents leave HC contribution columns blank.

3. U.S. Institution--See 1. above.

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

The need for a small increase in funds was mentioned in the previous section, II.B., Adequacy of Funding.

The current focus on U.S.-based research is represented by the severe skewing of the budget toward U.S. vs. HC expenditures.

D. Adequacy of Current Policies and Procedures

All satisfactory

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

Researchers are to be complimented on the accessing of non-CRSP funding as well as in-kind contributions. If in-kind contributions could be included in calculations, the estimated three-dollar outside contribution for every CRSP dollar would be even greater.

Although CRSP scientists have visited the USAID Mission in the DR, they have not accessed additional funds from the Mission.

III. PLANNING

A. Review of FY 89 Work Plan

No changes were made in the work plan.

B. Plans for FY 90

1. Research in the DR will include continuation of the evaluation of the DNA probes and of the field evaluation of germplasm.

In the U.S., the FY 90 research focus will include further research and publication on the molecular characterization of bean-infecting geminiviruses, design of strain-specific DNA probes for BGMV-NMT and BGMV-MT, and virus-derived resistance schemes.

2. Personnel changes expected in FY 90 include the following. In the DR, Ing. A. Sanchez will leave to study at the University of Puerto Rico, requiring that someone else be assigned his field work. At UWI, Dr. J. Faria will return to Brazil in December 1989. Ms. T. Martinez will return to the DR in August 1990. Ms. Enize Zambolim will come from Brazil to Madison in January 1990 for one year. Short-term training will be provided for Ms. Aridia Figueroa of the DR and Ms. Mercedes Otoya, CIAT, Colombia.

#### IV. STATUS

##### A. Appropriateness of Activities to Goals of the Global Plan

Highly appropriate and becoming more so as the severity of BGMV increases

##### B. Balance Between Research and Training

Minimum CRSP funds have been spent on training of scientists from the DR with a \$5,000 addition to the FY 89 budget, providing short-term training for Ms. Teresa Martinez. While Ms. Martinez's experience at UWI will clearly strengthen the research program in the DR and the linkage between U.S. and HC researchers, additional training for scientists from the DR is essential.

It seems that every effort is being made by U.S. researchers to identify scientists from the DR for training. The FY 90 budget includes funding for training. Some concern was expressed by U.S. scientists regarding the ability to identify and train DR counterparts. It would behoove the CRSP to determine whether or not there is a problem of identifying qualified counterparts in the DR and whether there are HC constraints on training. Once these issues are examined, it would seem appropriate for the CRSP to provide additional funding for training to this particular project. With the project's having recently moved to the DR, its training needs are not comparable to a project with a long history in a HC.

##### C. Balance of Domestic vs. Overseas Activities

Because of the technical nature of the research on this project, a majority of the research is being conducted at UWI. Additionally, with only one year's experience in the DR, field testing there is in its beginning stages. However, CRSP scientists are interested in strengthening the roles of DR scientists in the project. The training discussion above speaks to a need for more opportunities for DR scientists. It will be extremely important to maintain strong linkages with Ms. Martinez upon her return to the DR so that she can help increase the level of research activities there.

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

The level of collaboration on this project is not yet at the optimum although it appears to be improving. Plans have been made, for example, for Drs. D. Maxwell and R. L. Gilbertson and Ms. T. Martinez to travel together to the DR early in 1990 to work on research efforts there. The coordinated planning that has already begun, a focus on training for scientists from the DR, and appropriate travel by U.S. and DR scientists will do much to sustain this progress.

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

(The following is taken directly from the project's FY 89 annual report.)

A.I.D.:

|  |               |
|--|---------------|
| Direct Costs (funds for an assistant scientist, supplies, visiting scientist and travel) | \$54,000      |
| Indirect costs   | <u>24,000</u> |
| Total  | \$78,000      |

UWI (includes state funds, Hatch funds, graduate school grant, gift funds, Brazilian Government funds and World Bank funds):

|  |              |
|--|--------------|
| Salaries (funds for PI and Co-PIs, research specialist, two graduate students, visiting scientist) | \$139,240    |
| Supplies   | 12,000       |
| Travel   | <u>2,500</u> |
| Total  | \$153,740    |

Agracetus Corporation:

Their most important contribution has been cooperating scientists, equipment and technology which is not available at UWI

CIAT:

(approximate values)

|          |              |
|----------|--------------|
| Salaries | \$20,000     |
| Supplies | 3,000        |
| Travel   | <u>2,600</u> |
| Total    | \$25,600     |

Dominican Republic:

(approximate values)

|          |         |
|----------|---------|
| Salaries | \$2,000 |
| Total    | \$2,000 |

Other contributions by HC and U.S. institutions include experimental land and equipment provided for field research by the DR and use of laboratory space, secretarial staff and equipment at UWI.

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

The working relationship between the CRSP and the USAID Mission already established by UNL and UPR scientists has been accessed by UWI researchers and appears to be developing satisfactorily.

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

The effort has been highly cost effective, especially based on CRSP investment which has been "matched" on a three-to-one basis by funds from other sources.

#### H. Institutionalization of HC Component

Institutionalization in the U.S. institution is highly satisfactory with research cooperation across departments, support of administration and recognition for researchers. There is little or no evidence of institutionalization in the DR. However, there is potential for progress in this area as has been mentioned in previous sections on training, balance of activities between U.S. and HC, and collaboration.

#### V. PUBLICATIONS AND PRESENTATIONS

Highly satisfactory (see Section I.A.2. Research Results Disseminated and Currently in Use).

#### VI. OVERALL RATING: 1—Highly Satisfactory

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

Since this project was initiated during the last half of the year, a detailed treatment of accomplishments is not warranted. Good progress has been made in the transition from a modest involvement in the Mexico project to a larger engagement with Ecuador and others. The transition has been smooth and things are falling into place very well. Several lines of investigation are underway, both of a fundamental and of a more applied nature.

Dr. Graham and his colleagues bring a wealth of competence and capacity to the BNF element of the CRSP. His past and current relations with CIAT, NiftAL and other BNF programs will facilitate coordination, cooperation and collaboration among these programs.

A. Specific Research Contributions

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

In the HC, random collection and characterization of native *Rhizobia* has been initiated. HC PI has visited the U.S. PI's laboratory to learn methodologies.

In the U.S., work has begun to characterize Ecuadorian and other germplasm, bean genotypes that are active in N<sub>2</sub> fixation. Collections at hand include 1,000 lines from CIAT, 80 selected from the INIAP collection, and those at MSU, UWI and from the Mexico (INIFAP) resources.

Screening of cultivars tolerant to low soil P levels and to acid soil conditions has also begun. Genotypes selected for particular inoculant strains are also being identified.

2. Research results disseminated and in use in the U.S. and HC
3. Other research-related results
4. Changes in national production of beans or cowpeas in Ecuador

Not applicable

B. Institutional Development and Training

Five graduate students are involved: two from Ecuador and one each from the U.S., Colombia and Uganda. Funding is from diverse sources including CRSP, Work Study, USAID Country project and a MacArthur Fellowship. Recruitment is underway for a Post-Doctoral Fellow to provide continuity in Ecuador.

**C. Progress Achieved in Relation to the Log Frame**

Not applicable

**D. Evidence of Biological/Social Sciences Integration**

Not applicable

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

Due to past association, there is a natural linkage through Dr. Graham with CIAT, the NIFTAL project and other BNF activities. Intra-CRSP linkages also exist through Graham's past work in the Mexico project and other professional connections.

**II. FUNDING/FISCAL MANAGEMENT**

Not applicable

**III. PLANNING**

Not applicable

**IV. STATUS**

Activities undertaken will lead to superior varieties with enhanced yield and quality. Ecuador and other participants will benefit. All are appropriate to the Global Plan. Plans have been discussed with INIAP personnel. Discussions have also been initiated with USAID Mission personnel. Interest is good and may lead to in-country support.

**V. PUBLICATIONS AND PRESENTATIONS**

Not applicable

**VI. OVERALL RATING: 2—Satisfactory**

Since this project is now the foci for BNF research, the EEP encourages development of linkages and collaboration with other Bean/Cowpea CRSP projects where there is now or is potential for BNF contributions. The EEP should conduct a site review in Ecuador during the FY 90 review cycle.

GUATEMALA/CORNELL UNIVERSITY/WALLACE

*Agronomic, Sociological and Genetic Aspects of Bean Yield and Adaptation*

I. PROGRESS

This project has been difficult to evaluate in prior years because of the reports which have consisted "almost entirely of statements of a general, repetitive and rhetorical nature, unsupported by specific observational or experimental data."<sup>1</sup> In an effort to improve on the past, the PIs have included a considerable number of tables (19) and figures (25), although many of these may be redundant or could be summarized showing major trends. Much of the FY 89 report is devoted to theoretical explanations in support of physiological plant breeding as applied to beans.

A. Specific Research Contributions

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

The project 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 will identify superior genotypes, improve the efficiency of selecting for higher yield within segregating populations, and investigate the genetics of adaptation and yield expression. In addition to conventional plant breeding procedures, the project has introduced the yield system analysis (YSA) and advanced genotype x environment analysis (AMMI). These analyses utilize additional characters for selecting parental lines for crossing and estimating performance in segregating stocks. Additional information is also required on duration of growth (flowering, maturity, nodes) and on a modified harvest index (HI) determined from above-ground dry matter.

The Cornell/ICTA procedure stresses early generation testing and recurrent selection of superior parental stocks. These are well established breeding procedures that initially were used primarily to improve cross-pollinated crops (maize). The Cornell/ICTA researchers are directly concerned with genotype x environmental interactions, having observed that different temperatures and daylengths affect genotypes and gene action very differently in bean crops. For this reason, Guatemala provides an excellent field "laboratory" to test their hypothesis under a range of daylengths (compared with New York sites) and diurnal temperatures on an unrestricted scale. In these investigations, four contrasting environments are used:

- Guatemala highlands--19°C mean temperature and 13.5-hour daylength.

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<sup>1</sup>Report of the External Evaluation Panel of the Bean/Cowpea CRSP for FY 86, page 37.

- Guatemala Pacific Coast--29°C and 13.5-hour daylength.
- Southeast Guatemala--24°C and 11.5-to-13/5-hour daylength.
- Cornell--variable temperatures, probably averaging 18° to 25°C in summer and up to 16-hour daylength.

a. Research in HC

- (1) Guatemala highlands (Chimaltenango)--Some lines selected during 1986-87 based on yield, yield per day, erect architecture and multiple disease resistance outyielded the last released check, ICTA-Quinak-Che by 15 to 41 percent and local checks by 12 to 80 percent. All morphological components (number of pods/plant, seeds/pod, and average seed weight) were increased.

Testing of advanced lines at three highland locations identified three new strains (Ch87-44, Ch87-26 and Ch87-40) outyielded ICTA-Quinak-Che and the local check at two locations.

- (2) Pacific coast (Cayuta)--In the past, low yields plus pests and diseases (web blight, golden mosaic and bacterial blight) have largely precluded bean production in this high temperature and humid region. However, a testing effort consisting of several thousands of genetic stocks is underway to attempt to identify suitable bean varieties for this region and for El Peten in the Atlantic slope lowlands. Beans are in high demand and a good moneymaker for small farmers in these regions.

In 1988 trials, 142 lines were evaluated from which 26 superior lines were selected. Among the erect bush types, the best was Negro Cayuta.

Climbing beans are popular for relay cropping with maize at intermediate elevations, but eight bush-type bean composites (from the project) also show potential for similar use in the lowlands. A variation of the maize support is that interplanting climbing types with papaya increased profitability of both crops (same landrace) to 210 percent.

- (3) Southeast Guatemala--This is a bimodal rainfall area with difficult growing conditions and steep slopes where it is often impossible to use machinery or draft animals. The rainfall pattern is such that erect-bush beans appear promising. Therefore, ninety bush composites (from F<sub>2</sub>s) selected for high harvest index (>59 percent) were compared in intercrop trials with maize at three hillside and two flatland sites. However, the best of these did not significantly outyield the check varieties except at one hillside location.

