REPORT OF

THE EXTERNAL EVALUATION PANEL OF

THE BEAN/COWPEA CRSP FOR FY 93

February 1994

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THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)

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

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TABLE OF ACRONYMS

ALS	Angular Leaf Spot
AVRDC	Asian Vegetable Research and Development Center
BCMV	Bean Common Mosaic Virus
BGMV	Bean Golden Mosaic Virus
BGMV-GA	Bean Golden Mosaic Virus from Guatemala
BNF	Biological Nitrogen Fixation
BOD	Board of Directors
CB	Common Blight
cDNA	Cloned DNA
CIAT	Centro Internacional de Agricultura Tropical (International Center of Tropical Agriculture)
CID	Carbon Isotope Discrimination
CRSP	Collaborative Research Support Program
DNA	Deoxyribonucleic Acid
DNA-A	The A genomic component of geminiviruses
DNA-B	The B genomic component of geminiviruses
DR	Dominican Republic
dsDNA	Double-stranded DNA
EAP	Escuela Agricola Panamericana (Pan-American Agricultural School)
EEP	External Evaluation Panel
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria (Brazilian Enterprise for Agricultural Research)
FAO	Food and Agricultural Organization of the United Nations
FY	Fiscal Year
HC	Host Country
IARC	International Agricultural Research Centers
IITA	International Institute of Tropical Agriculture
INIAP	Instituto Nacional de Investigaciones Agropecuarias (National Institute of Agricultural Investigations)
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias (National Institute of Forestry and Agricultural Investigations)
IPM	Integrative Pest Management
IRA	Institut de la Recherche Agronomique (Institute of Agronomic Research)
ISRA	Institut Senegalais de recherches Agricoles (Senegalese Institute Agricultural Research)
M.S.	Masters Degree
ME	Management Entity
MINAGRI	Cameroon Extension Agency
MO	Management Office
MSU	Michigan State University
NCR&E	North Cameroon Research and Extension
PCR	Polymerase Chain Reaction
PI	Principal Investigator
PROFRIJOL	Research Network of Latin American and Caribbean Countries "For Beans"
RAPD	Random Duplicated Polymorphic DNA
RFLP	Restriction Fragment Length Polymorphic
RNA	Ribonucleic Acid
SADCC	Southern African Development Coordinating Committee
SODECOTON	Societe de Developpement du Coton (Cotton Production Cooperative in Cameroon)
ssDNA	Single-stranded DNA
SUA	Sokoine University of Agriculture
TC	Technical Committee
UCD	University of California-Davis
UCR	University of California-Riverside
UMN	University of Minnesota
UNL	University of Nebraska-Lincoln
UPR	University of Puerto Rico
USAID	United States Agency for International Development
USAID/W	United States Agency for International Development/Washington
USDA/ARS	United States Department of Agriculture/Agricultural Research Station
UWI	University of Wisconsin
WB	Web Blight
WID	Women in International Development
WSU	Washington State University
WVI	World Vision International

REPORT OF
THE EXTERNAL EVALUATION PANEL OF
THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)
FOR FY 93

INTRODUCTION

The Bean/Cowpea 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 and, during FY 92, the Program was extended for an additional five years. The present review covers FY 93. Evaluations are based mainly on project Annual Reports, perspectives gained from visits to Host Countries and U.S. institutions, and discussions with the CRSP MO/ME and the USAID/W Project Officer.

THE FY 93 EXTERNAL EVALUATION PANEL: 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 Pinchinat and Charlotte Roderuck). They were replaced by Drs. Edna McBreen and Kenneth Rachie. Two more of the original seven (Drs. Hugh Bunting and Peter Hildebrand) retired in 1988. They were replaced by Drs. John Robins and Arthur Siedler in 1989. The last of the original seven, Dr. Clarence Gray, retired in 1990. Two new members were appointed late in FY 93 (Drs. Donald Duvick and Patrick Rubaihayo). The current members and their affiliations are given in Attachment E.

ORGANIZATION OF THE BEAN/COWPEA CRSP: When it was organized, the Bean/Cowpea CRSP consisted of eighteen projects in thirteen countries of Africa, Central America, South America and the Caribbean area, in collaboration with ten U.S. lead institutions. At the end of FY 91, there were thirteen projects in HCs (beans-nine; cowpeas-four). The FY 92 extension resulted in termination of four projects and initiation of three new ones. In addition, the Socioeconomics Component at MSU was restructured and some of the ongoing projects were significantly revised. A Women in Development Component has been a significant part of the Program from the outset.

The Bean/Cowpea CRSP is funded through the Global Bureau, Economic Growth Center, Office of Agriculture. The Acting Project Officer is Ms. Joyce Turk.

FY 93 EEP REVIEW--SEQUENCE OF EVENTS: The following events comprised the FY 93 EEP review:

1. Site visits were made by EEP members, sometimes accompanied by MO staff, to one U.S. university and five HCs.

2. Using the *Guidelines for Collaborative Research Support Programs* and inputs from the TC and BOD, the MO developed, and USAID/W approved, a Scope of Work (see Attachment A) which was based on the outline distrib-uted to PIs to be used as a format and guide for preparation of Annual Reports (see Attachment B).

3. EEP members were assigned projects to review, for which discussion drafts were prepared prior to the annual EEP meeting in Charleston, South Carolina in February 1994.

4. Draft reviews of individual projects and special topics were discussed at the Charleston meeting. Final project and topic evaluations were made during the discussions.

5. The fiscal and administrative review was based on data/information supplied by the MO and through discussions of CRSP operations and procedures, status of activities and related matters with MO officials and the USAID/W Project Officer.

6. The overall evaluation of the Bean/Cowpea CRSP was made on the basis of individual project reviews, discussions of the progress towards amelioration of constraints, estimates of the performances of participating U.S. institutions, evaluation of fiscal and administrative operations, information acquired through conversations and discussions with CRSP officials and perspectives gained through site visits to HCs and U.S. universities.

PROGRAM EVALUATION: SUMMARY

For the FY 93 review, twelve projects; the Women in International Development, Agricultural Economics, and Socioeconomics Components; training; and the fiscal and administrative dimensions were evaluated with regard to progress, funding/fiscal management, planning, status and prospects. Eight of the projects (six in Latin America/Caribbean and two in East Africa) are concerned with beans. The remaining four (all in West Africa) are concerned with cowpeas. The final report of the Brazil/Boyce Thompson Institute Project was reviewed with special attention to comprehensiveness and a subjective observation about sustainability of effort in the HC. The WID, Agricultural Economics and Socio-economics Components are funded separately from the MO. The MO was evaluated on the basis of its Annual Report and discussions with MO personnel and the USAID/W Project Officer.

The EEP again finds that the Bean/Cowpea CRSP is being managed and operated in a highly satisfactory manner in full compliance with the *Guidelines for Collaborative Research Support Programs* and the enabling grant document.

Overall Rating of the Bean/Cowpea CRSP: 1--Highly Satisfactory

PROGRAM EVALUATION: FISCAL AND ADMINISTRATIVE

The Bean/Cowpea CRSP continues to operate in a manner that conforms to grant guidelines and acceptable accounting procedures while facilitating the Program's research and training activities. The budgeting and fiscal management processes developed over more than a decade of operations seem to work well. While accommodating the vagaries of USAID/W funding, they foster participation of the several CRSP entities; expedite release, accounting and monitoring of funds; and maximize flexibility in use of resources. The Panel, and we suspect others, appreciate the excellent Financial Report provided with the MO Annual Report.

The continued smooth and successful operation of the Program is in no small measure due to the leadership and effectiveness of the MO team--Director, Deputy Director, Administrative Officer, and support staff. The MO team could not demonstrate that leadership and effectiveness without the continued support and commitment of the ME (Michigan State University). The support for staffing, equipping, and servicing of the MO has been uniformly strong.

FY 93 was another busy one for the MO. Budgetary uncertainties were again a major headache and the same seems certain for FY 94 and beyond. Through continuous MO monitoring and excellent cooperation from the PIs, the Program remained afloat and continued its strong output in FY 93. Upgrading of computer equipment in the MO permitted reducing support staff and will increasingly improve efficiency in "paper management."

While devoting much time and effort to researching downsizing options, the MO continued to provide excellent backstopping and service to individual projects and to the TC, BOD and EEP. Notable in the support area were: Apparent resolution of the HC Institution problem in the DR; help in negotiating and continuation of buy-ins; assistance to projects regarding training plans and problems; special support to new projects and to the Tanzania/WSU Project as changes in PIs occurred; encouragement for intra-CRSP, inter-CRSP and other collaborative activities; and participation in CRSP Council Activities. The Panel commends the MO Director on national and international recognitions in FY 93. These attest to the quality of leadership that she brings to the Bean/Cowpea CRSP and CRSPs in general.

Finally, the Panel again expresses its appreciation for the excellent support provided for its activities. We clearly could not function effectively without that support.

Overall Rating: 1--Highly Satisfactory

PROGRAM EVALUATION: PROJECT SUPPORT COMPONENTS

WOMEN IN DEVELOPMENT: The WID Component continues to be an asset to the CRSP as a whole and especially to those programs with the far-sightedness to grasp the essential character of social science research in understanding the adoption of new technology. The Component leader is Dr. Anne Ferguson, an anthropologist. In addition to advising the MO and TC on WID issues, this year's efforts include:

1. Working with the new projects, especially the Ghana/Clemson IPM project. The incorporation of WID information at the beginning of the project bodes well for its success in this area and should be credited both to the WID Component and to the project. Similarly, the WID Component has been involved in planning efforts by the Costa Rica/MSU project.

2. Continuing work with ongoing projects, including the Cameroon/Purdue project.

3. Developing new working relationships with projects that have not included involvement with the WID Component in the past, including the Mexico/MSU project.

4. Maintaining efforts to keep PIs up to date on appropriate studies and articles related to WID issues.

Evidence of progress being made in the areas of WID and social sciences in the CRSP includes the fact that not all the enthusiasm for, interest in and support of the WID Component is found in the WID office. The progress and involvement of several of the ongoing projects bear special mention:

1. The Cameroon/Purdue project has a history of inclusion of WID information as a part of the research effort. It is ironic that, with the strong WID/social science background of the project, the WID Component is now worried that the social science knowledge gained from previous research efforts may not be being used to ensure the success of technology transfer.

2. The Dominican Republic/UNL project has begun to involve more women farmers in its technology transfer efforts and its field trials. To this end, there is a person at the research station who has been given special responsibility for WID issues and is embracing this responsibility enthusiastically.

3. The focus of the Mexico/MSU project on the problem of long cooking time for beans is one that has been under consideration for some time and action taken in this area this year appears to have been of particular interest. It seems to be a little late for the cultivars that the project has already released but it is encouraging that this interest might be maintained and considered earlier in the process for future cultivar development.

4. The Senegal project's inclusion of women in the mini-kit field testing program appears to be especially successful and fulfills a long-standing need to expand the program to women.