A second experiment in 1989 compared six other composites with high harvest index (>67 percent) with six intermediate harvest index (<55 percent) composites. The higher HI group consistently outyielded the intermediate HI group at the same five sites mentioned above. It was concluded that genotypes with high HI accumulate higher yield per day of plant growth and seedfill and therefore become smaller, less-competitive plants. These high HI genotypes are able to partition photosynthate into reproductive development at a faster rate than the lower HI genotypes.

- (4) Comparisons between lowland tropical, highland tropical and temperate environments and G x E interactions--A diallel cross amongst four Guatemalan bush cultivars was made and advanced to the F<sub>8</sub> generation as 421 homozygous lines. During 1989 these 421 lines were then evaluated on the Pacific Coast (50m and 29°C), in the highlands (1786m/19°C) and in a greenhouse at Cornell (ca. 25°C). Daylengths were 13.5 hours, 13.5 hours and 16 hours, respectively. Days to flowering varied significantly at two sites (the temperate and cool highland sites) but not at the warm tropical environment. Genetic control appears to be one or two genes and flowering occurred at nodes 2 to 5 at 19°C compared with nodes 4 to 20 at 29°C.

b. Research at Cornell University

- (1) Physiologic-genetic studies--Crosses between a New York determinate, photo-period insensitive cv. Redcloud and a Salvadoran indeterminate climbing type (requires <12-hour days to flower) produced three classes of segregates: (a) photo-period insensitive flowering at 35 days, (b) moderately photoperiod sensitive like Redkote and (c) sensitive types that did not flower until September when 12-hour days occurred. The latter also had more nodes, at least 8 to 10 on the main stem.
- (2) Application of YSA and AMMI--A complete yield system analysis of each cultivar entered into 52 New York State, national and international trials grown during a three-year period at several sites. Correlations were seen showing that harvest index was negatively correlated ( $r = -0.45$ ) with days to maturity; HI was positively correlated ( $r = 0.67$  and  $0.69$ ) with yield per day of plant growth and seedfill; and yield was not correlated ( $r = 0.01$ ) with maturity. It was concluded that variable temperatures from year to year and site to site under the same daylength alters the photoperiod gene activity and rate of partitioning to reproductive growth and, therefore, time to maturity. Variation in other growing conditions (including stresses like pests and moisture) over years and sites alters productivities, which in some situations favor early over later maturities and vice versa.

(3) Yields of advanced progenies--During 1987 and 1988, 22 lines developed by early testing/recurrent selection and YSA had 38 to 55 percent higher yields than Redkloud, Redkote and Red Kidney, although many of these did not possess acceptable canning quality. For this reason, the PI cautions that selection should be carried out for every conceivable morphological, architectural, ideotypical and physiological trait that can be selected for and is a possible contributor to higher yield. Results indicate that correlated negative consequences almost always attend selections for only one morphological or physiological component of yield because any change in partitioning of photosynthate simultaneously affects maturity, accumulation of biomass and harvest index.

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

a. Improved cultivars in Guatemala

The long-duration (nine to ten months) climbing beans grown with maize in the highlands is being replaced by earlier maturing bush beans. One variety, ICTA-TeXel, developed by the project and released in 1989 is becoming accepted in the highlands. A CIAT line, DOR-364, shows promise for the Pacific Coast owing to its adaptation and resistance to golden mosaic virus. A project-developed line, Ju89-3, also shows excellent BGMV resistance and is expected to be released in 1990 or 1991.

The Cornell YSA/early testing breeding method is now being used in both lowland and highland bean improvement as well as the mid-elevation of the southeast (Jutiapa). Moreover, there is increasing interest in the use of physiological traits for yield breeding, early generation testing and recurrent selection.

3. Other research-related results

Included in results described above.

4. Changes in national production of beans in Guatemala

Production in 1988 was estimated at 115,000 tons, but it may be down to 101,400 tons in 1989 due to heavy BGMV losses in the southeast. Yield trials have been down during the past four years owing to heavy pressure on the land, but per capita consumption has been up as a consequence of high cost for animal products.

B. Institutional Development and Training

The Guatemalan Bean Research Program remains one of the strongest and more progressive programs in the Central America/Caribbean region. The methods promulgated by this project to better

understand adaptation and yield physiology will contribute to more effective and efficient bean improvement for the highly variable environments of the HC.

There were no references to training in the report. Previously (up to 1987) two U.S. Ph.D.s and one HC M.S. were trained.

#### C. Progress Achieved in Relation to the Log Frame

In general, the project appears to have met most of the objectives of the original log frame during the past eight years. Even the U.S. PI admits the short-term goals have been achieved (i.e., the understanding of the biology of adaptation and yield). However, this knowledge can be further expanded--perhaps indefinitely.

The research has backstopped and strengthened the Guatemalan black bean breeding program--the only black bean breeding in Central America. CIAT joins the overall effort in the region by working on disease resistance, and ICTA participates in the regional bean improvement network in Central America, Mexico and the Caribbean.

Methodologies and knowledge developed by the project have enabled the ICTA bean research team to: more efficiently develop bean varieties for diverse cropping systems and several environments; more efficiently breed for higher yields; and develop leadership in breeding early maturing varieties for Central America and the Caribbean in collaboration with CIAT.

#### D. Evidence of Biological/Social Sciences Integration

Responsibility for social science and WID issues 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 collaborate with the IBSNAT network.
2. The USDA supports testing and validation of models that simulate bean growth and yield.
3. The USDA W-150 regional bean project supports analysis of the Cooperative Dry Bean trials (U.S. and Canada).
4. Four non-Cornell bean researchers used the YSA and AMMI at eight sites in 1988.
5. Collaboration with CIAT and biotechnologists at Cornell has begun to analyze molecular genetic comparisons of genotypes for photoperiod and adaptation.

## II. FUNDING/FISCAL MANAGEMENT

### A. Audit/Project Management Reviews

1. A site review of the Cornell component was made by the EEP in January 1990.

2. No report of an audit.

**B. Adequacy of Funding by CRSP Participants**

Presumed adequate from all sources. Earlier there was a problem with the international transfer of funds (presumed to be rectified).

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

Management difficulties were reported by Cornell in earlier years. These concerned delays in transferring funds to ICTA and in recovering unspent monies. Moreover, it was found impossible to control spending by the HC, resulting in reduced parity for the HC--42.5 percent of funds.

Equipment approval in A.I.D. became a lengthy, drawn-out procedure.

**D. Adequacy of Current Policies and Procedures**

No comment

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

None reported

**III. PLANNING**

**A. Review of FY 89 Work Plan**

No comment

**B. Plans for FY 90**

**1. Research in HC and U.S.**

- a. Guatemala--Breeding methods described above will be utilized to continue bean improvement in the three major growing zones: highlands; intermediate (southeast) elevations; and the lowlands--both the Pacific Coast and the Atlantic side.

Primary improvement focus will be on early bush types for all environments (NOTE: Planning in the HC is usually done in November).

- b. Cornell--Long-range plans will be followed to further expand and develop "physiologic breeding." YSA and AMMI analysis will be expanded further on national and international bean trials.

**2. Expected changes from FY 89 work plan**

No comment

#### IV. STATUS

##### A. Appropriateness of Activities to Goals of the Global Plan

Research and related activities are highly appropriate to the Global Plan.

##### B. Balance Between Research and Training

There is no account of training in the report.

##### C. Balance of Domestic vs. Overseas Activities

Apparently satisfactory

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

Satisfactory

##### E. Relative Contributions of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

Balanced--near equal participation

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

Little involvement or support

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

Excellent--strong support by ICTA

##### H. Institutionalization of HC Component

No comment

#### V. PUBLICATIONS AND PRESENTATIONS

Seven publications are in preparation or in press. Four publications include the HC collaborator.

#### VI. OVERALL RATING: 3--Satisfactory, but CRSP officials may wish to consider orderly phaseout.

This project appears to have achieved at least 90 percent of its initial objectives. Perhaps a twelve- to eighteen-month continuation from this point is justified to better define the analytical methodology, analyze and write-up results and transfer the Guatemala work entirely to ICTA.

NOTE: The EEP noted that the U.S. PI is the authority on temperature/ photoperiod effects in beans (35 years of experience). His knowledge on this subject needs to be captured for posterity.

HONDURAS/UNIVERSITY OF PUERTO RICO/BEAVER

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

I. PROGRESS

A. Specific Research Contributions

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

Collaborative research activities of the CRSP project are conducted primarily at sites in Honduras and Puerto Rico, with substantial support (mainly rust research) from the Dominican Republic/UNL project. The research has been underway for about eight full years and is directed towards improvement of small red beans which are grown extensively in Central America. The research covers a broad range of activities, all of which are important:

- a. Breeding for disease resistance to bean common mosaic virus, common blight, anthracnose and rust (Honduras and PR)
- b. Molecular genetic studies on rust (PR)
- c. Rust virulence (Honduras and PR)
- d. Yield losses due to anthracnose and common blight (Honduras)
- e. Evaluation of bean germplasm (Honduras and PR)
- f. Early maturity (Honduras and PR)
- g. Reproductive period (Honduras and PR)
- h. Visual indicators of physiological maturity (PR)
- i. Heat tolerance (PR)
- j. Outcrossing of common beans (PR)
- k. Heterogeneity in crosses (PR)

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

Eight promising red bean lines developed by the project have been included in the CIAT-coordinated regional performance nursery.

Seven presentations at the Annual Meeting of the PCCMCA have served to help disseminate research findings to other bean researchers in the Caribbean and Central America.

Four manuscripts accepted for publication in refereed journals.

### 3. Other research-related results

#### a. Germplasm conservation and use

Seed lines developed by the project have been requested by bean researchers in El Salvador, Haiti, Philippines, U.S. and Colombia (CIAT).

Seed Bank Unit at the EAP received equipment from the IBPGR.

368 accessions were received from CIAT for evaluation and seed increase (materials originally collected in Honduras).

#### b. Seed production and distribution

The Seed Production Unit of the EAP produced and sold approximately ten tons of high quality seed of Catrachita and Zamorranano varieties to farmers directly and to the National Seed Program of the Honduras Ministry of Natural Resources (MNR).

#### c. Impact of CRSP-produced technologies

Plans supported by the EAP for a national seed certification program are being considered.

#### d. Other project impact

See Item 4 below.

#### e. Needs of small-scale farmers and women

Small-scale farmers and their families will be the first to benefit from introduction and use of small red beans with enhanced levels of disease resistance, improved agronomic traits and stable yields.

### 4. Changes in national production of beans in Honduras

|                               | Bean Production |         |
|-------------------------------|-----------------|---------|
|                               | 1978-88         | 1987-88 |
| a. Hectares Planted           | 73,800          | 62,200  |
| b. Yields per Hectare (kg/ha) | 500             | 540     |
| c. Total Production (tons)    | 36,600          | 36,000  |

Over the past ten years, yields and the area of production of beans in Honduras have not changed greatly. At present, local production supplies approximately 60 percent of national demand, which is estimated to be 57,800 tons.

## B. Institutional Development and Training

This element of the project has been a matter of interest and concern since the beginning of the CRSP. The matter appears resolved, at least for the next few years. The EAP is a private, regional training institution located in Honduras with excellent research and training facilities. Increasingly in recent years, the EAP has moved into research and outreach programs. The MNR of the Government of Honduras has a national legume improvement program of which beans are a major component. Through agreement with the EAP and the CRSP, the EAP has been designated the MNR's agent in Honduras for conducting the CRSP. Increasing outside donor support to the EAP has resulted in substantial strengthening of research and outreach programs by the EAP. Following the Bean/Cowpea CRSP, INTSORMIL now headquarters its Honduras CRSP activities at the EAP with an American scientist in residence. There is also an MNR bean liaison scientist posted at the EAP. More and more, the EAP appears to be taking on a service role in Honduras and in doing so has provided an effective institutional role/framework for operating in Honduras. Given current and prospective economic and political realities, this is probably the only satisfactory means for the CRSP to collaborate with Honduras. While within the current arrangement some training is afforded the MNR, capacity building within Government of Honduras public institutions (i.e., experiment station and university research and extension units) is lagging.