5. In Tanzania the participatory research activities have provided excellent opportunities for the inclusion of women in research activities and, therefore, gaining insight regarding the impact of new technology on women farmers.

Overall Rating: 1--Highly Satisfactory

AGRICULTURAL ECONOMICS: The Agricultural Economics Component is a cross-project activity of the Bean/Cowpea CRSP and is a component of the total effort addressing economic, socioeconomic and WID issues. The Component leader is Dr. Rick Bernsten, an agricultural economist. This Component, in addition to contributing economic expertise to individual projects, also has an advisory function to the MO and TC.

During the past year, the Component leader has worked with six CRSP projects and has aided in developing a socioeconomic survey of bean farmers in Egypt funded via a Mission buy-in. He has responded to several requests for information and worked with the WID Component leader to develop "Measuring Social and Economic Impact: An Overview" for the *Operations and Policy Manual* for this

CRSP. Other activities have involved initiating the collection of economics data to assess the status of beans and cowpeas as commodities on a global basis. As part of this effort, questionnaires have been formulated for assessing bean and cowpea status in collaboration with several project PIs. The Component at present involves three M.S. and two Ph.D. candidates.

Working with the DR/UNL project, the personnel in this Component participated in a survey to determine the impact of the release of PC-50 and the implementation of a fallow period for beans, and to collect general information on bean production and marketing. Much to the disappointment of the U.S. and HC PIs, the study, which was supposed to have been completed in May 1993, still is not available,

Publication and presentation output includes two peer-reviewed publications plus one in press; three other publications plus one in draft form and one presentation.

Very good progress is being made in achieving the objectives of the work plan: obtaining worldwide (global) statistics on the economic status of beans and cowpeas; developing methodology for rapid appraisals for subsectors; and developing guidelines for conducting impact assessments and feasibility of new technology adoption. Dr. Bernsten continues to aggressively pursue these work plan objectives, however, budget constraints preclude intensifying efforts and the Component leader is pursuing alternative funding sources.

Overall Rating: 1--Highly Satisfactory

SOCIOECONOMICS: This Component, led by Drs. Ferguson and Bernsten, is part of a triad effort (WID, Agricultural Economics, Socioeconomics) addressing social-science-based issues encompassed by CRSP activities. The specific goal of this Component is to address the need to obtain meaningful assessments of the research accomplishments of the CRSP projects. The strategy employed involves (1) macro-economic studies of bean and cowpea production, distribution and utilization; (2) impact of CRSP-developed technologies; and (3) training in the social sciences.

Specific contributions in 1993 involve one completed and two ongoing studies. An M.S. thesis has been completed assessing the socioeconomic feasibility of improved grain storage in Cameroon. The results indicated that low producers of cowpeas consumed them before storage technologies became important whereas higher producers could benefit by using low-cost ash preservation technology but not necessarily by using multiple bagging.

The data on the impact assessment of the cultivar PC-50 in the DR has been collected and is being analyzed as an M.S. thesis. Field work involved the collaboration of social scientists in the Instituto Superior de Agricultura.

A study on the analysis of constraints to increasing bean productivity in Honduras has been initiated and involves a Honduran Ph.D. degree candidate. Funding for this study includes participation of the Latin American Scholarship Program for American Universities. Field work was begun in late 1993.

This Component continues to develop nicely and is a mechanism to assist the individual CRSP projects' social science components.

Overall Rating: 1--Highly Satisfactory

PROGRAM EVALUATION: TRAINING

The progress, successes and current impact of the long-term training provided through the CRSP has been well described in the overall training report. Clearly, the long-term impact of the CRSP is secure in the training of scientists and their potential impact on bean research and/or other agriculture research and related activities in the U.S., Host Counties and around the world.

Unfortunately, it appears that the individual projects have not been requested to update (or, in the case of newer programs, create) training plans. They appear to have basically been asked to fill in the new training reporting form which gives an excellent accounting of the status quo but fails to anticipate training needs or goals. Last year's EEP review requested specific information regarding the training plans of each project. **These requests stand**--especially in light of the TC's *Bean/Cowpea CRSP Guidelines Concerning Degree Training* that were included in the TC Minutes of May 14-15, 1993.

In 1992 the EEP Report included extensive discussion of the need for training plans for each of the CRSP projects. This has not occurred. The EEP requests that the MO solicit specific training plans for inclusion in the FY 94 Annual Report from each project. We suggest that a training plan format be distributed to each PI and include the following:

1. HC training needs related to project research priorities

2. Present plans for degree training including fields, degree levels, numbers and (if available) names of trainees and a timeline for implementation

3. A statement regarding progress made in implementing plans

4. Anticipated changes in plans as well as the reason for those changes

5. Plans for short-term training including content information, location and audience

This information would be provided to anticipate future training needs while the Training Activities Report Form reflects completed and ongoing training. Both are important.

These training plans will be especially important in determining which projects should receive funding for training for the rest of the CRSP life of project.

Rating of Training Management: 2b--Satisfactory
Rating of Training Quality: 1--Highly Satisfactory

PROGRAM EVALUATION: PROJECT RATINGS

BASES FOR EVALUATION--RATING CATEGORIES/FORMAT: Using *Guidelines for Collaborative Research Support Programs* provided by USAID/W, a Scope of Work was prepared which provided for evaluation of (1) progress, (2) funding, (3) plans and (4) 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 selected HC institutions and U.S. universities, data provided by the MO, and discussions with MO and USAID/W officials. Numeric and adjective ratings used are based on assessment of the criteria against the work plans for FY 93.

Category	Rating
1	Highly Satisfactory
2a	Satisfactory Plus
2b	Satisfactory
3	Unsatisfactory

SUMMARY OF RATINGS:

Category 1--Highly Satisfactory
- Bean/Cowpea CRSP
- Fiscal and Administrative
- Women in Development
- Agricultural Economics
- Socioeconomics
- Cameroon/Purdue
- Caribbean Basin/UWI
- Dominican Republic/UNL
- Ecuador/UMN
- Honduras/UPR
- Senegal/UCR

Category 2a--Satisfactory Plus
- Costa Rica/MSU
- Ghana/Clemson
- Ghana/UGA
- Malawi/UCD
- Mexico/MSU
- Tanzania/WSU

Category 2b--Satisfactory
- Training Management

CRITERIA FOR DOWNSIZING THE BEAN/COWPEA CRSP

The Panel was requested by the MO and the USAID/W Project Officer to provide guidance on how the CRSP might best be downsized in the event of serious budget reductions. While we were reluctant to identify specific reductions or time frames for individual projects, we did propose some criteria and some caveats that we think can guide the process should there be a need for substantial attrition.

We preface this presentation by asserting that the projects, budgets and time horizons specified in the five-year program proposed and approved in 1992 are as viable and appropriate today in most respects as when earlier approved. At that time, four projects were terminated, i.e., had achieved substantially the goals and objectives earlier set forth. Three new projects were initiated to continue response to the pest management and post-harvest technology elements of the Program. Those projects, along with the restructuring of the Socioeconomic Component, the addition during the previous funding interval (1989-92) of BNF and basic biotechnological research, and the restructuring of some ongoing projects, we believe, added up to an effective and productive Program.

Having said that, we recognize that there are multiple approaches to meeting a funding shortfall. The easy ones (i.e., "everyone tighten the belt another notch" or "rank the projects on the basis of some quantifiable characteristic [research, publications, HC production increases, etc.] and start eliminating projects from the bottom of the list") we discard out of hand. We do think that a selective downsizing and restructuring is possible based on some rather basic criteria and with some innovative adjuncts to present funding mechanisms.

So, first, let's look at the research in each project--its quality, quantity, and relevance to the constraints in the Global Plan; the prospects for short-, intermediate- or long-term progress--in both the HC and in the U.S. What is the current status and what are the prospects?

Second, let's look at sustainability--both in the HC and in the U.S. If the research inspection is passed, what are the prospects, with a variety of funding scenarios, that the HC and/or the U.S. team(s) can (will) deliver? From the outset, a guiding principle has been the development and institutionalization of HC capacity to sustain research in their countries and regions on the bean/cowpea production/consumption constraints. In the U.S., is there commitment and rationale for continuation of the research with reduced or terminated funding?

Third, let's consider collaboration--HC/U.S., regional, cross-commodity, cross-country, cross-institutional. How effective and how essential is the HC/U.S. collaboration? Is it essential to the conduct of the research or is it simply a need for access--to the HC by the U.S. researcher or to the U.S. by the HC counterpart? We see a great deal of regional collaboration. Can (should) this be increased? Does (should) this improve efficiency? Technologies for bean and cowpea post-harvest practices/products have many similarities. Is there a cost-saving division of labor here? Similar questions can be asked in

terms of inter-institutional and inter-country sharing of responsibilities. We think there is mileage here while maintaining the integrity of the Bean/Cowpea CRSP.

So, we suggest looking at options that wean activities (and, incidentally, the level and nature of individual and institutional involvement) from CRSP funding rather than the easy-out options noted earlier.

Finally, we think there are some ways to "cushion the shock" of project downsizing. The USAID/W Project Officer indicated that another CRSP has instituted a "special grants" program to assist in the transition from higher to lower (or no) funding. These are small (perhaps up to $5,000 or $10,000) and short-term (one to three years) to complete, pilot test, or evaluate specific activities. We think this concept could be expanded to accommodate training or institutional activities, again of a finite and short-term nature. Let's look for ways to avoid serious opportunity costs or, yes, sooth the pain of any serious budget shortfall.

We did a preliminary evaluation of ongoing projects based on the above. The necessary flexibility for this approach to succeed requires abandoning the 50/50 U.S./HC funding concept. In some cases, it's 25/75 and, in others, perhaps 80/20. In the process, however, the integrity of the Program's goals, objectives and activities can be preserved. We choose not to record our results lest they, after a two-hour exercise by the five of us, be accepted as gospel. Surely, it needs attention well beyond what we can give and must involve a wider array of participants than we represent.

FY 93 EXTERNAL EVALUATION PANEL SCOPE OF WORK

Use the outline below to write your report. Discuss <u>every</u> item listed based on the information presented in the corresponding section of the project's Annual Report and/or your site visit. This report is to be an evaluation of the data presented by the project. Thus, <u>do not</u> transfer verbatim the information provided in the Annual Report. When a judgment of adequacies/inadequacies is requested, the EEP's opinion (distinct from the PI's assertion) is what is needed. If an item does not apply to a particular project, please do not omit but indicate "Not Applicable."

I. **EVALUATION OF PROGRESS DURING FY 93** (October 1, 1992-September 30, 1993)

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. Improved cultivars, food products, inoculants, tests, methods, and systems

b. Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use

c. How new research findings address the needs of small-scale farmers and women or other beneficiaries

2. Impact of research achievements in HC

a. On production/consumption of beans/cowpeas or new food products

b. On technology needs/constraints facing small-scale farmers

c. On the developing and developed world

B. Evaluation of Institutional Development and Training

1. Personnel changes since FY 92

2. Status of training program

C. Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan

1. U.S.

2. Host Country

3. Length of time project has been engaged in lines of research addressing these objectives

a. Progress in relation to log frame

b. Reasons for delay, if any

4. Relationship of project research to other research being conducted in the HC, IARCs, and elsewhere

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

D. Evidence of Biological/Social Sciences Integration

1. Identification of and attention to socioeconomic and WID-related constraints

2. Specific inputs into FY 93 research by social scientists in addressing these constraints

3. Progress in strengthening the social science/WID component

E. Sufficiency of Baseline Data

F. Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. Problems Regarding Funding, Budgeting, Release of Funds, Procurement, and Other--in U.S. and HC

B. Adequacy of Current Management, Policies and Procedures

C. Activity Towards Buy-ins and/or Other Funding

D. Responsiveness to 50/50 Split Policy

III. EVALUATION OF STATUS IN FY 93

A. Impact of Training Program

B. Collaboration/Cooperation Between U.S. and HC Institutions and Personnel

C. Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives

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

E. Evidence of Institutionalization in HC and U.S.

1. Faculty (researcher) recognition for international activities and awards

2. Integration of domestic program with CRSP project(s)

3. Internal support for project management and institutional management

4. Opportunities for and frequency of student/professor interactions

The following sections are not included as such in the Annual Report format. They are areas needing judgments by the EEP based on the overall Annual Report.

F. Appropriateness of Activities to Goals of the Global Plan

G. Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives

H. Other Comments

IV. WORK PLAN CHANGES

Comment on changes/additions/deletions in the FY 93 work plan, reasons for such changes and your assessment of the appropriateness of these changes

V. PUBLICATIONS AND PRESENTATIONS IN FY 93

Evaluate quantity and quality of project's output

VI. OVERALL RATING

A. General Strengths

B. General Weaknesses

C. Recommendations

FY 93 ANNUAL REPORT FORMAT

Due November 1, 1993

(Report is to be single-spaced in at least 12-pitch type.)

EXECUTIVE SUMMARY--A one-page synopsis of the year's research activities, written in non-technical language for use in CRSP publications. The first paragraph should be a general summary of the overall objectives and strategies of the project. Middle paragraphs should summarize activities/achievements/ impacts during FY 93. The last paragraph should address the project's training activities.

TECHNICAL SUMMARY (the only limitation on length is that Section I.C. may not exceed ten pages, not including appendixes). Do not omit items. Those which do not apply should be answered "not applicable."

I. **PROGRESS DURING FY 93** (October 1, 1992-September 30, 1993)

A. Specific research contributions in FY 93.

1. New research results from FY 93 disseminated and currently in use in HC and U.S. (list only CRSP-funded FY 93 activities).

a. List and describe improved cultivars, food products, inoculants, tests, methods, and systems.

b. List and describe accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use.

c. Discuss specifically how the new research findings address the needs of small-scale farmers and women or other beneficiaries (indicate).

2. Impact of research achievements including changes in national production (or consumption using appropriate indicators) of beans and cowpeas or new food products in HC: Estimate of hectares planted/yields per hectare/total production for most recent 10-year period.

a. Provide evidence of project impact on production and consumption of beans and cowpeas (e.g., on-farm trial results and/or changes in production statistics or development and adoption of new products or processes. Indicate the type of new value-added product produced.).

b. Discuss specifically (1) the technology needs/constraints facing small-scale farmers, (2) how these needs/constraints were identified and (3) how the research findings address the needs of small-scale farmers and women or other beneficiaries (indicate).

c. Discuss the impact(s) that your results have had on the developing and developed world.

B. Institutional development and training, i.e., strengthening HC bean and/or cowpea research and improvement systems.

1. Cite any institutional personnel changes since FY 92.

2. Update the attached training form.

C. Progress achieved in relation to the objectives stated in your FY 93 work plan (attached).

1. List each U.S. research activity and then describe the progress made in that activity. Indicate whether each objective is a primary or secondary project objective.

Example: 1. Identify and determine the inheritance of additional sources of resistance to web blight and bean golden mosaic (primary objective).

2. List each HC research objective and describe the progress made towards each. Indicate whether the objective is a primary or secondary project objective.

3. Indicate how long your CRSP project has been engaged in lines of research addressing these objectives. How does the progress relate to the log frame? Is the research on or ahead of schedule? If not, give reasons for the delay.

4. Discuss how your project research relates to other research being conducted in the HC, IARCs, and elsewhere. Is it complementary, duplicative, unique, etc.? Describe how you interact with this related work.

5. Provide an update on the likely contribution of research to the HC, the U.S., and to the amelioration of global constraints.

D. Evidence of biological/social sciences integration.

1. What are the socioeconomic and WID related constraints related to the achievement of your research objectives?

2. List specific inputs into your 1993 research made by social scientists (ag. economists, WID, sociologists, anthropologists, etc.) in addressing these constraints.

3. Discuss progress in strengthening the social science/WID component of your project by identifying and integrating into your research team (a) U.S.-based social scientists, and (b) HC-based social scientist.

E. Baseline data, i.e., does your project have baseline data adequate to evaluate the impact of your project? Please describe. If not, what do you plan to do to obtain this baseline data? (If there is no change from what you reported last year, answer with "No change".

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

II. FUNDING/FISCAL MANAGEMENT IN FY 93

A. Problems regarding funding, budgeting, release of funds, procurement, and other--in U.S. and HC.

B. Adequacy of current management, policies and procedures (especially regarding follow-up on use of funds and use of equipment).

C. Activity towards buy-ins and/or other funding.

D. Responsiveness to 50/50 split policy (and plan to rectify any imbalance).

III. STATUS IN FY 93

A. Impact of the training program on your project. Indicate any changes in your five-year (92-97) training plan.

B. Collaboration/cooperation between U.S. and HC institutions and personnel. Describe process for research planning, budget development, training, and publications/presentations.

C. Contributions of collaborating institutions and individuals towards accomplishment of objectives. Report other funding over and above core CRSP funds and participating U.S. and HC institutions' match, with accompanying comments as to the uses and impact of this additional funding.

D. Interest, involvement, and support of USAID Mission and/or U.S. Embassy. Discuss contacts made and the prospects of Mission support for your project.

E. Evidence of institutionalization in HC and U.S.

1. Faculty (researcher) recognition for international activities and awards.

2. Integration of your domestic program with the CRSP project(s).

3. Internal support for project management and institutional management.

4. Opportunities for and frequency of student/professor interactions.

F. Other comments.

IV. WORK PLAN CHANGES

Describe changes/additions/deletions in the FY 93 work plan (submitted to the TC in May 1992) regarding funding, personnel, research activities, commodities, etc. Give reasons for such changes (e.g., availability of funds, successes, failures, marginal activities, inadequate performance, unrealistic plans, etc.).

V. PUBLICATIONS AND PRESENTATIONS IN FY 93

A. List publications in two categories: refereed and non-refereed journals.

B. List presentations (including poster sessions, seminars, workshops, etc. and also in this section, list proceedings of meetings).

VI. ROSTER

A. U.S.

B. HC.

CAMEROON/PURDUE UNIVERSITY/MURDOCK

Post-Harvest Preservation of Cowpeas by Low-Resource Farmers

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. **Improved cultivars, food products, inoculants, tests, methods and systems:** Three technical bulletins describing project technologies (solar disinfestation, improved ash storage and triple bagging) have been disseminated in Cameroon and seven other West African countries and shared with several colleagues in Latin America.

MINAGRI and SODECOTON extended a project-developed package comprised of triple bagging and solar heater materials to more than 100 villages in northern Cameroon. Extension agents were trained in these technologies by the NCR&E Project and IRA CRSP scientists.

The project, the acknowledged leader in cowpea genetic engineering, has set the stage for transforming cowpeas initially carrying resistance/immunity to bruchids using a range of sources including exotic genes.

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** The project collected some cultivated weedy and wild *Vigna* species and shared these with their colleagues, e.g., some *V. vexillata* collections with A. E. Hall (UCR/Senegal).

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** The storage technology developed is specifically aimed at small-scale, low-income farmers, many of whom are women. The recent focus on biotechnology will contribute much more to peasant agriculture, but the scientific methodology being developed will have a profound effect on cowpea improvement strategies throughout the world.

2. Impact of research achievements in HC

a. **On production/consumption of beans/cowpeas or new food products:** No change.

b. **On technology needs/constraints facing small-scale farmers:** This project has been highly successful in finding a practical solution to a major problem of small-scale farmers (including women), i.e., conserving the quantity and quality of harvested food grains in storage under hazardous conditions.

c. **On the developing and developed world:** The longer-term strategy of the project is to develop affordable, effective, environmentally sound, and sustainable technologies that do not rely on insecticides. It is assumed that these strategies--particularly those pertaining to stored insect pests--will become attractive to use on other crops in both developed and developing countries.

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** A new Host Country PI, Mr. Seyni Boukar, replaced Mr. Samuel Nziecheung who assumed other duties in IRA.

2. **Status of training program:** Mr. Georges Ntoukam, who is completing his Ph.D. in Entomology, will remain at Purdue until he completes his degree requirements in mid-1994.

In other respects, training is on track. Mr. Chevalier Endondo completed his M.S. degree at Purdue in 1991 and a plant breeder (presumably Mr. Boukar Ousman) will receive training abroad later. The project would also favor training a Cameroonian economist/anthropologist/ rural sociologist/women's specialist in the future.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan:** Project activities including research/training are now shared by Purdue and Auburn Universities in close collaboration with Cameroon. Auburn is located in a cowpea-growing region, has extensive experience in cowpea agronomy/breeding and has some similar production problems as Cameroon.

1. **U.S.:** The project has primarily focused on production and storage problems of the HC, as well as pioneering plant research strategies involving basic genetic engineering. Since the project is closely integrated, researchers from the three institutions plan, review results and address problems together. The progress achieved for the different objectives is reported under I.C.2. below.

2. **HC**

a. Storage science and technology

(1) Seed storage

(a) New solar disinfestation technology studies on replacing the lower black plastic sheet with 3 feet x 8 feet corrugated tin or aluminum sheets (readily available at reasonable cost in Cameroon) found them just as effective and more durable than plastic. It quickly reached 60°C in the sun even in Indiana.

(b) Developing smaller plastic packages for solar disinfestation was studied. For small-scale farmers the use of 1.5m x 2.0m (15kg of seeds) was found more appropriate than the recommended 3m x 3m size. Even smaller sizes were studied, e.g., heavy plastic "Ziploc"-type bags holding 200g of seeds reached 60°C after a few minutes on the foundation in the sun and could prove very useful for plant breeders in developing countries.

(2) Pod storage

(a) **Computer modeling:** Cooperative studies on computer modeling of bruchid buildup in loose seed and in stored seed pods are underway by Drs. Tim Mack and Bertram Zinner at Auburn. Such information would prove useful in guiding future IPM trials and reassessing research objectives.