## C. Progress Achieved in Relation to the Log Frame

1. A bean breeding program has been established in Honduras.
2. Breeding lines have been produced with improved agronomic traits and resistance to one or more of the following diseases: BCMV, rust, common blight and anthracnose.
3. Extensive collaborative research is underway in the region.
4. While steady progress is being made, bean varieties with multiple disease resistance are probably some years away.
5. Arrangements for extensive, thorough field testing to reveal the strengths and weaknesses of the program are yet to be made and conducted.

## D. Evidence of Biological/Social Sciences Integration

None to date

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

Satisfactory; primarily with the Dominican Republic/UNL project but also with the Dominican Republic/UWI project

## II. FUNDING/FISCAL MANAGEMENT

### A. Audit/Project Management Reviews

Financial review was made by the UPR Finance Officer and recommendations were implemented.

An EEP representative made a site review of operations and arrangements in Puerto Rico.

### B. Adequacy of Funding by CRSP Participants

Adequate

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

No major problems have been encountered.

### D. Adequacy of Current Policies and Procedures

Satisfactory--PIs would like more flexibility in purchasing research equipment.

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

Impressive at EAP; funding of related projects by A.I.D. PSTC, NAS/BOSTID, IBPGR/CGIAR and Profrijol/CIAT

## III. PLANNING

### A. Review of FY 89 Work Plan

No significant changes

### B. Plans for FY 90

There will be increased attention to rust at EAP through the addition of a scientist. There is a need for increased attention to the bean golden mosaic virus.

## IV. STATUS

### A. Appropriateness of Activities to Goals of the Global Plan

1. Disease resistance research on small red beans is important throughout Central America.
2. Rust resistance research is important in tropical and temperate regions.
3. Early maturity, heat tolerance and longer reproductive period are traits important to many bean improvement programs.

**B. Balance Between Research and Training**

Adequate

**C. Balance of Domestic vs. Overseas Activities**

Very satisfactory

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

Excellent--There is an annual joint preparation of work plans and budgets and consultations are held throughout the year.

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

Outstanding--Puerto Rico is ideal for breeding enhanced levels of disease resistance for the region. UNL and UPR provide very strong, effective inputs; UPR and USDA location and cultural/language features are special, unique advantages.

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

Prevailing circumstances regarding USAID/Honduras are not conducive for close working relationships. See Annual Report for specifics.

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

Project leverages resources of several U.S and HC institutions.

**H. Institutionalization of HC Component**

See comments in I.B. above.

**V. PUBLICATIONS AND PRESENTATIONS**

Very impressive--indicative of close collaboration and project productivity

**VI. OVERALL RATING: 1--Satisfactory**

**A. General Strengths**

1. High quality, highly relevant support to Honduras by UPR, UNL, UWI and USDA. Dr. Beaver and Dr. Echavez-Badel and their collaborating colleagues in the UPR are conducting a fine program with excellent support from university officials.
2. Regional collaboration
3. Geographical location of the UPR
4. Institutional strengths of the EAP

**B. General Weaknesses**

1. Socioeconomic and political circumstances in Honduras which adversely impact the MNR and its programs
2. Lack of socioeconomic components, including WID

**C. Recommendations**

This FY 89 review has been based on a site visit to the University of Puerto Rico by two members of the EEP (Drs. Gray and Rachie) in November and on review of the FY 89 annual report.

The U.S. advantages in Puerto Rico with regard to outstanding institutional resources (UPR, USDA and others), geographic location, transportation, operating costs, and cultural and 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.

INCAP/WASHINGTON STATE UNIVERSITY/SWANSON

*Improvement of Dry Bean Nutritional Quality and Acceptability*

I. PROGRESS

A. Specific Research Contributions

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

a. Factors responsible for low protein digestibility of beans

Soluble dietary fiber reduced protein digestibility without reducing the overall nutritive value of the protein. Insoluble dietary fiber did not significantly affect the protein nutritive value. Increased tannin reduced the protein value, but did not correlate with protein digestibility. The role of procyanidins and protein concentration during cooking of the beans with respect to protein quality is being investigated. The digestibility of various extractable fractions of protein are being studied regarding their digestibility.

b. Physiological mechanism responsible for the hard-to-cook phenomenon

Dehulled beans have a rate of hardening less than that of whole beans. The seed coat was found to play a significant role in inducing the hard-to-cook phenomenon which was not solely responsible for inhibiting water uptake. The hard-to-cook phenomenon is associated with moisture, temperature and time of storage. However, modification of atmospheric gases did not influence these characteristics. Other studies included calcium treatment of stored beans, starch granule extractability, and the development of methods to determine cell wall components related to the hard-to-cook phenomenon. A cooperative effort with Michigan State University regarding seed characteristics is under way. In addition to breeding studies, biotechnology techniques are being developed to study the genetic transmission of factors affecting bean seed cookability and digestibility.

c. Socio-cultural and traditional factors influencing decisions to produce market purchase, prepare, and consume beans

A research survey of 20 percent of approximately 1,500 households in a rural community west of Guatemala City was conducted. A second survey of 681 students at the grade school was also conducted. The results of this study, entitled "Patterns of Malnutrition in Guatemala," were written by Jim Hogg, at that time with the Department of Anthropology, University of Washington. The general

conclusions were as follows: Adequate nutrient intake will not completely solve child mortality problems; malnutrition is caused by numerous factors other than food intake; factors include diverse food availability, sanitation aspects, understanding of health and other environmental factors. There also appears to be a hierarchy of importance between the various factors. It was concluded that the causes of hunger/malnutrition are not well defined and must be determined before appropriate remedial actions can be made. No indication was made as to whether this report is being readied for submission for publication.

d. Utilize beans in appropriate foods acceptable to rural populations

Bean soups containing significant quantities of beans and other components were generally acceptable and provided excellent nutritional quality. Production costs were assessed for preparing these soups.

A combination of red beans and texturized soy protein was formulated to mimic chili. Acceptability was less than that of traditional chili made with red beans and ground beef. Current changes in the product are being assessed regarding acceptability.

Extrusion cooking was investigated for the preparation of an instant bean flour for use in fried bean dishes. The cost analysis indicated that the price of this type of preparation was approximately twice that of dried beans, and sensory evaluation indicated the acceptability was less when prepared with extrusion cooked flour.

The research report consisted of programs ongoing at Washington State University, INCAP, Michigan State University and Kansas State University. The Michigan State University approach is to develop raw materials to fit processed parameters, for example, by eliminating the hard-to-cook phenomenon in the bean itself. They are also investigating enhancing consumer quality, such as nutritional quality and sensitizing toxic factors to heat in beans. Their research has involved factors included in the hard-to-cook phenomenon and overall techniques to screen for the quality of bean seeds. This includes development of a laboratory manual to screen quality factors for use by breeders. In addition, Michigan State University has looked at methods to screen the flatulence potential of bean seeds.

2. Research results disseminated and in use in the U.S. and HC
  - a. Methods and instrumentation to determine cooking quality of beans continues to be disseminated and used in the U.S. and Host Country.

Storage parameters to enhance bean quality (prevent hard-to-cook phenomenon) have been reported. In addition, development of convenient bean food products has occurred. Screening methodology to determine quality characteristics of bean seeds for breeders is being prepared.

b. Evidence of extended use to date

Evidence has included the sale of penetrometers and citations of methods to determine hard-to-cook beans in the literature. Presentations have been made to the U.S. bean industry regarding the research results. It appears that much of the data are still being disseminated and evidence of the extent of use will be forthcoming. Publication output appears excellent consisting of thirteen presentations, nine papers, plus two accepted for publication and two recently submitted for publication, one book chapter, three Ph.D. theses and one M.S. thesis.

3. Other research-related results

a. Germplasm conservation and use

(1) Development of quick cooking bean lines--Information on quick cooking bean lines is being accumulated and the distribution of bean lines for collaborative studies is being done.

(2) Exchange of bean germplasm for research purposes--Exchange of bean germplasm for research purposes has occurred between INCAP, Michigan State University, Washington State University and Kansas State University. Objective methods to assay the cooking quality of beans has altered the approach to research by the investigative team.

b. Project impact on production and consumption

New bean products are being adapted to preferences. The solving of the hard-to-cook bean problem will allow more beans to be used for human consumption.

c. How research findings address the needs of small-scale farmers and women

Identification of a storage environment to prevent hard-to-cook beans or beans that will not germinate will increase their utilization. Increased utilization will impact positively the nutritional and health status of the consumer.

4. Changes in national production of beans in the Host Country

Information is not available.

## B. Institutional Development and Training

### 1. Changes since FY 88

None that were reported.

### 2. Over life of project

Based on information available, it appears that sixteen Guatemalans were trained at INCAP in this program since 1986, but, at the present time, it does not appear that any Guatemalans or other Central Americans are in training at INCAP via funding from this project.

### 3. In prospect

Institutional development has apparently not been an issue with this particular project since participating U.S. institutions and a regional research and development institution (INCAP) are the participants. However, training of personnel who would function in the geographical area of importance to this project would seem to be appropriate (Guatemalans, as well as other Central American students).

### 4. Project training targets

According to the training schedule of January 21, 1989, there were two M.S. and three Ph.D. degrees completed at U.S. institutions. One Ph.D. completed the degree in late 1988. In addition, one M.S. and one Ph.D. candidate are expected to complete their studies in 1990. As noted in the previous EEP Report, it appears that the training component is not well defined and needs further attention, particularly regarding the role of INCAP.

## C. Progress Achieved in Relation to the Log Frame

This project continues to make progress toward the achievement of the goals of the log frame. The goals are relatively long-term; therefore, time estimates are not available for completion of the project. It appears that the project is reasonably on schedule.

INCAP has had a long history of being interested in projects which would ameliorate the nutritional problems of Guatemala and Central America and they have various projects which would integrate well with the thrust of the CRSP project. The geographical area for which INCAP functions has historically been a bean and corn consuming area. Therefore, the potential contribution of the research to the geographical area is excellent. In the U.S., the problem is primarily one of consumer acceptance of a low-cost item, but health issues appear to be changing the importance of beans in the diet. The issue of flatulence remains one of importance to U.S. consumers. Overall, this research will contribute to ameliorating the global constraints regarding availability and acceptance of bean-based products.

#### D. Evidence of Biological/Social Sciences Integration

Identification of and attention to relative WID issues is good. The recent involvement of an anthropologist from WSU (see I.A.l.c., J. Hogg) to assess patterns of malnutrition in Guatemala is an excellent step in this direction.

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

This project appears to maintain its excellent activities in this regard. Particularly noteworthy are the interactions between Michigan State University and WSU researchers in the breeding area.

### II. FUNDING/FISCAL MANAGEMENT

#### A. Audit/Project Management Reviews

None were reported. No information was given regarding requested audits or management reviews.

#### B. Adequacy of Funding by CRSP Participants

The PI indicated that A.I.D. support is adequate to meet the proposed scope of work. However, additional funding appears to be necessary to encompass raw material assessment, product development, consumer acceptance, nutritional evaluations and social and economic issues.

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

It appears that budgeting and allocation policies are improving, but the reporting of itemized encumbrances is still slow. There are late Host Country receipts, as well as late reporting of encumbrances, which delay financial reports.

#### D. Adequacy of Current Policies and Procedures

The current policies and procedures for this project appear to be satisfactory, and the current management was reported to exceed the expectations of the Principal Investigator.

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

Funding from industry and various federal sources other than A.I.D. are being pursued.

### III. PLANNING

#### A. Review of FY 89 Work Plan

The work plan was reviewed in June 1989 at the Annual Institute of Food Technologists Meeting in Chicago and re-reviewed in October 1989 at the American Association of Cereal Chemists Meeting in Washington, D.C. There were no significant changes in the plans resulting from these two meetings.