(b) **Cowpea breeding (Cameroon and Alabama):** A program has been designed to (i) identify genotypes with broad-based insect resistance for study and use in breeding programs, (ii) identify genotypes adapted to Alabama with possible relevance to insect resistance efforts to the broader southeastern U.S. and (iii) screen advanced lines for pod resistance to bruchids, particularly the Cameroonian rough-seeded types. In Alabama, 300 African and American cowpea lines were screened at three sites for resistance to cowpea curculio and pod-sucking bugs. The lines exhibiting bruchid pod resistance (Cameroon) were crossed with curculio resistant lines (Alabama). Progenies advanced by single seed descent to the F_6 generation will be field screened in the U.S. and HC in FY 94.

Earlier work showed that seed coat thickness and texture were related to pre-establishment mortality (Pre M)--thick, smooth seed coat texture was best. However, there was considerable variability for Pre M, suggesting other factors besides seed coat were involved. Resistant pod types would have important advantages including pre-harvest resistance to infestation and farmer preferences for drying and storing cowpeas in pods rather than as shelled seeds (in Africa).

Preferred pod types tend to be non-dehiscent and non-breakable. A local Cameroon landrace (Guetale 63) appears to combine a high level of pod resistance (Pre M) with rough, white seeds and is being used extensively in crossing.

(c) **Triple bagging:** Preliminary results from studies by Mr. Ntoukam suggest that bruchids will succeed in penetrating even multiple layers of plastic if the seed they emerge from is tightly apposed to the bag. Three layers help reduce close apposition and may provide a tighter seal against oxygen exchange.

(d) **Applied ecology of bruchids and curculio:** The objective of this study is to investigate sources of infestation of bruchids including alternative host plants, defining the physical environment of storage and collecting population abundance data. Six ecological studies in Alabama and Cameroon are underway but are mainly in the preliminary stages. Cowpea curculio (in U.S.) were observed feeding on six different plant species (ten previously) and over-wintering on broomsedge (*Andropogon virginicus*) and vasey grass (*Paspalum urvillei*). Similarly, there are numerous alternate hosts of bruchids in Cameroon: *Cassia senna, C. obtusifolia, Celosia argentea, Hibiscus* spp. and numerous wild *Vigna* spp. In the same study, Dr. Mack and Mr. Don Sudbrink (Auburn) discovered at least one egg parasite as well as wasp species that attack the larvae of *C. maculatus*.

(e) **Artificial rearing of *Bruchidius atrolineatus*:** An attempt was made to establish a colony of *B. atrolineatus* to test advances made against *C. maculatus*. Unfortunately, it has not been possible to initiate this collaboration to date.

b. **Farmer participation network:** This activity was organized under three categories, but the major one was collaborating with the USAID/W-supported NCR&E project on training sessions for MINAGRI and SODECOTON on seed storage problems. The IRA/CRSP solar disinfestation and triple bagging methods were advanced to the level of regional testing by the Maroua Testing and Liaison Unit of NCR&E in the extreme North Province. This test was carried out in 100 villages with an estimated 30 farmers participating per village. The trial consisted of solar disinfestation followed by triple bagging. The control was local practice. After four months, readings were taken, but the data have not yet been analyzed. Preliminary data suggests that about 82 percent of the control seeds were damaged (bruchid holes) but only 18 percent of the treated seeds were damaged (possibly before the seeds were solar heated and triple bagged). Further evaluation, however, is required to determine the overall success of the project.

c. **Cowpea breeding**

(1) The primary objective of cowpea breeding is to develop germplasm and varieties which possess high levels of seed and pod resistance to bruchids, are broadly adapted in North Cameroon and are acceptable to low-resource farmers in the region. This germplasm should be resistant to cowpea aphid-borne mosaic virus, retain leaves after harvest (as forage) and possess large-white seeds and desirable plant type besides bruchid resistance. Good progress was made in crossing and selection of superior segregants: 7,000 F_4 bruchid resistant seeds were selected and 930 F_5 bruchid seed resistant families were grown out at Makebi where 220 F_5 family selections were made. In addition, nearly one hectare of F_2s, F_3s and F_4s were advanced in this (1993) growing season.

(2) Preliminary, regional and advanced trials based on CRSP work were not yet ready--IITA variety trials were grown instead. These produced two outstanding entries (IT88DM-363 and IT89KD-444) which are being further evaluated and used in breeding.

(3) Crosses to determine inheritance of pod resistance to bruchids in TVu1890 and TARS 36 are being made and will be evaluated in 1994.

(4) The results of comparisons of single seed descent and pedigree methods for developing weevil resistant cowpeas are so far inconclusive.

d. **Bases for genetic engineering cowpeas and beans for insect resistance**

(1) **Search for biologically active proteins whose genes might be useful to confer resistance to common bean weevil and other bruchids:** Among the large number of protein sources tested for biological activity against common bean weevil, Mexican bean weevil and cowpea weevil, the most effective (at 5 percent of diet) were wheat protein, Kentucky coffee tree seed extracts, pin oak acorns, pokeweed berries, snakeroot blossoms, golden rod blossom and a mushroom. Another source of biological resistance is α-amylase inhibitor from common bean transferred into the garden pea for bruchid resistance. This should also apply to cowpea--if it becomes possible to transform this species. A second "ready-made" form of genetic resistance is the active toxin gene from *Bacillus thuringiensis*. One strain of *Bt* (MAU 293) was found highly effective against cowpea weevil in Cameroon by Dr. Mack.

(2) **Bioassay *Bacillus thuringiensis* protoxins for effectiveness against cowpea weevil, pod borer (*Maruca testulalis*) and other cowpea pests:** Among several proteins tested against these pests, using controlled diets, were trypsin inhibitors I and II from potato (serine proteinase inhibitors) at 1 percent (w/w) but the effects were modest. The most effective spore crystal preparation against *Maruca* was CryIA(b) (LC50 = 0.03ug/g and at LC90 = 0.09ug/g).

(3) **Ways to assist in guiding national programs in using the products of biotechnology:** Biosafety and intellectual property rights issues are an increasing concern of the U.S. PI and Purdue. Dr. Larry Murdock attended meetings on these topics in May (Agricultural Biotechnology for Sustainable Productivity project at MSU) and November (International Service for National Agricultural Research at the Hague). At Purdue, Dr. Suzanne Nielsen assumed leadership for food safety issues related to cowpea transformation.

(4) **Explore the construction of chimeric proteins and chimeric genes effective against the cowpea weevil:** At Auburn, Dr. Narendra Singh cloned a CryIIA gene into a plant expression vector pMON 530 and isolated an α-amylase inhibitor cDNA clone from tepary bean. These genes could be useful when cowpea transformation is possible.

e. **Regionalization**

(1) **Formalize relationships with Nigerian scientists and officials:** Despite mutual interests, efforts have collapsed for lack of support.

(2) **Explore additional satellite activities in other countries:** Drs. Murdock and Laurie Kitch visited Mali in February 1993 and found considerable interest in all aspects of cowpea improvement, production and utilization.

(3) **Assist other CRSP projects:** Information on cowpea storage has been shared with all other cowpea projects, as well as bean programs in Ecuador and CIAT (Colombia).

(4) **Plan for a cowpea conference in Africa in FY 94:** Due to difficult financial conditions and other problems, this conference has been postponed indefinitely. However, a conference of CRSP and other scientists (ca. 30) was held at Purdue on April 22-23, 1993. Major focus of discussion was regionalization of the Bean/Cowpea CRSP activities in West Africa.

(5) **Link with the Semiarid Food Grain Research and Development (SAFGRAD) cowpea network:** Attempts have not succeeded.

f. **Support Activities:** All support activities of the project, including the laboratories, seed production, equipment and supplies have been fulfilled to the extent that the IRA/CRSP laboratory in Maroua is among the best such facilities in West Africa.

g. **Training:** Training objectives are on track. The cowpea agronomist (Mr. Endondo) has completed training; Mr. Ntoukam (entomologist) will complete training at Purdue in 1994 and the cowpea breeder (Mr. Ousman) is scheduled for training in the next 2-three years.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Ahead of schedule

   b. **Reasons for delay, if any:** N/A

4. **Relationship of project research to other research being conducted in HC/IARCs/elsewhere:** The project has cooperated closely with other countries (West Africa and Latin America) and especially with IITA and CIAT.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** This project will contribute significantly to both increased production and product quality of cowpeas in the HC and elsewhere, (see I.C.1. and 2.).

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** There is continuing recognition of the importance of WID issues and ongoing encouragement of participation of women in demonstration tests.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** Project leaders have repeatedly expressed the need for socioeconomic inputs into cowpea production/losses constraints. An excellent opportunity for such studies will be survey results from the NCR&E demonstration tests on cowpea storage in Northern Cameroon (FY 93-94).

3. **Progress in strengthening the social science/WID component:** This issue is not address specifically in the Annual Report. The PIs, however, have continued stressing the importance of social science/WID issues and pointed out opportunities to carry out survey studies on forthcoming NCR&E demonstration tests in northern Cameroon (see I.D.1. and 2. above).

E. **Sufficiency of Baseline Data:** The project has good information on cowpea production practices and social science issues--much of which was obtained from earlier studies by Dr. Jane Wolfson (Purdue). Current activities focus on the overall importance of cowpeas in Cameroon, magnitude of losses from storage pests and potential impact of new CRSP technology.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** There is strong collaboration with the other CRSP cowpea projects and with the Ecuador/UMN and Caribbean Basin/UWI bean projects.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** Past problems with transfer of funds and reimbursements in Cameroon have been resolved. However, the Government of Cameroon is experiencing severe ongoing financial difficulties which directly or indirectly pose severe hardships on CRSP personnel and collaborators in Cameroon.

B. **Adequacy of Current Management, Policies, and Procedures:** These are adequate.

C. **Activity Towards Buy-ins and Other Funding:** Encouraged by the USAID/Yaounde Mission, a major proposal is being prepared: "Economic, Agronomic and Cultural Development of the Cowpea Subsector in Cameroon: Increased Production, Marketing and Consumption." The budget is $420,000 and time frame is 18 months. A large number of researchers from Purdue, Auburn, Cameroon, other CRSP projects and others have contributed to planning this buy-in.

D. **Responsiveness to 50/50 Split Policy:** The project agrees with this policy and attempts to honor the underlying principle.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** Goals are appropriate. The project is on schedule and expects to complete training of Cameroonian scientists (breeder, entomologist and agronomist) by 1997.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Excellent

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** IRA contributes its scientists' time, administrative services, facilities, field research areas, utilities, auxiliary vehicle, technicians and land preparation (mechanical) services estimated at $100,000 annually. The CRSP has also benefitted considerably from collaboration with NCR&E in testing and demonstrating the new IRA/CRSP technology. Also, the French-supported Projet Garoua has provided infrastructure and services at Garoua field station.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** The USAID/Yaounde Mission has been a strong supporter of the project and has encouraged the large buy-in proposal.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** N/A

2. **Integration of domestic program with CRSP project(s):** Integration is virtually complete. The project has become a leader for new innovations in plant improvement and pest protection on several crops and methodologies (10).

3. **Internal support for project management and institutional management:** Purdue administration has given excellent support to the CRSP at both the School and Departmental levels. The new Director of International Programs in Agriculture, Dr. David Sammons, has been particularly supportive. In addition, an economist, Dr. Jess Lowenberg-DeBoer, has recently joined the CRSP team at Purdue.

4. **Opportunities for and frequency of student/professor interactions:** Excellent

F. **Appropriateness of Activities to Goals of Global Plan:** Goals are appropriate.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** Balance is good. The addition of the Auburn team has helped balance the project. Inclusion of biotechnology research will further strengthen program activities.

H. **Other Comments:** This project is maturing and it will have reached most of its research and training goals within the next two to four years. In the future, the project will evolve more toward biotechnology and regionalization of activities in Africa.

IV. **WORK PLAN CHANGES:** Mr. Sudbrink's trip to Cameroon was postponed from Fall 1992 to 199? because of political unrest. The CRSP's international cowpea conference for Africa in FY 93 was postponed indefinitely (lack of funds) and replaced by a conference on Regional Economic Development for Sub-Saharan Africa held at Purdue in April 1993.

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93**

Refereed Publications: 4
Non-Refereed Publications: None
Presentations: 13

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

A. **General Strengths:** This project is exceptionally well-planned, organized and executed. It has the capability to expand into a broad range of disciplines--like biotechnology--to accomplish its goals. It has also integrated well with social sciences and was fortunate to have had initial baseline data available from the onset. Leadership has been outstanding.

B. **General Weaknesses:** None

C. **Recommendations:** Some additional training in the area of social sciences and WID issues would be desirable. Other (particularly short-term and specialized) training in critical areas of cowpea breeding (at Auburn) and in biotechnology would help strengthen the HC program. The evolution of the project toward regionalization in Africa (as proposed by the U.S. PI) is an attractive future development deserving of urgent consideration.

Molecular Approaches for the Control of Bean-Infecting Geminiviruses and Other Viruses

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. **Improved cultivars, food products, inoculants, tests, methods and systems:** Six major research results were disseminated and used by others in 1993. In addition, the project provided assistance and polymerase chain reaction primers and geminivirus clones to several laboratories in Africa, South/Central America, Middle East and Asia for geminivirus diagnosis. These six results include:

(1) **Pseudo-recombinants between tomato and bean geminiviruses:** Component exchange experiments showed that pseudo-recombination can occur between two distinctly different geminiviruses like tomato mottle geminivirus from Florida and bean dwarf mosaic virus from Colombia. This could be a mechanism for evolution of geminiviruses in nature.

(2) **Diversity of geminiviruses in Mexico:** Studies in the Valle del Fuerte in Sinaloa, Mexico showed that more than one geminivirus can infect the same host. The dominant geminivirus infecting beans in this area was bean calico mosaic virus, but BGMV-II was not detected.

(3) **Classification of characterized bean geminiviruses:** The concept of types I and II for bean golden mosaic virus in Latin America was accepted by the editorial board of *Phytopathology*.

(4) **Replication assay methods:** PCR-mediated replication assay was developed using a tobacco suspension cell system to facilitate studies at the cellular level.

(5) **Function of geminiviral genome:** Site-directed mutagenesis in the putative nicking motif of the replication gene of BGMV-II showed some codon changes would prevent infectivity and replication of the virus in tobacco suspension cells. This has implications for designing transdominant lethal strategies for virus control.

(6) **Transmission studies:** In addition, collaborative studies with the University of Puerto Rico on whitefly transmission of viruses demonstrated that expression of virus coat protein is required for vector transmission.

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** N/A

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** The project is mainly supportive of global bean research. Accurate diagnosis will accelerate applied breeding efforts, and genetic transformation of bean plants could lead to "permanent" solutions for BGMV as well as other impediments to bean productivity. The project will, in time, contribute directly to uplifting the bean productive capacity of the poorest sector of farmers and increase bean supplies for consumers. It also provides training opportunities for many women, e.g., six women from foreign countries and six women from the U.S. in 1993 alone.

2. **Impact of research achievements in HC**

   a. **On production/consumption of beans/cowpeas or new food products:** N/A

   b. **On technology needs/constraints facing small-scale farmers:** A major objective of this project is to develop durable resistance to BGMV, a rapidly spreading disease that is threatening bean production throughout the Americas. Since small-scale, subsistence farmers (including women) are directly dependent on beans for subsistence and cash, they will benefit the most from this effort.

   c. **On the developing and developed world:** This project has during its short life made several contributions including:

      (1) **Training:** Twenty scientists (twelve women, eight men) in 1993, about equally divided between U.S. and foreign nationals, were trained in geminivirus research. The CRSP provided no training funds but about thirteen other entities did.

      (2) **Networking:** The project developed and provided protocols, primers and gemini virus clones for research in the U.S. (UCD, USDA, etc.), Puerto Rico, Costa Rica, Jamaica, Dominican Republic, Mexico, Brazil, Colombia (CIAT), Zimbabwe, Egypt, South Africa, Taiwan (AVRDC), Thailand, Indonesia and others.

      (3) **Research breakthroughs:** The project accomplished the first-ever genetic transformation of beans by inserting the genes coding for BGMV protein coat and herbicide resistance into beans. Of perhaps greater importance to bean researchers is the development of protocols and general PCR primers for amplification of whitefly-transmitted geminiviruses and their distribution to scientists around the world, allowing them to characterize their own geminiviruses and identify alternate reservoirs (e.g., weeds).

      (4) **Leadership in geminivirus research:** The project has already had a major impact on the morale of bean researchers around the world who have, for at least 25 years, worked intensively on highly intractable problems like BGMV. These investigators are beginning to realize that potent new approaches to almost impossible problems of bean improvement will become available during the next several years.

B. **Evaluation of Institutional Development and Training**

   1. **Personnel changes since FY 92:** Bean transformation activities were carried out in part using the gene gun at Agracetus under the direction of Mr. Jeffery Frazer from January-August 1993 and Ms. Martha Maxwell from July. Mr. Stephen Hanson joined the group as a graduate student in September 1993 and Ms. Rebecca Hoogstraten was employed as a research specialist in August 1993. Ms. Amy Loniello departed in August for Cornell University to work on her Ph.D. Other changes were not connected with Bean/Cowpea CRSP funds.

   2. **Status of training program:** The project has been very successful in training students and visiting scientists in highly technical procedures to identify geminivirus strains and in genetic transformation of bean plants. Of the twenty students and scientists being trained in FY 93, twelve were women.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan:** Greater focus in FY 93 was given to two areas: (1) whitefly transmission of the coat protein mutants of BGMV and (2) development of a replication assay to study viruses at the cellular level.

   1. **U.S.**

      a. **Molecular characterization of bean geminiviruses:** Four bean-infecting geminiviruses (BGMV-I, II and III and bean dwarf mosaic virus) have previously been characterized. In addition, analysis of the nucleotide sequences of clones of bean calico mosaic virus

indicate this is a distinct geminivirus. Two other geminiviruses from Mexico were found distinct from BGMV-II that occurs in the Caribbean Basin. One was related to bean calico mosaic virus and the second was related to the tomato geminivirus found in Mexico.

Signature sequences for BGMV isolates from beans, vegetables and different weed species were obtained from Mexico and Jamaica using PCR technology. Preliminary results showed the presence of different geminiviruses on different hosts. However, mixed infections were detected in beans and peppers and pseudo-recombination was observed to occur between different geminiviruses.

Studies of alternate hosts for BGMV using whitefly vectors on seedlings of lima beans, cowpeas, *Macroptilium lathyroides, Euphorbia heterophylla* and *Rynchosia minima* in Puerto Rico showed that lima beans and *Macroptilium lathyroides* could serve as alternate hosts of BGMV. Both species may occur in the vegetative stage for much of the year in this region.

The project assessed geminiviruses in 16 different countries. Moreover, the PCR technology is now used regularly in Costa Rica and Jamaica. The Costa Rica PI organized a geminivirus field day for farmers and extension personnel to disseminate information on these viruses and their whitefly vector.

b. Antiviral strategies

(1) Studies on the importance of coat protein were focused on coat protein mediated protection strategies which have proven successful in controlling plant RNA viruses. Results showed that coat protein mutants had 50 times less ssDNA than the wild type BGMV-GA, but the level of dsDNA was not affected by the introduced mutations. It was therefore concluded that coat protein is essential for efficient viral ssDNA accumulation. Three additional experiments demonstrated that whitefly transmission of BGMV requires the expression of coat protein.

(2) The role of DNA-B in determining host range and symptoms of BGMV was investigated using site-directed mutagenesis to introduce XhoI restriction enzyme sites at both ends of the common region of DNA-B of bean dwarf mosaic virus and BGMV-GA. The Agracetus gene gun was used to inoculate both excised common regions into bean radicles. The results indicated host range determinants reside in the DNA-B components. The information will be useful for developing new virus control strategies.

(3) Polyclonal antibodies were obtained from the *Escherichia coli* expressed coat protein of BGMV. It was evaluated in Wisconsin and Florida where it reacted well to coat proteins from BGMV-GA. Polyclonal antibodies will be tested further to check the spectrum of diversity against a range of geminiviruses in different crops.

(4) Mutational analysis was used to determine the function of four regions of the BGMV-GA genome, i.e., AL1, AR1, BL1 and common region. The AL1 product is essential for viral replication and was targeted, therefore, to evaluate trans-dominant interference mechanisms. Site-directed mutagenesis was used to change three amino acid codons at this catalytic site in the AL1 product. These three codon changes also abolished replication capability. This requires that levels of introduced DNA and newly synthesized viral DNA be measured over time. An essential first step in this approach will be to measure the production of AL1 protein. Therefore, an *E. coli* bacterial expression system is being developed to produce AL1 protein to be used in polyclonal antisera production.

(5) A double mutant in AL1 (two of three mutations that individually eliminate infectivity) was used to construct a plasmid for transformation of beans. The Agracetus particle gun was used to blast 7,472 explants of the EAP10-88 bean (Honduras) during January/ August and 2,000 small red and pinto beans in the latter half of 1993, but

results were unsatisfactory Efforts are continuing but bean transformation is a major bottleneck without a protoplast system.

2. **HC:** Eight Host Countries were closely integrated with the PI at UWI in carrying out the project's objectives.

   a. **Jamaica (University of West Indies):** Samples (107) of beans, vegetables and other weed species were collected and challenged with a DNA probe using project primers. With the bean geminiviral probe, 62 percent of the vegetables and 37 percent of the weeds gave positive hybridization signals.

   b. **Costa Rica (University of Costa Rica):** Collection of crop and weed samples in BGMV-infected areas showed that the geminiviruses infesting weeds were different from the viruses infecting beans and tomatoes. In the future, a more efficient probe based on PCR-amplified DNA-A will be developed.