## B. Plans for FY 90

Washington State University/Michigan State University/INCAP has developed a plan to collaborate on protein quality and digestibility research. WSU/MSU/INCAP are planning to conclude the research on hard-to-cook beans. INCAP will continue development of acceptable bean-based food products. It is also presumed that appropriate socioeconomic studies will be concurrent with the development of acceptable bean-based food products. The Kansas State University inputs on the hard-to-cook phenomenon will be phased out. As additional funding sources become available from industry and other organizations, it is anticipated that efforts will be increased via this leveraging.

## IV. STATUS

### A. Appropriateness of Activities to Goals of the Global Plan

The activities appear to be appropriate for the Global Plan.

### B. Balance Between Research and Training

Based on information available, it appears that the major portions of the funding are used for training purposes. Although the research component as reported seems to be a minor portion of the total funding, the balance is probably satisfactory if one considers graduate student research. The expenditures budgeted in FY 88 were similarly heavy on training and light on research.

### C. Balance of Domestic vs. Overseas Activities

Research appeared to be well balanced and within respective program constraints. The U.S. universities conduct primarily basic research in collaboration with INCAP. INCAP has the primary leadership in conducting product development research and socioeconomic research. Based on the information available, it would appear that additional practical and research training at INCAP may be appropriate.

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

It appears to be satisfactory.

#### 1. Research planning for FY 89

Planning and development of work assignments was conducted by the Principal Investigators, primarily via telephone. The U.S. investigators also met at professional meetings to plan the specifics. Dr. Bressani developed written objectives and suggestions, and contributed via telephone discussions.

#### 2. Preparation of budgets for FY 89

Budget guidelines and requests were mailed to the Principal Investigators during the spring of 1988, and budget allocations were discussed and agreed upon via telephone and at professional meetings.

3. Decisions regarding training of CRSP personnel in FY 89

There is no information given on this.

4. Decisions regarding publications/presentations in FY 89

No information was presented. However, the output appeared to be excellent and, therefore, no serious difficulties seemed to be apparent.

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

U.S. and HC contributions appear to be appropriate and satisfactory.

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

None reported

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

The cost effectiveness appears to be quite satisfactory. There appears to be considerable leveraging of the research activities at Washington State University and Michigan State University. The cost effectiveness of the INCAP component cannot be assessed at the present time.

H. Institutionalization of HC Component

This is not applicable since INCAP is not a HC institution. It should be noted that faculty at Michigan State University, Washington State University, and Kansas State University have been noted for international activities. The lead institution (WSU) has good support for its international programs and the new dean (Dr. Lawrence E. Schrader) is a proponent of international agriculture. Integration of the project research within the framework of the participating institutions appears excellent. Internal project management and institutional management support were deemed as satisfactory. Student/professor interactions were observed to be highly satisfactory.

V. PUBLICATIONS AND PRESENTATIONS

The list of publications/presentations looks very impressive. The participants are strong researchers and publish on schedule.

VI. OVERALL RATING: 3—Satisfactory, but CRSP officials may wish to consider orderly phaseout

A. General Strengths

The research components at Washington State University and Michigan State University are excellent. Strong integration is occurring

between these two institutions. In addition, there is some collaboration with the Tanzania project in the area of utilization.

**B. General Weaknesses**

The contribution/participation of INCAP is difficult to assess. Both Principal Investigators (Professors Swanson and Bressani) may be stretched thin. This appears to have resulted in delays in reporting and, in certain aspects, inadequacies of reporting.

**C. Recommendations**

The project is satisfactory, but the EEP concurs with the recommendation of the TC that it is time for this project to be gradually phased out. A new project focused on nutritive value and digestibility could be strengthened in a proposal for the next extension.

MALAWI/MICHIGAN STATE UNIVERSITY/ISLEIB

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

Following on the successful completion of the original Bean/Cowpea CRSP in Malawi, this new project is still in the process of organizing and launching its program; its title, log frame and arrangements emphasize its goal to develop and employ strategies for improvement of components of bean and mixtures themselves and to develop disease-resistant varieties for farmers. Integration of this CRSP project into the Malawi National Bean Programme seems assured. The HC PI is also the Acting Coordinator of the National program, which is located in the Bunda College of Agriculture. The new law that follows reflects the status of this new Bean/Cowpea CRSP project in Malawi.

PROGRESS

Specific Research Contributions

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

The research in process is a combination of biological initiatives related to the new thrusts and continuation of the socio-cultural studies which are being re-directed to be supportive of and coordinated with the new thrusts.

- a. Screening of Malawian and introduced bean germplasm for disease resistance, drought resistance, insect resistance and nitrogen fixation
- b. Yield performance trials
- c. Evaluation of inter-cropping systems
- d. Sampling of plant pathogens to determine patterns of variability and racial identity
- e. Genetic studies/isozyme analysis
- f. Socio-cultural studies--longitudinal study, breeding strategy and survey of bean production practices in Dedza Hills
- g. Research on farmers' perceptions and management of ALS and ANTH (planned but not initiated)
- h. Genetic studies (in association with e. above)

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

- a. A longitudinal study/report on socio-cultural influences on diversity in beans in northern Malawi was completed and distributed in the U.S. and HC.

- b. A component breeding strategy was developed and advanced as a bean breeding strategy suitable for Malawi and other areas where farmers plant mixtures of bean genotypes.

3. Other research-related results

a. Germplasm conservation and use

Seed of seventy bean accessions from Malawi was added to the USDA germplasm collection.

1600 accessions of CRSP-collected *Phaseolus* germplasm is in storage at Bunda College; 900 of these accessions have been evaluated for seed and plant characteristics.

b. Seed production

Limited

c. Impact of other CRSP technologies

Greater understanding of the processes involved in the generation and maintenance of genetic diversity in beans, with special regard to agronomic, genetic and socio-cultural characteristics/features. Such understanding is likely to influence bean breeding strategies and government agricultural extension programs in Malawi.

d. Impact on production and consumption of beans

Probably none

e. How the research findings specifically address the needs of small-scale farmers, equity, WID and environment protection issues

The sociological surveys have confirmed and emphasized the major role of women in bean production on small farms in Malawi. Small farmers will be the first to benefit from CRSP activities currently underway.

4. Changes in national production of beans in Malawi

Information not available

B. Institutional Development and Training

1. Changes since FY 88

Dr. A. B. C. Mkandawire became the HC PI and other changes occurred during the year both on the U.S. and HC sides.

2. Over life of the project

Over the life of the project there have been salutary staff additions to the point that HC scientists are now in place to conduct the national bean program and the HC component of the CRSP.

3. In prospect

No comment

4. Project training targets

Baccalaureate and graduate training at Bunda College is now such that no new Malawi students will be brought to the U.S. for degree training.

C. Progress Achieved in Relation to the Log Frame

New project has been recently initiated.

D. Evidence of Biological/Social Sciences Integration

The project has a complement of biological and social scientists in the U.S. and HC components, and their CRSP activities are integrated and mutually supportive.

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

Very satisfactory

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

None requested; none conducted

B. Adequacy of Funding by CRSP Participants

Inadequate to support graduate students--Predictably, this will be a major setback to conducting research support for the Malawi project.

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

Difficulties in management of CRSP funds at Bunda College and the Ministry of Agriculture have been reported.

D. Adequacy of Current Policies and Procedures

Adequate/satisfactory

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

Possible buy-in from USAID Mission and support from the Rockefeller Foundation program in Malawi

### III. PLANNING

#### A. Review of FY 89 Work Plan

Progressed according to plan

#### B. Plans for FY 90

Completed--They appear to be realistic and appropriate regarding the current log frame.

### IV. STATUS

#### A. Appropriateness of Activities to Goals of the Global Plan

Fully appropriate

#### B. Balance Between Research and Training

Formal degree training by the CRSP discontinued

#### C. Balance of Domestic vs. Overseas Activities

Satisfactory as planned

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

Excellent--There is a high degree of cooperation.

#### E. Relative Contributions of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

Moving towards satisfactory inputs/contributions from HC

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

Cordial and helpful

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

Substantial financial and in-kind inputs by the HC and MSU make this project a highly cost-effective investment.

#### H. Institutionalization of HC Component

HC scientists and staff are now in place in a national legume improvement program.

### V. PUBLICATIONS AND PRESENTATIONS

Satisfactory output; CRSP officials should consider a policy of joint HC and U.S. authors for publications of CRSP research results.

**VI. OVERALL RATING: 2—Satisfactory**

**A. General Strengths**

Too soon to estimate

**B. General Weaknesses**

Too soon to estimate

**C. Recommendations**

None

**SPECIAL NOTE:** This review was based on an EEP site visit to MSU and on the FY 89 Annual Report. Since that visit, the EEP has been informed by the MSU IR that the recently appointed U.S. PI, Dr. Thomas Isleib, has received an attractive position offer from North Carolina State University and that Dr. Isleib will assume the position in March 1990. The EEP is confident that the loss of Dr. Isleib will be only a temporary setback and that the CRSP Management Entity and Board of Directors will make satisfactory arrangements for continuation of the Malawi program as currently planned and executed.

MEXICO/MICHIGAN STATE UNIVERSITY/HARPSTEAD

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

I. PROGRESS

A. Specific Research Contributions

The collaborative research underway is directed mainly toward bean production in the semiarid highlands of central-north Mexico but is of importance elsewhere, including the bean-growing areas of the United States. CRSP-sponsored research is being conducted principally at two sites: one in Mexico (Durango) and the other in Michigan. In Mexico, the work is a part of the National Legume Program directed by INIFAP (the national agricultural research organization); in Michigan, the work is integrated with MSU's Experiment Station research on beans.

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

a. Genotype selection

Investigations are in process designed to determine the capacity of selected genotypes growing under moisture stress to extract nitrogen from the soil, to remobilize nitrogen from vegetative to reproductive organs, and to fix atmospheric nitrogen. In FY 89, F<sub>2</sub> populations were grown and 2,300 individual plant selections were made. Seed increase of these selections will be carried out at a winter nursery in FY 90. This work is going well.

b. Nitrogen fixation studies

Strains of Rhizobia from soils in Mexico are being evaluated.

Competition between and among strains of Rhizobia is being evaluated.

The effects of drought on nodulation are being determined.

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

Drought-tolerant breeding lines for Mexico and superior N-fixing strains of Rhizobia

3. Other research-related results

a. Germplasm conservation and use

Sixty accessions of wild beans (*Phaseolus* spp.) collected in Mexico in 1988 have been entered into genebanks in INIFAP and CIAT.

b. New cultivars

Seeds of previously released varieties, Bayo Victoria and Pinto Villa, adapted to the semiarid regions of Mexico are commercially available.

c. Molecular marker studies

Forty genotypes from Mexico, CIAT and MSU classified as drought resistant or drought-sensitive have been subjected to isozyme analysis. Of the 23 enzyme patterns observed, the results from two enzymes have been inconclusive. Distinct polymorphisms were recorded for ten enzymes, which suggests an association between drought reactions and isozyme patterns. Greater use of restriction fragment length polymorphism (RFLP) analysis to map dry bean drought responses, though expensive, appears indicated.

d. Impact on production and consumption

During the past decade in Mexico, there has been a definite shift to the production of higher market value crops into the traditional, relatively-favorable, bean-growing areas. This shift in crop production patterns is pushing bean production into the semiarid areas less favorable for crop production. The consequence has been a drop in national average bean yields from 612 kg/ha to 512 kg/ha. The value of this project is clear in light of the adverse impact of changing cropping patterns, i.e., slowing or prevention of further declines in bean productivity and production.

B. Institutional Development and Training

1. Changes since FY 88

The Mexico PI, Dr. Jorge Acosta-Gallegos, was promoted to National Coordinator of the Mexico National Legume Program. Dr. Acosta is no longer at Durango but continues as HC PI.

2. Over life of the project

There was continued growth in cooperation between the CRSP INIFAP and MSU research programs with mutual strengthening of both programs.

3. Project training targets

Training of personnel has been assumed by INIFAP. Because of existing training capacity in Mexico, the CRSP is no longer sponsoring formal training.

C. Progress Achieved in Relation to the Log Frame

Not reported in the annual report, but during a recent EEP site visit to MSU, it was clear that highly satisfactory progress is being achieved towards the accomplishment of objectives.

**D. Evidence of Biological/Social Sciences Integration**

Modest--Some research on cooking time of beans was reported.

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

Not reported in the annual report, but there is collaboration with the MSU component of the INCAP/WSU project.

**II. FUNDING/FISCAL MANAGEMENT**

**A. Audit/Project Management Reviews**

No audit was requested in FY 89. MSU's ongoing management controls and internal audit arrangements are adequate.

**B. Adequacy of Funding by CRSP Participants**

Funding by A.I.D., MSU and HC appears to be adequate to cover priority research activities.

**III. PLANNING**

**A. Review of FY 89 Work Plan**

No changes

**B. Plans for FY 90**

Apparent salutary shifts: first, a separate CRSP sub-contract with the University of Minnesota for additional work on N-fixation; and second, increased investigations of plant physiological adjustments to moisture stress, with special regard to greater use of basic science approaches, i.e., cellular and molecular biology.

**IV. STATUS**

**A. Appropriateness of Activities to Goals of the Global Plan**

Fully satisfactory

**B. Balance Between Research and Training**

This project no longer funds formal training. CRSP funds are used for support of research.

**C. Balance of Domestic vs. Overseas Activities**

Highly satisfactory with emphasis on comparative strengths of collaborating institutions

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

Outstanding--a model of CRSP collaborative research

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

Both MSU and INIFAP bring special strengths and weaknesses. The strengths of each are being exploited in mutually rewarding ways. The result is a fully-integrated, effective, collaborative research program.

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

No support required, but is available if needed.

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

Collaborative bean improvement research activities through the CRSP are cost effective for Mexico and the U.S. Each receives benefits that would not likely be possible otherwise, i.e., through working alone.

H. Institutionalization of HC Component

Both in Mexico and in Michigan through the appointments of Dr. Jorge Acosta as coordinator of the Mexico's National Legume Program and Dr. Eunice Foster as plant physiologist in bean research at MSU

I. Other Comments

Despite the loss of the original MSU PI, who organized and guided this project so successfully and who was effective in establishing highly-productive, mutually-beneficial arrangements for the collaborating institutions, the project has made the transition in excellent fashion with a highly competent, experienced, Spanish-speaking interim PI with long involvement in Mexico and Latin America. He is being ably assisted by several scientists. Currently, the work at MSU is going well, with a definite shift towards cellular and molecular biology, areas in which MSU may have a comparative advantage.

V. PUBLICATIONS AND PRESENTATIONS

Satisfactory

VI. OVERALL RATING: 1--Satisfactory

This is a highly successful CRSP project in transition with very favorable prospects. MSU has done a fine job as the lead university. The project exemplifies the mutual benefits which can accrue to participants in CRSP projects. Personnel associated with this CRSP project deserve great credit for their contributions in turning concept into reality.

**A. General Strengths**

1. Caliber and dedication of Mexican and American scientists
2. Outstanding leadership by Mexico and U.S. PIs
3. High degree of collaboration

**B. General Weaknesses**

Lack of a social science component

**C. Recommendations**

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NIGERIA/UNIVERSITY OF GEORGIA/McWATTERS

*Appropriate Technology for Cowpea Preservation and Processing  
and a Study of Its Socioeconomic Impact on Rural Populations in Nigeria*

I. PROGRESS

A. Specific Research Contributions

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

a. University of Georgia

- (1) Develop and test integrated model of cowpea hardening as a function of storage temperature and relative humidity (RH)—A kinetic model for rate of hardening under accelerated conditions has been developed. Hardening is more dependent on RH than temperature. Seeds stored at 30°C and 33 percent RH don't develop the hard-to-cook (HTC) defect. Long-term storage (eighteen months) of cowpeas is underway with data being collected at regular intervals. Comparison of hardening rate characteristics will be possible from these data. Problems with mold growth and insect infestation have delayed some activities. Chemical composition (dietary fiber) as a function of hardening is planned.
- (2) Apply technology to develop methods using HTC and germinating cowpeas in traditional and weaning foods—Milling behavior evaluation and incorporation of cowpeas with varying degrees of HTC into traditional products will take place at the end of the storage study (estimated start: May 1990). A germination/incubation procedure has been developed which significantly reduces the flatulence potential of cowpeas.
- (3) Develop cowpea-based food products with improved digestibility—Assessment of the effect of HTC on nutritional quality has been done and reveals an effect of both hardening and processing on protein, but not starch quality. Development of HTC has been shown to reduce protein nutritional quality, especially when seeds are ground prior to cooking. The expectation that HTC seeds may be used as meal-based products may have to be re-evaluated in light of these findings.

Specific storage and process conditions have been established which produce cowpea meal with excellent nutritional, functional and sensory properties. New cowpea-based weaning foods have been developed and are

being subjected to pediatric evaluation. The microbiological characteristics of cowpea products have been established. The effect of holding time and shear rate on cowpea paste and *akara* quality was determined. These data established suitable processing parameters for this product.

The response of U.S. consumers to *akara* (fried cowpea paste) was assessed using a mobile kitchen in various Atlanta, Georgia area shopping centers. The results indicated a reasonable acceptance rate, with acceptance increasing with the age of the consumer.

b. University of Nigeria, Nsukka

- (1) Field test acceptability of cowpea products in village and urban areas--Process parameters for the canning of *moin-moin* (a traditional Nigerian, steamed cowpea paste) have been established.

Two village mills have been installed and their processes and products introduced to local and surrounding populations. The Ogbodo-Aba mill location became operational at the end of 1988 and production is largely confined to supporting workshops for village women. The mill at Isiala Ngwa was installed as part of a joint Imo State-AFRICARE child survival project.

- (2) The University of Nigeria has done corollary studies to those at the University of Georgia on the functional role of proteins in cowpea paste and *akara*.

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

The research group continues to be highly productive as evidenced by the large number of research publications (six), theses (four) and presentations at scientific meetings (eleven) this past year.

The adoption of the milling technology by the AFRICARE facility in Imo State is particularly impressive since it is a strong indicator of the acceptance of the process for use in-country. Therefore, this research has resulted in new technology for cowpea processing and utilization in the HC which has been implemented at the village level. While it is too early to report a sweeping impact, the potential is in place. In the U.S., consumption of cowpeas and other legumes has fallen due to the limited modes of consumption, lack of convenience and reputation for adverse physiological effects. This project is also addressing these constraints.

3. Other research-related results

- a. Germplasm conservation and use
- b. Seed production and distribution of cultivars
- c. Impact of other CRSP-produced technology

Not applicable

- d. Project impact on production and consumption of beans and cowpeas.

This project is focused on the development of processing technologies and products for the increased utilization of cowpea-based products. The HC is Nigeria, which is facing serious economic problems with resultant need for cheap sources of good nutrition that are acceptable.

- e. Major impact on production and consumption of beans and cowpeas

The major impact is on housewives, vendors and anticipated small-scale processors who produce cowpea-derived foods. The development of pre-processed (preserved) products will significantly reduce the work-time required in the kitchen, make possible a steady supply of cowpea foods and increase their availability.

4. Changes in national production of beans in Nigeria

Not applicable

B. Institutional Development and Training

1. Changes since FY 88

Training at University of Nigeria

| <u>Student</u> | <u>Field</u>            | <u>Degree</u> | <u>Date<br/>Comp'd</u> | <u>Research</u>   |
|----------------|-------------------------|---------------|------------------------|---|
| E. C. Okeke    | Home Sci/<br>Nutrition  | Ph.D.         | 1988                   | Nutrition and impact<br>assessment surveys  |
| J. Enwere      | Food Sci/<br>Technology | Ph.D.         | Expt.<br>1990          | Spending leave<br>in U.S. studying<br>starch and protein                          |
| P. Okechukwu   | Food Sci/<br>Technology | Ph.D.         |                        | On leave at Cornell<br>studying thermal<br>processing and texture<br>of moin moin |

The University of Nigeria expects to complete the training of eight B.S., four M.S. and three Ph.D. students by 1992.

## Training Activities at the University of Georgia

| <u>Student</u> | <u>Field</u> | <u>Degree</u> | <u>Date<br/>Comp'd</u> | <u>Research</u>   |
|----------------|--------------|---------------|------------------------|---|
| M. Bulgarelli  | Food Sci     | Ph.D.         | 1988                   | Effects of micro flora on properties of cowpea paste                      |
| Yu-Hui Tuan    | Food Sci     | M.S.          | 1989                   | Impact of the HTC defect and processing on nutritional quality of cowpeas |

Discussions between Dr. Thomas Ndubuizu, Dean of Agriculture, University of Nigeria, and Dr. Louis Boyd, International Agriculture Coordinator, University of Georgia, occurred while attending the meeting of institutional representatives for the Africa region in Dakar, Senegal. These individuals discussed cooperative aspects. In addition, Dr. Angus Chidebelu, an agricultural economist, has joined the project at the University of Nigeria to analyze the economic impact of village mills on consumers, vendors and processors.

### 2. Over the life of project

This project continues to be extremely important to the Departments of Food Science and Technology and Home Science and Nutrition at the University of Nigeria. It has resulted in significant increases in the training of technical people to do research and extension-type activities in the project area. Training is very important for the application and development of cowpea-based technologies, as well as adoption of cowpea-based products by consumers.

### 3. In prospect

As opportunities present themselves, additional training activities will be implemented.

### 4. Project training targets

It is expected that approximately eight B.S., four M.S. and three Ph.D. students will complete their training at the University of Nigeria.

## C. Progress Achieved in Relation to the Log Frame

This project has had the continuing goal of increasing utilization of cowpeas among Nigeria's rural and urban poor. This project continues to make progress toward achieving its goal, and it has continued its focus as indicated in the log frame. Methodology is available for processing ready-to-eat, cowpea flour products using appropriate technology. The implementation of this technology is

currently being pursued using operational village mills. Village women and urban vendors are currently being instructed on the use of cowpea flour, and the impact on the economic and social life is being assessed.

**D. Evidence of Biological/Social Sciences Integration**

No comment

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

The research under this CRSP is complementary to other work on various cereals and legumes in Nigeria. This has resulted in publications by HC scientists on the use of various combinations using cowpeas, rice, maize, groundnuts, fish and other commodities. The village mill technology is being applied to other commodities, as well as cowpeas. IITA is beginning to conduct research on the utilization of its crops, and contacts have been made for collaboration between the University of Nigeria and IITA. These include workshops on cowpea flour utilization and possible joint research on extrusion cooking. As noted in the previous EEP Report, some consideration should be given to the identification and types of cowpeas used in this research in order to be of value to production projects.

Preliminary proposals have been developed among the University of Georgia (Bean/Cowpea), Alabama A&M (Peanut), and Texas A&M (Sorghum-Millet) CRSP projects for integrating the food use of their commodities. In addition, there is a very strong interaction between the Peanut CRSP and Bean/Cowpea CRSP researchers at the University of Georgia.

**II. FUNDING/FISCAL MANAGEMENT**

**A. Audit/Project Management Reviews**

These are conducted via standard University of Georgia auditing systems. No problems are apparent. The University of Nigeria accounts are audited annually by an international firm of auditors, and the project funds are scrutinized regarding financial guidelines and regulations.

**B. Adequacy of Funding by CRSP Participants**

1. A.I.D.--In spite of the highly productive outputs of this group, the funding is quite low. Although this group has a very strong, integrated approach, more rapid progress could be made by increased funding owing to the multi-faceted requirements for a utilization program. Utilization requires raw material assessment, product development, consumer acceptance studies, nutritional implications and social and economic impact studies.
2. Host Country--The high inflationary rates and the devaluation of currency continue to be an additional problem. As project activities in Nigeria are developing, current funding is

inadequate. This is compounded by the necessity to purchase a new vehicle in order to continue progress.