      The Costa Rica PI organized the first-ever BGMV/whitefly field day to disseminate knowledge about geminiviruses and methods for controlling whitefly. A total of 155 participants, including 38 percent agriculture engineers, attended.

   c. **Dominican Republic:** Transmission studies were carried out using whiteflies on eggplants and several weed species. One month past inoculation only croton (*Croton lobatus*) and *Macroptilium lathyroides* exhibited BGMV symptoms. The information obtained will be used in recommending whitefly spray schedules early in the season.

   d. **Nicaragua (Universidad Agricola Nacional):** BGMV-infected samples were collected and sent to UWI for diagnosis. Concurrently, whitefly rearing facilities are being improved to expand transmission studies.

   e. **Colombia (CIAT):** Infectious clones produced from particle gun intromission of BGMV-GA and BGMV-Dominican Republic were exposed to whiteflies. The whiteflies were then moved to healthy plants which exhibited BGMV symptoms fifteen days later. Previously only tomato yellow leaf curl and Texas pepper geminivirus had been tested in this way.

   f. **Puerto Rico (UPR):** The primary objective at UPR was to evaluate transgenic bean plants for resistance to whitefly transmitted BGMV. The complete results of this work are not yet available. However, most bean lines reported to be resistant to BGMV were found susceptible when inoculated by whitefly transmission in the greenhouse. One notable exception was a *Phaseolus coccineus* (scarlet runner bean) which is being crossed with *P. vulgaris* to determine whether this resistance is useful.

   g. **Brazil (EMBRAPA):** Two Brazilian scientists joined the UWI lab to develo constructs of plant vectors for bean transformation for BGMV resistance. One plant vector contained the coat protein of BGMV-Brazil and another contained the antisense of the genes AL1-AL2-AL3 and BL1 of BGMV-Brazil. These constructs were returned to Brasilia for incorporating into bean explants using a helium (gene) gun.

   h. **Zimbabwe (University of Zimbabwe):** This work involved diagnosis of viral diseases of cowpea, especially aphid-borne mosaic potyvirus, using PCR technology. PCR fragments obtained from twelve isolates and subjected to amino acid sequence analysis revealed a 92 percent similarity and 85 percent identity to the soybean mosaic virus coat protein gene.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Intensive research on BGMV was begun in January 1987. Progress has been steady and ahead of schedule on most objectives:

      (1) Four bean-infecting geminiviruses were cloned, sequenced and found to be infectious.

(2) New detection methods, using radioactive and non-radioactive probes as well as PCR, were developed.

(3) Transgenic beans with coat protein and mutated AL1 genes were engineered and are being evaluated at UWI and UPR.

(4) Various aspects of viral genome functions are being evaluated.

(5) Numerous other geminiviruses have been detected in weeds and other crops.

(6) Whitefly transmission facilities have been developed at UPR.

(7) HC labs are using biotechnology.

b. **Reasons for delay, if any:** N/A

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere**

a. **Global role:** This project is the major research effort in the world on bean-infecting geminiviruses and phylogenetics of whitefly-transmitted geminiviruses. Its services have been used by sixteen different countries around the world, encompassing the diverse teams working on geminivirus diagnosis, and it has contributed to setting up independent facilities for molecular characterization of geminiviruses in AVRDC (Taiwan); Agricultural Research Center, Giza, Egypt; University of West Indies, Jamaica; University of Witwatersrand, Johannesburg, South Africa; University of Costa Rica; and University of Florida. Major collaboration efforts are underway with CIAT (Colombia), the University of Puerto Rico and Bean/Cowpea CRSP scientists at UCD, EAP (Honduras), the University of Nebraska and Brazil (EMBRAPA). The project has assisted twelve other laboratories in the diagnosis of geminiviruses: Argentina, Ecuador, India, Taiwan, Nepal, Spain, Jordan, Lebanon, Nigeria, Bhutan, Sri Lanka and Mexico.

b. **Geminivirus workshop:** A ten-day workshop on geminivirus detection was held at AVRDC, Taiwan in March 1993. The project (Maxwell) participated in organizing the meetings with participants from Bhutan, Nepal, Pakistan, India, Sri Lanka, Bangladesh and Taiwan.

c. **Visiting scientists and collaboration:** The UWI lab has hosted a number of visiting scientists for periods of up to a year studying geminiviruses. These include: Brazil (Dr. Josias Faria and Mr. Simone Ribeiro), Zimbabwe (Dr. Idah Sithole), IITA-Nigeria (Dr. George Thotottapilly), Illinois (Dr. Richard Ford) and others. Project-connected personnel have also investigated geminiviruses on cowpeas (IITA and Zimbabwe), mung beans (AVRDC) and tomato. Because of their economic importance, geminiviruses are receiving considerable attention in several labs around the world, e.g., UCD (Dr. Robert Gilbertson) on tomatoes and John Innes Institute at Norwich, United Kingdom (Dr. Roger Beachy).

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:**

a. **Importance of BGMV:** The spread and severity of BGMV has become the number one problem of bean production in the Western hemisphere. Moreover, formerly resistant varieties (e.g., DOR 364) have been severely infected in Guatemala. New approaches to control are needed including genetic transformation, interspecific crossing (e.g., *P. coccineus*) and intervention at the vector (whitefly) level.

b. **CRSP contributions:** Project contributions to BGMV control include:

(1) Five different bean geminiviruses were identified.

(2) PCR methods were developed to show distribution of BGMV type I and II isolates.

(3) New detection methods (DNA probes and PCR) have been developed and are being applied to diagnosis of crops other than beans.

(4) Changing cultural practices have reduced losses in the Dominican Republic in the January-April season.

(5) One of the eleven transgenic bean lines with the viral coat protein gene showed delayed BGMV symptoms.

(6) A novel virus-derived scheme (trans-dominant lethal) is being evaluated for potential in BGMV and for other viruses of plants and animals.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** During 1993, the project trained eighteen participants of which twelve were women--six women each from the U.S. and foreign countries. They ranged from undergraduate to graduate students and post-doctoral fellows.

   The project is aware of the implication of releasing transgenic plants in the developing world. Therefore, the project adheres to all safety procedures outlined for genetically engineered organisms in the U.S. and elsewhere and closely cooperates with the Animal and Plant Health Inspection Service (APHIS) policies and procedures. In order to meet requirements, appropriate modification of greenhouses at UPR was carried out to allow whitefly transmission of genetically engineered bean plants or other crops.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** This highly technical and biologically oriented project does not have a social science component *per se* since it has not yet developed applied technology. Moreover, it relies on the Host Countries and other Bean/Cowpea CRSP projects for baseline data.

3. **Progress in strengthening the social science/WID component:** A social science input is not yet relevant to the project's activities (see I.D.2. above). However, women have, and have had, a prominent role in carrying out the basic biological research and participating in highly technical training.

E. **Sufficiency of Baseline Data:** The project relies on baseline data collected by other CRSP projects in the DR and Honduras. However the project is neither equipped nor funded to carry out this activity except for BGMV spread.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** New linkages in 1993 include the Jerusalem University-Israel on tomato geminiviruses and the University of Ambato-Ecuador on diagnosis of tomato tree geminiviruses. Other contacts and requests came from sixteen different countries, Texas and Florida.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:**

1. **U.S.:** The current budget level is too low to provide adequate support for current broad-based activities. Moreover the project--unlike other projects--has no funding for training.

2. **HC:** There were frustrating delays in providing equipment to the Costa Rica lab.

B. **Adequacy of Current Management, Policies, and Procedures:** Administrative problems with official policies in one HC (Dominican Republic) umbrella continued into FY 93. The MO and UNL worked with USAID/W on the resolution of this problem.

Several policy areas required, and will continue to receive, attention including biosafety and political implications of transferring genetically engineered plants to the HC.

C. **Activity Towards Buy-ins and Other Funding:** The project is highly leveraged (about 200 percent) by non-CRSP funds totalling $229,000 ($134,000 for beans and $95,000 for tomatoes). Other sources of support came from the State of Wisconsin, Hatch Act, USDA, Consejo Nacional de Investigaciones Cientificas y Technologicas (CONICIT--National Council for Scientific and Technological Investigations--Costa Rica), UWI-Graduate School, Riker Fellowship, Taylor Undergraduate Research Internship, EMBRAPA (Brazil), Agracetus, UWI and volunteers. Tomato geminivirus support, which complements the bean work, mainly came from other sources.

D. **Responsiveness to 50/50 Split Policy:** Essentially, all of the research supports HC needs, but the highly technical nature of the program requires greater funding to the UWI lab. Additional funding, however, will be shifted to Jamaica and Costa Rica.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** The project receives little or no support for training from the CRSP. Nevertheless, the PI has been highly successful in securing support from non-CRSP sources for training at several levels beginning with undergraduates. This training (eighteen participants in FY 93) has been a keystone of project accomplishments.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Collaboration has been excellent. However, it has not been possible to have all participating scientists at one place and time to discuss budgets and programs. Instead, these activities were carried out by phone, fax and E-mail and by visits by individual participants both in the U.S. and HCs. Several major scientific papers have been authored jointly by PIs and other researchers.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** About $229,000 in additional funds were spent in FY 93 to support the bean geminivirus team. CRSP funds support about 30 percent of the activities related to bean-infecting geminiviruses (i.e., evaluation of transgenic bean plants, analysis of AR1 [the coat protein gene] and 25 percent of the mutational analysis of AL1). Agracetus contributes to use of gene gun.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** The Missions in Jamaica and Costa Rica were very supportive of the project, but Mission support in the DR is still questioned.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** The U.S. PI is widely recognized for his contributions. He serves on the International Program Committee at UWI, assists with the Undergraduate Educational Grant (Kellogg Foundation) and served as Interim Assistant Dean for Academic Student Affairs.

2. **Integration of domestic program with CRSP project(s):** The U.S. PI's activities are primarily related to international agriculture. However, the growing importance of geminiviruses in the U.S. has focused increasing interest and attention on the biotechnical aspects of geminivirus research. The U.S. PI has also been appointed to the UWI Institutional Biosafety Committee.

3. **Internal support for project management and institutional management:** Excellent support has been received from the Director of International Programs in providing office staff for USAID/W requirements and in promoting widespread political support.

4. **Opportunities for and frequency of student/professor interactions:** The team has a weekly laboratory meeting and the PI meets frequently with students (five undergraduates and five graduates), four visiting scientists and one post-doctoral fellow in addition to support staff.