### 3. U.S. Institution

- a. Support--University support derives primarily from the department. The department head has been very supportive of this project. The secretarial, accounting and technical support from departmental personnel has been outstanding. This project has also been extremely well integrated into the Georgia Experiment Station program.
- b. CRSP funds--It is unfortunate that less than 20 percent of total CRSP funds are oriented toward utilization programs. The eventual success of this program will rely on the expanded use of cowpeas by consumers. Therefore, strong consideration should be given to more adequately balancing the funding for the production and utilization components of cowpea research in the CRSP.

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

The current procedure of transferring monies to the Host Country is greatly improved from that of previous years. Checks are being sent directly to the HC PI upon receipt of monthly expenditure reports and a letter from the University of Nigeria bursar requesting funds. The check is then deposited into the Cowpea Research Account at a local bank, and the HC team receives funds from the bursar's office via normal disbursement procedures.

#### D. Adequacy of Current Policies and Procedures

Difficulties still arise regarding the safe delivery of supplies to Nigeria. Chemicals are often classified as hazardous, and they are particularly difficult to have shipped. The University of Nigeria regulations have made the process of claiming shipments difficult for the university's receiving agent in Lagos. Therefore the U.S. team encourages the HC team to order supplies directly from vendors and to be responsible for shipping and receiving.

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

This was not commented on in the annual report. However the opportunity for buy-ins and other funding sources continues to be pursued by the research team. For example, the proposed inter-CRSP project integrating the Bean/Cowpea, Peanut and INTSORMIL programs represents an opportunity. The inter-CRSP proposal is presently being reviewed by individual CRSP management entities.

### III. PLANNING

#### A. Review of FY 89 Work Plan

Research during FY 89 was well within the work plan. Re-evaluation of the cowpea storage conditions regarding contamination by molds

and insects delayed the completion of that component of the work plan, while the other accomplishments seemed to be on schedule.

#### B. Plans for FY 90

##### 1. Research in Host Country and U.S.

Work is proceeding according to plans submitted to the Technical Committee in May 1989. These include continued studies on the hard-to-cook defect with special reference to the use of hardened seeds for food applications and on the evaluation of a suitable drying system for cowpeas. HC research will include thermal processing of cowpea paste, village mill operation, impact assessment and the utilization of flour from germinated cowpeas to avoid flatulence.

##### 2. Expected Changes/Additions/Deletions from FY 89

Unfortunately, the HC PI has had surgery and is temporarily forced to relinquish Department Head and project duties in the HC. This has interfered with some of the management of the project in the HC, despite the efforts of the other team members. The success of the HC research activities depends, in part, on the improvement of his medical condition. If his condition does not permit full participation, it may be necessary for another team member to assume his duties. No other major changes, additions or deletions in the overall project are expected.

#### IV. STATUS

##### A. Appropriateness of Activities to Goals of the Global Plan

This project is directed toward increasing the availability of food by developing information and technologies related to the utilization of cowpeas. As cowpeas are among the most important food legumes in the region, they have been targeted for expanded research efforts by FAO/WHO. The activities are highly appropriate.

##### B. Balance Between Research and Training

There appears to be a very suitable balance. Training is a significant component of the total expenditures (approximately 25 percent of budget). This fits well within the training and research plans for FY 89.

##### C. Balance of Domestic vs. Overseas Activities

Excellent--The activities were coordinated to take advantage of the relative strengths and resources of the institutions. Appropriate components of the project were handled in the Host Country or the University of Georgia.

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

This appears to continue in excellent fashion. There are strong collaborative interactions, and they are very productive. Plans are discussed extensively during regular visits to Nigeria by the U.S. team.

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

Satisfactory

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

There is no USAID Mission in Nigeria. The USAID liaison at the U.S. Embassy in Lagos and the agricultural attaché are aware of the project and its activities in Nigeria.

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

As noted in previous reports, the cost effectiveness is exceptional. This is based on the highly integrated activities of the research teams, both in the HC and in the U.S., as well as the level of integration in the research programs of the University of Georgia, with particular reference to the Experiment Station.

H. Institutionalization of HC Component

Progress continues to be excellent. The HC is a major contributor to the project.

1. Faculty recognition for international activities

Members of the U.S. team have been recognized as major grant recipients by the institution. Many are invited, both from the U.S. and HC institutions, to present findings at national and international meetings.

2. Integration of domestic and international commodity research programs with CRSP projects

CRSP activities are very well integrated into overall research at the U.S. institution. Cowpeas are recognized as an important crop in the state. Increased utilization of cowpeas in various food products would make major contributions to U.S. growers and processors.

3. Internal project management and institutional management support

There are frequent team meetings for management and development of plans. Administrators at the institutional level have been very supportive and helpful when project needs are brought to their attention.

#### 4. Student/professor interactions

The program has an excellent record of success regarding its graduates. Students and faculty have worked extremely well together. The U.S. faculty have benefited from working with HC students, who have provided unique perspectives on the culture and needs of their country.

#### V. PUBLICATIONS AND PRESENTATIONS

The publication record continues to be very impressive in the food science area. Several publications have included the socioeconomic component via theses.

#### VI. OVERALL RATING: 3—Satisfactory, but CRSP officials may wish to consider orderly phaseout

##### A. General Strengths

General strengths are the dedication and cohesiveness of the project team at the University of Georgia and the highly integrated structure within which they function, resulting in extremely efficient outputs.

##### B. General Weaknesses

This project is inadequately funded for a comprehensive programmatic thrust which would require components of product development, technology development and transfer, acceptance and marketing. Therefore additional (perhaps external) resources are needed to accomplish the objective.

The Host Country environment has impeded in-country utilization progress because of policy, economic and social factors.

##### C. Recommendations

In general, the EEP concurs with the TC regarding the difficulties in developing the utilization component in Nigeria owing to government policy and concomitant economic and social factors. Therefore, with the initial objectives realized, phasing out of the Nigeria component and determining an alternate Host Country for the utilization program is recommended (such as Senegal and/or Cameroon). However, Nigeria is the largest consumer of cowpeas in Africa, and this project has been successful in having some of its cowpea milling technology adopted by an independent organization (AFRICARE) in Nigeria. Therefore it seems that continuation of some involvement should occur in order not to lose the gains made. Additional funding will be required to develop a programmatic approach needed in a utilization project.

FY 89 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

A. Specific Research Contributions

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

Impressive advances continue to be made along the three primary improvement thrusts. Concurrently, some potentially important breakthroughs have been achieved in more fundamental backup research. The most recent of these developments include:

a. Varietal improvement

Yield testing and mini-kit trials have further narrowed the list of promising new genetic materials. An advanced breeding line (IS86-275) with resistance to bacterial blight, mosaic viruses and bruchids has also shown superiority in yield in farmers' mini-kit trials in terms of yield and adaptation. It is being further studied for possible release in Senegal in 1990.

A second important development is progress in developing cowpea aphid resistance.

b. Management

Field research in northern Senegal shows that modest levels of fertilizer, closer plant spacing and varietal intercrops combined with good husbandry (timely sowing, weed control, etc.) can increase productivity in the cowpea-growing region.

c. Seed storage

Sealed drum seed storage is highly effective in preserving cowpea seeds for both human consumption and future planting. This method is also well-accepted by Senegalese farmers, although costs may be higher than desirable.

A second important development is the use of a safe, inexpensive chemical treatment (K-Othrine PP2 at 50g/100kg) of grain in sacks or plastic bags. This treatment protects the seeds for at least six months with less than 5 percent damage.

d. Supporting research

Significant advances were made in more fundamental areas. The most relevant of these are:

- (1) Genetically conferred delayed leaf senescence has potential for increasing mid-season drought resistance and seed yields.
- (2) Genotypic differences in heavy isotope of carbon (C13) discrimination are related to water-use efficiency. This potential screening method may be useful in helping identify genotypes with low discrimination against C13 uptake and better water-use efficiency.
- (3) Short, "internal" peduncle genotypes have been shown superior in yield to varieties with long, exposed (pods carried above the canopy) peduncle types.
- (4) Heat tolerant strains have been identified and intercrossed with Ghanaian types to improve this essential character. The stressful, high summer temperatures of California's Imperial Valley provide an excellent screen for heat tolerance.

a. Research in the Host Country

- (1) Mini-kit trials were increased from 35 at seven villages in 1988 to 45 at eight villages in 1989. Special seeding plates were provided to allow farmers to plant with peanut planters. The new varieties (IS86-275 and IS86-283) were compared with two traditional varieties (58-57 and Ndiambour). Combined results show a yield superiority of 30 to 40 percent for the newer varieties under both improved and traditional management.
- (2) Improved management (closer spacing, seed dressings, modest fertilizer: 9-30-15 per ha) increased yields by 5 to 20+ percent.
- (3) Seed storage studies based on 77 drums used by farmers showed that 65 drums had less than 15 percent damage after six months. However, the drums should be sealed for at least two months after harvest to ensure elimination of bruchids. Also, chemical treatment with delta-methrine, a synthetic pyrethroid at 509/100kg is extremely promising (>5 percent damage after six months) because of safety and cost (50g costs U.S. \$0.25).
- (4) Varietal mixing of an erect (e.g., CB5) and spreading variety (58-57 or B21) in alternate rows is more productive (LERs ranged from 1.17 to 1.46) than a single variety and will probably contribute to production stability.

- (5) Harvesting of green pods (as a vegetable---"southern peas") is increasing rapidly in Senegal. Studies on the effects of this practice indicate that partial picking increased reproductive duration by 63 percent, leaf area duration by 58 percent and number of pods harvested by 41 percent in CB5 (California). Early picking also increased resistance to mid-season drought. However, early picking can also reduce final yields where late season drought occurs and it may extend the pest-susceptible period.
- (6) Advanced-improved lines (e.g., IS96-275 and IS86-283 with resistance to virus, blight and bruchids) consistently yielded better than the older, farmer's varieties; but a newer line IS87-408 offers similar advantages as well as better quality seeds. Further testing is indicated.

b. Research underway at UCR

Cowpea research underway in California is both extensive and well balanced in support of both the State and Senegalese programs. A brief listing of the various activities is as follows:

- (1) Incorporation of desirable attributes like heat and drought tolerance, delayed leaf senescence and high yielding potential into African germplasm
- (2) Improvement of California dry peas varieties---New UCR lines considered for release in California are 1393, 160 and 524B.
- (3) Genetics studies carried out
  - (a) Tolerance to heat during floral bud development (Prima and TVu 4552) is a single dominant gene, but narrow sense heritability is only 0.26 in F<sub>1</sub>, F<sub>2</sub> and BC generations.
  - (b) Mid-season drought resistance (8517) appears related to delayed leaf senescence (genetic).
  - (c) Cowpeas (268 accessions) were classified based on their reproductive responses to heat and long days---eight major groupings.
- (4) Physiologic studies
  - (a) Heat/daylength response (see above)
  - (b) Heavy carbon isotope discrimination studies to ascertain intrinsic water-use efficiency---a screening tool

(c) Podding within the leaf canopy considerably higher yielding than pods carried above the canopy (54 percent)

(5) Entomology studies

(a) Resistance to hairy caterpillar in the field observed in seventeen out of seventy accessions

(b) Resistance to cowpea aphid observed in 175 lines, but not at seedling stage

(6) Plant pathology studies

(a) Resistance to mosaic virus complex (cucumber, aphid-borne and southern bean mosaic) was found in Bambey 21, CB5, TVx 3236 and IT8452246-4; 58-57, Ndiambour and Mougne are susceptible.

(b) Resistance to bacterial blight was screened in 58 lines; Mougne, TVx 3236 and IT8452246-4 were resistant, but IS86-275 and IS86-283 showed some segregation.

(c) Yield reduction studies showed that mosaic viruses cause substantial yield reduction.

(d) Granox seed dressing substantially improved germination and emergence at 2 to 4g/kg of seeds.

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

Mini-kit trials have introduced "new" varieties and practices to farmers in Senegal and they are growing trial varieties like 58-57, Ndiambour, Mougne and Bambey 21 more extensively. Also, cowpeas are increasingly sown in rows with peanut planters, achieving higher plant populations, more uniform stands and better weed control. Sealed drum seed storage is also being adopted. However, the overall effect of these improvements has not yet been documented owing to shortage of funds and personnel.

3. Other research-related results

a. Germplasm conservation and use

The glasshouse and field facilities at UCR are very useful owing to the long dry season (irrigated) for cleaning up, multiplying and evaluating introductions. Approximately 1,100 lines from IITA were grown out for this purpose in 1989. In addition, 280 accessions were so processed for the USDA Introduction Station in Georgia in 1989. High levels of seed-borne viruses were observed on African sources. UCR/Senegal have provided cowpea germplasm to several projects in the U.S. and elsewhere.

b. Seed production

UCR assisted ISRA in roguing and cleaning up several seed production fields and increasing clean seed in the dry season under irrigation.

c. Impact of other CRSP-produced technology

Farmers producing sealed-drum seed storage provide a much higher seed quality to their neighbors. Moreover, the mini-kit trials result in direct farmer training in improved technology and these farmers are becoming certified seed growers serving their villages and neighbors.

d. Project impact on the production and consumption of cowpeas

Production statistics are inaccurate (as in the rest of Africa), but the project has had a major impact on food availability and income from the use of both fresh and dry cowpeas in Senegal.

e. Meeting the needs of families on small farms

Emphasis on cowpea production has increased production in the Louga region of Senegal where rains and growing conditions are often unfavorable for peanuts and millet (e.g., 1988). This may result in shifting more production to cowpeas, part of which is marketed (often fresh) to purchase millet. The "fresh" cowpea harvest meets an important need during the "hungry period" prior to the normal harvest.

4. Changes in national production of cowpeas in Senegal

Production of cowpeas in Senegal was reported to be 69,721ha and 17,320 tons in 1988. This represents a substantial reduction from the post-drought years of 1985 and 1986 when seeds had to be imported (CB5 from California) and up to 66,000 tons of seed were produced or an estimated 121,000ha. However 1988 was a very difficult year when early rains were exceptionally heavy, leaching nutrients from the upper soil layers, followed by a severe drought. Moreover, agricultural statistics in tropical Africa are often unreliable and, in any event, do not account for the fresh pod harvest which has become so important.

B. Institutional Development and Training

One senior staff member, Mr. D. G. Gaikwod, a senior plant pathologist from India, completed his assignment and returned to his country, leaving an important gap in the program. ISRA is attempting to find the means to replace him with a Senegalese.

Considerable training is underway or completed as a total of nine graduate students are currently in training at UCR or returned to their home countries (Senegal, one; Ghana, two; Malawi, one; Sudan, three; U.S., two) in 1989.

### C. Progress Achieved in Relation to the Log Frame

The project purpose is to develop improved cowpea management methods and storage practices for small farms in Senegal and substantial progress has been made in this area in a very short period of time. On-farm (mini-kit) trials and on-station trials have demonstrated that sealed drum seed storage, improved varieties (IS86-275) and improved production practices (row planting, modest fertilizers, alternate varieties and higher plant densities) all contribute to increased productivity.

Backstop research at UCR is particularly adept and successful in understanding the effect of high temperatures and drought on reproductive development in cowpeas, identifying genetic stocks superior in these desirable attributes--including delayed leaf senescence, and initiating a crossing program to introduce the desired genes into otherwise desirable commercial varieties.

The outputs include the provision of technical assistance and training opportunities on a continuing basis.

### D. Evidence of Biological/Social Sciences Integration

#### 1. Identification/attention to relevant WID issues

No comment

#### 2. Identification/attention to other social/food science issues

This project involves collaboration in the biological sciences departments of UCR and Senegal's ISRA. Although rapid progress has been made on developing the crop improvement aspects, ISRA does not have a social sciences mandate nor the essential positions. Now, as much biological progress has been made and demonstrated to farmers, there is an increasing need to assess the impact of the new technology on national production and on the farmers and consumers who benefit therefrom. This situation was addressed by a socioeconomics study initiated by the CRSP in the summer of 1989 (to June 1989).

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

ISRA representatives visited Purdue University for discussions with the Purdue/Cameroon project, and IITA cowpea breeders visited UCR to discuss collaboration and exchange of germplasm.

## II. FUNDING/FISCAL MANAGEMENT

### A. Audit/Project Management Reviews

The project was audited in 1986 by the CRSP Management Entity and the ISRA component was audited by the government of Senegal in 1987.

**B. Adequacy of Funding by CRSP Participants**

A.I.D funding is only marginally adequate and both training and equipment needs have suffered. However, modest funds became available for some critical purchases of equipment. Funding to the project by both ISRA and UCR has been excellent.

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

The ISRA component is slow in providing financial reports to UCR (about a year behind).

**D. Adequacy of Current Policies and Procedures**

ISRA accounting procedures are slow and cumbersome, precluding timely financial reporting and effective budgeting of available funds.

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

The USAID Mission to Senegal provided some support for extending cowpea research to the Senegal River.

**III. PLANNING**

A major change was delaying crosses between ISRA and UCR lines to insure that the lines from ISRA had resistance to mosaic viruses and bacterial blight. A second change is the additional socio-cultural studies to be conducted as part of the mini-kit trials.

**IV. STATUS**

**A. Appropriateness of Activities to Goals of the Global Plan**

The project is highly appropriate to the Global Plan. Senegal is a cowpea-technology-producing country and the project has helped Senegal meet this responsibility. The technology and research findings are highly relevant to cowpea improvement elsewhere in the world.

**B. Balance Between Research and Training**

Highly satisfactory--Training receives support from several sources allowing training of students from other countries including Malawi, Ghana and Sudan. Training for Senegalese was budgeted at \$29,000 in FY 89.

**C. Balance of Domestic vs. Overseas Activities**

The two components are exceptionally well balanced and mutually complementary.

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

Excellent--There are two planning meetings per year: March at UCR and September (three weeks) in Senegal.

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

The A.I.D. contribution in FY 89 was \$220,500 with \$120,032 for UCR and \$100,468 for ISRA, providing the same direct costs of \$85,129 to each participant. The UCR contribution in FY 89 was \$89,908, mainly for staff salaries, experiment station operations and indirect costs. ISRA support was \$183,690 for salaries, operations and indirect costs. Therefore, UCR and ISRA contributions totalled \$273,598-- more than the A.I.D. support.

The level of support for cowpea research is highly appropriate to the importance of the crop with an estimated gross value of \$50 million equally split between California and Senegal.

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

The USAID Mission in Dakar is highly supportive of the cowpea project, using it as a model for other crop research programs in Senegal.

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

Highly cost effective on all counts--particularly from A.I.D. and MO perspectives.

**H. Institutionalization of HC Component**

The HC has enunciated a public policy of strong support for cowpea research in the north-central zone of the peanut basin. Moreover, Senegal continues support for salaries, facilities, equipment and transportation. The CRSP provides most of the operational costs.

The UCR component is supported through regular university "channels" and directly by the Blackeye Varietal Council and by the USDA on germplasm maintenance/evaluation. The university strongly supports training of foreign students and international activities of its staff. The PI is also supported by the university on his basic research using cowpea as a model system for studying the interaction between physiology and genetics.

**V. PUBLICATIONS AND PRESENTATIONS**

A. U.S. Researchers: Eleven publications, six in refereed journals; two Ph.D. dissertations

B. HC Researchers: Seven publications and reports

**VI. OVERALL EVALUATION: 1--Highly Satisfactory**

**Comments:**

This continues to be the most effective and successful CRSP project among those reviewed in terms of its direct contributions to all phases

of the program and with very little compromise to any aspect. It is exceptionally well balanced in every respect and in assigning resources/ personnel to priority areas. Collaboration and cordial relations between the two institutions are excellent, resulting in a real sense of teamwork focused on the major problems of cowpeas in both countries. The mini-kit testing program is a "stroke of genius" for Senegal.

In the future, more attention on the potentially devastating striga (*S. gesnerioides*) problem may be justified. Since host plant resistance is the most practical defense, a much greater effort is needed to search for genetic resistance both in Senegalese materials and in exotic stocks with the transfer of resistance to otherwise desirable advanced lines and commercial varieties. In this regard the project is presently testing the recently re-discovered B301 (introduced from IITA) found by the former CRSP Botswana/CSU project (working with the Long Ashton group in the UK) to be resistant to all known striga strains in West Africa.

This reviewer would also like to see a more aggressive stance in cowpea breeding in the future. To a limited extent, the project is now carrying (with irrigation) three generations in the field per year in Senegal and three generations (one field + two greenhouse) per year in California (with less photosensitive materials). With increased resources, it could expand the number of crosses made and generations advanced per year. In addition, there is little disadvantage, nor is much trouble or expense incurred, by making crosses and advancing generations even before promising parental lines are fully evaluated since the benefits of being one or two generations ahead are considerable.

FY 89 EEP REVIEW

TANZANIA/WASHINGTON STATE UNIVERSITY/SILBERNAGEL

*Breeding Beans (Phaseolus vulgaris L.) for Disease, Insect and Stress Resistance and Determination of Socioeconomic Impact on Smallholder Farm Families*

I. PROGRESS

A. Specific Research Contributions

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

HC emphasis continued in pathology, breeding, agronomy and food science. Vehicle problems limited on-farm trials. Studies of bean diseases (rust, angular leaf spot, bean common mosaic virus and halo blight) and screening of hybrid populations for resistance continued to be the major focus in FY 89.

Breeding work to improve yield, resistance to insects and diseases, BNF, cookability and tannin content also received emphasis. One line (TMO 216) has consistently performed well and will be released. Several others including 86EP5070-8 have multiple resistance and generally outyield TMO 216 so are candidates for future release.

Dry inoculum (WSU CRSP technique) proved to be more effective than spreader rows in screening for ALS.

Resistance to beanfly was the major emphasis in entomology. Crosses of advanced disease-resistant lines with CIAT line A-55 will be tested for beanfly resistance in HC and the U.S. The thick stem of A-55 is thought to be a factor in beanfly resistance.

Sprouting of beans before cooking significantly reduced tannin content with concurrent increases in *in vitro* digestibility.

On the U.S. side, the biological research continued to emphasize BCMV, halo blight and root rots. Behavior of the Adzuki strain of BCMV has necessitated reclassifying bean host differentials and BCMV strains. Inheritance of resistance to the Adzuki strain is under study. Cooperative work with Texas Woman's University researchers continued in developing cDNA probes for the seven bean genes for BCMV resistance and the virus genes for pathogenicity.

Collaboration is continuing in validating the bean growth model developed at the University of Florida.

Peanut mottle virus has in the past been misdiagnosed as a necrotic reaction to BCMV. Identification of PMV has led to development of resistant cultivars and isolation from peanut fields to control the disease.

Heat tolerant hybrids appear to yield less than non-tolerant sister lines when grown at lower temperatures.

F<sub>2</sub> hybrids for drought resistance and upright growth habit (CIAI A-55) have been sent to Tanzania and are in use in improving U.S. bean lines.

The social science component (University of Illinois) activities included (1) student counselling, (2) program planning with Tanzanian colleagues and (3) documentation of past research. The Co-PI has retired and it is hoped that arrangements to continue this element (socioeconomic research) can be made in the near future.

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

a. Host Country:

An effective inoculant, "NITROSUA," developed at SUA, is available in 100g packets--enough to inoculate beans for one hectare.

Bean mixtures are in use to reduce severity of certain diseases.