F. **Appropriateness of Activities to Goals of the Global Plan:** This project is highly appropriate in that it specifically addresses BGMV emerging as the number one problem of bean production in Latin America. Poor and disadvantaged farmers and consumers can be major beneficiaries of the advances being made.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** The highly technical nature of the research involving molecular biology and very sophisticated equipment necessitates that the majority of activities be carried out at UWI. Activities and support, however, are rapidly increasing by the U.S. team in Puerto Rico, and in Costa Rica, Jamaica and the Dominican Republic where trained researchers are available.

H. **Other Comments:** The U.S. PI requests additional support be provided to Agracetus for using the gene gun ($30,000/year for a technician). The U.S. PI has made an attempt to travel less and write up pending manuscripts.

IV. WORK PLAN CHANGES: Two minor changes occurred in the work plan for FY 93.

A. The project was unable to evaluate AL1 mutant transgenic plants by whiteflies this year. This was due to a transition in personnel at the University of Puerto Rico and to changes required in the glasshouses before being used for transgenic beans evaluation.

B. The initiation of the whitefly transmission study of the DR took longer than expected.

V. PUBLICATIONS AND PRESENTATIONS IN FY 93

Refereed Publications: 10
Non-Refereed Publications: 2
Presentations: 17 + 10 papers given at the BGMV Conference in Guatemala, November 9-13, 1992.

VI. OVERALL RATING: 1--Highly Satisfactory

A. **General Strengths:** This is an exceptional project, having combined the basic and applied aspects of biological research in the effort to solve one of the most critical and emerging problems of crop production today. The excellent progress which has been made in only five to six years is due to (1) the long hours, hard work and dedication of each member of the team; (2) the many trained and dedicated collaborators from several countries who have been attracted to the project; (3) a wide base of institutional support and public interest in biotechnology; and (4) the brilliant, inspired leadership of the U.S. PI.

B. **General Weaknesses:** There are three primary weaknesses of the project: (1) lack of training funds, (2) inadequate funding for using a gene gun and (3) over-extension of activities--particularly on international collaboration.

C. **Recommendations:** Add a training component (if funds are available) and discourage over-extension of activities.

Improvement of Digestibility and Nutritional Quality of Common Bean (Phaseolus vulgaris L.) Through Traditional Breeding, Molecular Biology, Genetics and Food Technology

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. Improved cultivars, food products, inoculants, tests, methods and systems: This is a relatively new project, initiated in 1992; therefore, new research results have been limited to the following:

1. Procedures developed to modify bean-derived ingredients for use in formulating suitable weaning foods include pre-treating bean preparations with various enzymes to modify the bean preparations prior to drum drying. The specific enzymic treatments were not specified in the Annual Report. Analytical data from these pre-digested preparations are being compiled and will be reported in 1994. This research is being done cooperatively with Gerber Products Company.

   An alternative approach to preparing weaning-food ingredients from beans consisted of a pre-soak step followed by discarding the soak water containing non-digestible oligosaccharides. The beans are then ground and extracted with water. Subsequently, the water extract containing proteins and some carbohydrates can be used for a rice-based weaning food, thereby significantly enhancing the amount and quality of protein. The non-soluble bean meal still contains a significant amount of protein and can be used as an ingredient for adult meal preparations. This approach would be very adaptable to home or village-level processing.

2. The bioavailability of the iron in beans is inhibited by a number of factors. Efforts to enhance bean iron bioavailability include germination to decrease the iron-binding compounds, tannin and phytate. Methodology to determine iron bioavailability has been developed and is being used to assess the effects of germination. Atomic absorption analysis for iron content has been developed at the University of Costa Rica.

3. Bean starch is digested slowly, which is a constraint to its use in weaning food and limits the caloric potential of beans. Methodology to assess starch digestibility was developed and used to determine differences between various bean stocks and processing treatments. No differences in starch digestibility were observed in ten cultivars tested.

   Results indicate that starch indigestibility is related to lack of complete gelatinization during heating, including commercial canning. Cooling of cooked beans apparently decreased digestibility and re-cooking enhanced digestibility. The effect of germination on starch digestibility is also being investigated.

   Oligosaccharides in beans (e.g., raffinose and stachyose) are essentially non-digestible (causing gastric problems in infants and adults) and, therefore, constrain the use of beans (particularly in weaning foods). Analytical methods have been developed to monitor the amount of oligosaccharides in various bean preparations.

4. A nutritional evaluation of lower-middle-class urban children (6-37 months of age) from the San Jose area of Costa Rica was initiated. Economic status data of participants indicate that 85 percent were essentially "poor." The average heights and weights of

the 109 children in the survey appeared adequate as well as average dietary calories and protein, but average iron intake appeared inadequate. A distribution assessment, however, indicated that energy intake also was deficient in over 40 percent of the children studied. It also indicated that children at this age were fed milk with some meat and only 26 percent were fed beans. The iron data indicated that meat intake does not satisfy the iron requirement.

5. An *in vitro* method to evaluate protein digestibility has been adopted. Beans are being stored under conditions which develop the hard-to-cook defect for further study. Protein and methionine contents of thirty bean varieties were measured and two strains (P-766 and BAT 41) were highest in methionine content.

6. Experiments which will incorporate the BEX gene (Brazil nut, high methionine protein gene) are underway.

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** Technologies for bean utilization are in the early stages of development and technology transfer was not initiated in 1993.

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** Beans are a source of low-cost, high protein food with a reasonable amount of carbohydrate energy. Constraints for bean utilization are indigestible carbohydrate fractions causing gastric problems, particularly in infants; lowered protein digestibility under certain storage conditions (hard-to-cook defect); low iron bioavailability and long cooking times. Rural populations in developing countries are often dependent upon beans to supply adequate amounts of dietary protein. Development of bean-based foods, including weaning food, without these nutritional constraints would benefit both rural and urban poor. In addition, the availability of simple processing procedures for bean utilization has economic development implications for both small rural communities and urban areas.

2. **Impact of research achievements in HC**

a. **On production/consumption of beans/cowpeas or new food products:** Lower-middle-class urban children are at risk for iron deficiency, and 40 percent of the children have caloric intakes below the recommended level. A survey of rural households is being planned to determine socioeconomic constraints and their basis. Dr. Sue Kenyon, an anthropologist, has made a site visit and she will be working closely with the project. Her visit indicated that early weaning may result in nutritional problems and that iron deficiency may be endemic in Costa Rica.

b. **On technology needs/constraints facing small-scale farmers:** There have been none at this early stage of the project. Constraints to small-scale farmers include government policy on bean production, women's roles in household decisions, and nutritional implications regarding weaning practices and the role of beans in the rural diet (with emphasis on weaning foods).

c. **On the developing and developed world:** This is the only CRSP project focused on the utilization of *Phaseolus vulgaris*. The information on various processing methods, nutritional quality and acceptance will have broad application to other countries in which beans are an important food source and have potential application in the Ghana-UGA cowpea project.

B. **Evaluation of Institutional Development and Training**

1. **Personnel changes since FY 92:** The report indicated that Dr. Eugenia Lopez, an anthropologist at the University of Costa Rica, will be contributing to the project and Ms. Monica Lois will work on a part-time basis with Dr. Ana Bonilla's food science research

program. No changes were reported for the Purdue University component and MSU has added a graduate student to the project.

2. **Status of training program:** As this project is new, the training program is just being developed. A specific plan was not presented in the FY 93 report. In FY 93, two additional trainees were added, a Ph.D. candidate in Food Science at MSU and a B.S. student in Food Technology at the University of Costa Rica.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan:** Overall progress has been satisfactory.

1. **U.S.:** Thirty varieties of beans were screened for total protein and methionine content. Two varieties were found to be superior. Arrangements were also made to obtain a soybean which contains the BEX gene (high methionine content) as a model for producers to insert the BEX gene into *Phaseolus vulgaris*.

   Protein digestibility methodology has been developed for evaluation of digestibility of varieties and to assess the effects of post-harvest processes which would enhance protein digestibility. Beans with the hard-to-cook defect are being evaluated regarding protein digestibility. A method to determine starch digestibility, a constraint to bean utilization, was evaluated in various cultivars. The effects of gelatinization of bean starch on digestibility was also determined. No major differences were observed in the ten cultivars examined.

   A strategy was developed using simple processes to produce a culturally acceptable protein weaning food. A process was used to fractionate bean preparations, one of which could be utilized to produce a protein-enriched, cereal-based weaning food and the other fraction used for adult consumption.

2. **HC:** Activities included: (a) an enzymatic process being developed to reduce the indigestible oligosaccharides in beans, (b) germination being investigated as a means of enhancing iron bioavailability and (c) a study completed to assess the socioeconomic and nutritional constraints imposed on the development of bean-based weaning foods.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Progress appears adequate at this early stage of the project. Equipment and methodologies are essentially in place and research progress appears to be adequate.

   b. **Reasons for delay, if any:** No delays were indicated at this early stage of the project.

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** It appears that the use of beans in weaning food is relatively unique because of the problems in digesting their proteins and carbohydrates. However, Gerber Products Company has cooperated in this research, which is indicative of its possible feasibility. The Ghana/UGA project is pursuing development of a weaning food containing cowpea, which has similar digestibility problems as well as the hard-to-cook defect. Some of the technology developed may, therefore, be interchangeable. Research addressing utilization problems associated with beans is not a primary focus of other CRSP projects or IARCs. The University of Costa Rica has had research activity concerned with the nutritional quality of beans prior to this project. Both the University of Costa Rica and MSU have had breeding activities with goals in support of the utilization program regarding protein quality and digestibility in addition to increasing bean production.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** From the information presented, it appears that iron, and perhaps caloric requirements, may not be met in a fairly large segment of the infant population in Costa Rica. This project is specifically focused on potential responses to this situation. The involvement of Gerber Products

Company is indicative of U.S. interests. Beans have also been touted as a health food in the *American Institute for Cancer Research Newsletter, Winter 1994, issue 42.* A large proportion of the population of developing countries in Africa and Central and South America are dependent on beans as a primary source of protein and a significant source of calories in their diets. Research oriented toward increasing the nutritional quality of the bean and technologies for better utilization have obvious global impact.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** Addressing WID issues has been a major component of this project since its inception and a strong social sciences/anthropology activity is apparent in both the HC and U.S. programs. Information on the role of women in bean production and utilization in Costa Rica is being compiled. Food science/food technology and nutrition programs which are central to this project have historically had a strong WID orientation.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** The site visit by Dr. Kenyon, during which she worked closely with her counterparts, has resulted in delineating some of the constraints involved in bean utilization. Social scientists at the University of Costa Rica have been involved in assessing constraints to both bean utilization and bean production.

3. **Progress in strengthening the social science/WID component:** The social science/WID component is, and will continue to be, a significant part of this project.

E. **Sufficiency of Baseline Data:** Considerable baseline data has been obtained over the past year and efforts are currently underway to establish additional baseline data.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** Informal collaboration is occurring with the Mexico/MSU project. Linkages have also been established with bean programs in Mexico and Tanzania (SUA), with the Rockefeller Foundation, and with agronomists and anthropologists in Costa Rica.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** Problems seem to be minimal to date aside from the usual and often unavoidable delays in fund transfers to the HC for reimbursements.