Technical papers and reports are in great demand and are being widely distributed in Tanzania and elsewhere in East and Southern Africa.

b. United States:

Germplasm with resistance to new necrotic BCMV strains and screening methodologies have been widely distributed along with identified strains of BCMV to use in testing hybrid populations for resistance.

b. Monoclonal antisera against standard (B) and necrotic (A) strains of BCMV and differential bean hosts for strain identification have been disseminated worldwide.

3. Other research-related results

a. Germplasm collected by SUA has been made available to SADCC/CIAT researchers. Promising materials have been provided to Zambia upon request.

b. Work has focused on women and smallholders from the beginning. "NITROSUA" is a low cost input ideal for small-scale producers.

c. The Wisconsin dry-inoculation technique has worked well in Tanzania.

#### 4. Changes in national production of beans in Tanzania

Production in 1989 was in excess of 500,000 MT compared to about 280-290,000 MT in 1987-88. This 70 percent increase has been variably attributed first to higher rainfall but also to higher prices (which held even with increased supplies) encouraged by CRSP socioeconomics research; the effectiveness of NITROSUA distributed in many areas; and the contribution of the SADCC/CIAT team in the region.

#### B. Institutional Development and Training

1. Changes since FY 88
2. Over life of the project

No comment

3. In prospect

SUA bean team needs a virologist (candidate has applied for Ph.D. admission in the U.S.) and an agronomist.

4. Project training targets

Two Ph.D.s and one M.S. completed studies and returned to posts in Tanzania in 1989. A third Ph.D. candidate is nearing completion. Two additional Ph.D. candidates are continuing. Most of the trainees will soon be in place. The three remaining candidates expect to complete studies and return to HC during this grant period.

#### C. Progress Achieved in Relation to the Log Frame

Research has been in progress for eight years. Development of cultivars takes eight to ten years. TMO 216 is candidate for release in 1990. Others show promise for release over the next five years. Baseline data developed over the past several years will be useful in impact studies over the next five years or so as technologies are evaluated. At least three improved varieties are expected during this extension period. The activity is generally on schedule. Developing high yielding, pest and disease-resistant varieties is the central thrust. Modest support to other factors important to varietal release (soil fertility, BNF, cookability, digestibility, acceptance) is provided as needed to supplement and/or complement work of the national program and the SADCC/CIAT regional program. A unique aspect generally underemphasized in other programs is the socioeconomic studies relating to small-scale producers and women.

Development of improved varieties and practices to enhance their effectiveness in smallholder settings, will benefit research in the HC. In the U.S., strain identification of, and breeding for resistance to, BCMV and halo blight have progressed about as far as was envisioned at the outset. Emphasis is shifting to molecular biology of BCMV resistance and pathogenic genes. The cDNA probes

will greatly speed up and make easy the rapid identification of new strains of the virus and BCMV resistance genes in the host. This will take three to five years.

D. Evidence of Biological/Social Sciences Integration

In the HC, the WID component has been a major attribute of this project. Extensive work has been done on cooking, digestibility, tannin content and acceptability. BNF research has provided a means of reducing use of expensive fertilizers. Work on the human-powered thresher was aimed at increased efficiency and reduced workload in threshing.

In the U.S. negotiations are underway to replace the competence previously provided through the University of Illinois sub-project. This is critical to the planning and implementation of research at SUA.

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

Close and effective working relations have developed with the SADCC/CIAT regional program. Other cooperation includes CRSP projects (Malawi/MSU, Ecuador/UMN and INCAP/WSU), IBSNAT/UFL and MSTAT.

Other collaboration is ongoing through the Western Regional project and, of special significance, with Texas Woman's University in the DNA probe work.

II. FUNDING/FISCAL MANAGEMENT

A. Audit/Project Management Reviews

None reported

B. Institutional Development and Training

1. A.I.D.--The reduction in A.I.D. funding is purported to have caused serious problems, especially in the HC. It also places a strain on the U.S. side in exploring ways to replace the social science component. Information available is inadequate to judge the reality but it does need follow-up.

2. Host Country--No comment on HC funding

3. U.S. Institution--Funding is integral to the social science question.

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

Repair of transport has been a serious problem in HC. Need is urgent for new vehicle (provided for in FY 90 budget).

D. Adequacy of Current Policies and Procedures

No comment

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

USAID/Tanzania has been approached to pick up minor costs of SUA food science, thresher and ten-year follow-up to the Malawi conference.

### III. PLANNING

Plans for FY 89 remain intact. For FY 90, the HC will drop CRSP food science and thresher work. In the U.S., study of the molecular basis of resistance and pathogenicity, verification of the bean growth model, and breeding and selection of upright habit and multiple disease resistance will continue.

### IV. STATUS

#### A. Appropriateness of Activities to Goals of the Global Plan

Activities are appropriate to the Global Plan.

#### B. Balance Between Research and Training

Project has been heavy on training, but that is changing as programs are completed. Data are not available on details of expenditures.

#### C. Balance of Domestic vs. Overseas Activities

Seems appropriate

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

U.S. and HC PIs consult annually on budgets, training and priorities during the U.S. PIs' annual visit which coincides with the bean workshop.

#### E. Relative Contributions of Collaborating Institutions and Individuals Toward Accomplishment of Objectives

Direct contributions are from A.I.D.; SUA (12 percent) and WSU (25 percent) contributions are in-kind. Ministry of Agriculture bean teams assist SUA efforts in yield and adaptation, and in disease and insect screening trials. Services of U.S. PI (25 percent) by USDA. Other CRSP projects, CIAT and national programs provide collaborative assistance.

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

The USAID Mission has been generally supportive but has not given any dollar support.

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

Very cost effective due to building on a wide range of other activities, programs, facilities, etc.

#### H. Institutionalization of HC Component

HC PI has been a Kellogg International Fellow and was recently appointed SUA Director of Graduate Training.

USDA, after a long-standing negative stance, now is seeing large benefits to PI's participation. A collaborating WSU scientist has achieved major national and international recognition for his serological detection techniques.

Integration of U.S. and international research programs has been extensive, synergistic and highly productive. The U.S. PI is a well-recognized authority in both U.S. and international circles (internationally due in major part to his participation in the CRSP).

Both U.S. and HC PIs have appointed program assistants to help with management details.

With more emphasis on M.S. training, quality and appropriateness of activities at SUA have greatly improved.

#### V. PUBLICATIONS AND PRESENTATIONS

Two Ph.D. and two M.S. theses, one book chapter, several presentations at technical meetings, several reports published in proceedings of conferences, and three technical journal publications

#### VI. OVERALL RATING: 1—Satisfactory

##### A. General Strengths

Progress has been achieved in disease and resistance identification including methodologies. Adequate progress has also been made in breeding and varietal development.

##### B. General Weaknesses

Potential loss of social science component

##### C. Recommendations

1. Replace Professor Due
2. Add support for graduate (M.S.) activities at SUA

## FY 89 ANNUAL REPORT FROM THE MANAGEMENT OFFICE

Following the completion of the MO responsibilities required for the extension of the CRSP beyond May 6, 1989, a sabbatical leave was initiated by the CRSP Program Director, Dr. P. W. Barnes-McConnell. This leave triggered other personnel changes important for maintaining MO functioning. The Deputy Director, Dr. Russell Freed, was made Acting Director and Ms. Nancy Axinn, former WID Specialist with the CRSP (1980-1983), rejoined the staff as Acting Deputy Director. There was no change in the position of the Administrative Officer, Ms. Sue Bengry. However, during this period it was discovered that the Program Secretary, Ms. Annette McGarey, had a brain tumor which would require surgery. McGarey, now slowly recovering from the surgery, was replaced by Ms. Bonnie Zell. Barnes-McConnell returned to the office in May 1989.

During this sabbatical period, the MO concentrated on two major undertakings. The first was the organization and implementation of the Second Regional Review, Evaluation and Planning Meeting, this time held in Dakar, Senegal. Invited to this meeting were all of the US IRs, the HC IRs from the Africa region, the region's USAID representatives from countries participating in this CRSP and USAID representatives from countries that might be interested in participating at some time in the future. The Board of Directors hosted the plenary group as well as held separate meetings of their own. As in the past, the EEP also made use of this meeting to hold their evaluation meeting and report their findings to the group. Through the leadership of Freed and the MO staff, the meeting was very successful and stimulated a productive interchange between US and HC administrators.

The second major undertaking during this period was the publication of the CRSP Annual Report, the first since the major budget reductions in 1986. This publication required substantial editing of the individual reports and frequent communications with the PI authors. With contributions from Freed where needed, Axinn concentrated her attention on organization and basic editing of the report.

Further MO activities during this period involved providing regular TC, BOD and EEP support, publishing the FY 88 EEP Report and the CRSP newsletter *Pulse Beat*, and updating the CRSP Training Report and Bibliography. The comprehensive financial records continued to be maintained for the projects and the CRSP as a whole.

The MO also organized project changes. As the Wisconsin/Brazil (Fred Bliss) project was closing out, interested CRSP institutions were invited to submit proposals. These were received and distributed to the TC for their evaluation. The subsequent TC recommendation of the University of Minnesota for the new BNF project was approved by the Board. The MO facilitated the addition of Minnesota as a lead institution and the designation of its partner, Ecuador.

In addition, the Administrative Officer assumed responsibility for preparing for publication the major report developed by Barnes-McConnell from the extensive Malawi research data generated over a three-year period. She had taken the sabbatical leave to analyze these data for presentation to the appropriate groups. At the end of that period, the completed report was presented to the Government of Malawi, the EEP and other interested persons.

Summaries of CRSP accomplishments were prepared and distributed to A.I.D., BIFAD and other organizations. The MO wrote or helped edit several articles for the A.I.D. publication, *STAR*. These articles included:

1. "From Famine to Surplus: Cowpea Research in Senegal"
2. "New Microcomputer Programs for Agriculture"
3. "Increasing Bean Yields through Biological Nitrogen Fixation Research"
4. "Socioeconomic Examination of Tanzania Bean Farmers"

Freed participated in CIAT's workshop to determine their bean strategy for the 1990s. This activity exemplifies the continuing close collaboration between the Bean/Cowpea CRSP and CIAT. The MO was also instrumental in the participation by Dr. Jim Steadman in the CIAT review of their East Africa project.

Since May, the MO, in addition to its regular duties, has conducted an orientation for new EEP members and organized the EEP US site reviews. Attention has also focused on initiating a training impact survey of CRSP graduates, negotiating a Basic Ordering Agreement (BOA) document with A.I.D./ Washington, generating buy-in discussions with USAID Missions (to date eight have expressed interest), and participating in the organization of a CRSP Council made up of the seven existing CRSPs (Small Ruminants, Sorghum/Millet, Bean/Cowpea, Soil Management, Peanut, Pond Dynamics/Aquaculture, and Fisheries Stock Assessment).

An economic impact study of the Senegal project has been done through MO collaboration with the MSU Department of Agricultural Economics. The MO is working also with the DR project to generate an impact study of their major release, PC-50. Both projects' PIs are being encouraged by the MO to work socio-economic and socio-cultural research into their programs:

Over the course of the year, MO travel has included the following:

1. Bengry and McGarey to WANG Workshop in Boston in November
2. Freed and Bengry for Board meeting in Dallas in November
3. Freed to Phoenix for INTSORMIL Annual Meeting in January
4. Freed to Ecuador in January to set-up Minnesota/Ecuador CRSP project
5. Freed to January TC meeting in Atlanta
6. Freed, Bengry and Axinn to Senegal to conduct the Second Regional Review, Evaluation and Planning Meeting in February
7. Freed to CIAT in April to participate in CIAT's 1990s meeting
8. Barnes-McConnell to Malawi to present research results in April
9. Barnes-McConnell and Freed to May TC meeting in Denver
10. Freed to Brazil in July to review Robert's project for the TC
11. Freed to Purdue in July to discuss Brazil review with Jackai (IITA) and Murdock (TC Chair)
12. Freed to Cornell and BTI in August to review projects

BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM  
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