B. **Adequacy of Current Management, Policies, and Procedures:** Apparently this is not a problem.

C. **Activity Towards Buy-ins and Other Funding:** The possibility of obtaining support for the hard-to-cook defect research from a Mexican bean program is being explored. No other activities were reported.

D. **Responsiveness to 50/50 Split Policy:** The current split is appropriate.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** The project was initiated in September 1992; therefore, the training program has just started.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Collaboration is excellent. This is accomplished via an annual meeting in which progress is reported, plans are formalized, fiscal issues are clarified and budgets are set. Minutes are taken and circulated to

participants. This meeting is also used to alert participants to recent literature that is of importance to the project.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** The University of Costa Rica, MSU and Purdue are all very supportive of this project. Support includes physical facilities, equipment and part of personnel salaries. Gerber Products Company also has contributed expertise and access to equipment.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** The Embassy gave verbal support to the project but the USAID Mission in Costa Rica is being phased out.

1. **Faculty (researcher) recognition for international activities and awards:** Although not reported, the faculty at MSU and Purdue are well recognized for their expertise in bean research. As the project matures, publications and presentations on the research will generate considerable recognition. It is anticipated that the nutritional and social science researchers will make significant contributions to the literature on Central American culture and nutritional status.

2. **Integration of domestic program with CRSP project(s):** Bean research programs have been underway at MSU, Purdue and the University of Costa Rica for some time and project participants have been, and are, involved with these domestic programs. Therefore, there is excellent integration of the bean programs at these institutions.

3. **Internal support for project management and institutional management:** The participating institutions and Gerber Products Company are generating considerable support for this project via human resources, physical facilities and equipment access.

4. **Opportunities for and frequency of student/professor interactions:** Appear to be excellent

F. **Appropriateness of Activities to Goals of Global Plan:** This project is very relevant. Utilization research is vital to increasing the quality and acceptance of bean-based material in food systems throughout the world. Beans are an important source of nutrients and have potential for enhancing the diets of people in developed countries as well as developing countries.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** Balance appears to be very good and the locations of specific components are appropriate.

H. **Other Comments:** The comments of the TC and the BOD indicate that perhaps this project needs to consider regaining more focus on protein digestibility. The Annual Report indicates that a proliferation of research direction may be occurring which may impede progress in the main thrust areas. Carbohydrate digestibility is a real problem in bean utilization particularly as an ingredient in weaning formulations. Iron availability also seems to be limited in infant Costa Rican diets. Although beans contain substantial amounts of iron, much of it is not bioavailable. Vitamin C is known to enhance iron absorption and phytate and tannins inhibit iron bioavailability. Indigestible protein and perhaps carbohydrate components in beans may also influence iron absorption. It would seem that this project should focus on all the above factors important to enhancing bean utilization with less of a priority given to enhancing protein quality by increasing methionine in bean protein. The focus on obtaining suitable baseline data should be continued. Training programs should reflect the project priorities as well as look toward HC institutional development.

IV. **WORK PLAN CHANGES:** Research on the development of weaning food was moved to MSU (from Costa Rica) under the direction of Professor Mark Uebersax. This change was made to use the expertise and equipment available at MSU and because this component of the work plan involves Gerber Products Company, whose corporate resource and development component is located in Fremont, Michigan. Dr. Bonilla's research will focus on the bioavailability of bean nutrients with a focus on iron availability which was shown to be a nutritional constraint (see comments in III.H.).

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** As this project is in its infancy, publications and presentations were not reported.

VI. **OVERALL RATING: 2a--Satisfactory Plus**

A. **General Strengths:** The capability of the personnel involved in the project and strong institutional support are noteworthy.

B. **General Weaknesses:** There is some indication that the research efforts thrusts are multiplying.

C. **Recommendations:** A careful evaluation of the research priorities followed by appropriate dedication of resources would seem to be in order.

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. **Improved cultivars, food products, inoculants, tests, methods and systems:** FY 93 saw the introduction of the new cultivar Anacaona in the DR. This white-seeded bean has resistance to rust, web blight and the BGMV vector, whiteflies. In the U.S., Chase, a new pinto cultivar, was released. In both cases, it is, of course, too early to evaluate the results of these introductions. In the DR, however, the impact of this new white-seeded release will not be as great as a mottled, red bean would have been because white beans are the less popular of the two. On the other hand, white beans are sold in the markets in the DR. Therefore, the particular quality of this bean, as well as the plant on which it grows, may be an asset to its production.

The new research methods developed and in practice in the project during FY 93 included a new method for growing F_1 crosses of Andean x MesoAmerican beans; a rooting method for detached trifoliate leaf stems to test for common blight resistance; and improved methods to regenerate bean plants from callus through organogenesis. The rooting method was the topic of an article entitled "Rooting of Bean Leaves and Use in Germplasm Evaluation for Common Blight Resistance" which appeared in the journal *Euphytica*, and the methods for regeneration were published in the *Journal of the American Society for Horticultural Science* in an article entitled "Shoot Organogenesis in Callus Induced from Pedicel Explants of Common Bean (*Phaseolus vulgaris* L)." The inclusion of these articles in refereed publications provides both positive evaluation of the quality of the methods and dissemination of the information.

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** In FY 93, through its excellent linkages, the project continued contributiNG to various national and international nurseries as well as sharing materials with U.S. and international scientists.

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** It is too soon to determine how the FY 93 research results will address the needs of small-scale farmers and women, but it is clear that recent results (the dissemination of red mottled PC-50, the implementation of the fallow period for bean production in the DR as a cultural protection against the whitefly vector for BGMV, and other cultural practices) have had a positive impact.

2. Impact of research achievements in HC

a. **On production/consumption of beans/cowpeas or new food products:** Although research results from FY 93 have been in effect for an insufficient time to have a clear impact in the HC or anywhere else, results from previous CRSP research are beginning to have a positive impact in the DR. Specifically, as noted in interviews with Ms. Ana Julia Reynosa (Director of Research) and Mr. Francisco Miguel Gonzalez (Vice Minister for Research and Extension of the Ministry of Agriculture), impacts have included maintaining, and in fact increasing, production of beans through initiating a fallow period for control of the whitefly (the vector for BGMV); increases in production and/or decreases in the cost of production through initiation of cost-saving cultural practices, including those that will decrease susceptibility

to diseases; and variety development (including PC-50) to increase yield and quality of the product for sale and availability to the consumer.

b. **On technology needs/constraints facing small-scale farmers:** The introduction of cultural practices to control the BGMV vector and the incidence of rust and other diseases has been clearly evident on the small farms of the DR. Recent workshops for farmers that focus on decreasing costs of production and increasing both the efficiency of production and the production itself have had a positive impact on small-scale farmers.

c. **On the developing and developed world:** This project's research results have had, and will continue to have, a positive impact on production and consumption of beans. This impact will result from the quality of cultivars and cultural methods developed, the scientists' interest in and commitment to farmers' involvement in the research process, and the linkages between the scientists participating in these activities and their counterparts worldwide.

The quality of the cultivars produced is exemplified by the 1993 introduction in Nebraska of the cultivar Chase which has increased yields and rust resistance. Similarly, the introduction of PC-50 in the DR increased production and quality of production.

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** The long-time supporter and highly effective Ing. Freddy Saladin Garcia resigned as HC PI of this project to move to a position with PROFRIJOL, where he can have an even greater impact on bean research in the region. His replacement on the CRSP project with Dr. Eladio Arnaud-Santana signals a new phase in the CRSP program in the DR. Dr. Arnaud-Santana's strong relationship with the U.S. PIs, his clear commitment to the research efforts in the DR as well as his interest in increasing farmer involvement in the research process, his excellent training and personnel and program management skills all promise continued excellent leadership in the DR. The continuing Co-PI research role of Dr. Graciela Godoy is especially encouraging. These two appointments bode well for the future of research in the DR.

2. **Status of training program:** The impact of training on the research priorities of the CRSP is well exemplified by the current status of the research program in the DR. With the CRSP program having trained by far the majority of the personnel involved in the research on beans in the DR (including two Ph.D. and four M.S. graduates), the country is clearly profiting from CRSP-funded training.

The training is continuing both at UPR and UNL. Most training of students from the DR appears to be being conducted at UPR while training at UNL includes students from other developing countries and newly industrialized countries (USAID/W graduate countries). While this allocation of students, probably due to language preferences of the students involved, is an efficient allocation in the short run, in the long run it will be important to continue the process of including English language capability as an important element of training students from the DR. It is clear that Drs. Arnaud-Santana and Godoy are well on their way to becoming important members of the international community of scientists involved in bean research. While this success is a function of their expertise as scientists, it is also facilitated by their English language capabilities.

C. Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan.

1. **U.S.:** Progress is being made in the areas of rust resistance, common blight resistance and multiple disease resistance, all primary research objectives.

In the area of rust resistance, the FY 93 work plan included work on "the mechanism of long straight hairs on dew formation and lower rust intensity, the inheritance of leaf pubescence and its association with adult plant assistance and molecular markers associated with

virulence of rust patterns. . . ." Progress includes greater understanding of the relationship between leaf pubescence and rust resistance--including the limitations of leaf pubescence in rust resistance. Progress is also being made in inheritance studies.

Research plans related to genetic resistance to common blight included use of RAPD molecular markers " . . . to determine associations with the different gene systems controlling the reactions to CB in different plant parts using inbred backcross and F progenies in order to improve selection efficiency." Research in this area appears to be proceeding as planned.

The efforts to develop multiple disease resistance in dry beans including plans for development of lines with " . . . resistance to BGMV and web blight (for use in Puerto Rico and DR) and in Nebraska . . . for resistance to CB, white mold, rust and BCMV." Plans included testing of transgenic plants for resistance to BGMV in Puerto Rico. Progress apparently is being made in developing greater understanding of BGMV and, therefore, of the potential for plant resistance. The release of the disease-resistant pinto bean Chase in Nebraska is a result of such successes.

2. **HC:** Research plans for FY 93 in the HC include work on the epidemiology of WB and CB; breeding efforts aimed at multiple disease resistance and increased yields; evaluation of bean lines with determinate and indeterminate growth patterns; and landrace Pompadour germplasm collection. In considering the level of results from the HC research program, it is important to note the amount of time the HC PI has had to devote to administrative matters during FY 93. Because of USAID Mission antagonism toward the CRSP, as well as the need to change the HC management entity (a decision that appears to have resulted in a new supportive administrative structure for the project), the PI has had to commit an inordinate percentage of his time to administrative efforts. In spite of these constraints, progress has been made during FY 93.

   Research plans related to WB and CB focused on studies of "the distribution, variation, dispersal and survival of the WB pathogen . . . along with the influence of cultural practices and inoculum density on WB disease incidence [and] seed transmission of field grown bean lines. . . ." The greatest increases in understanding the problem appear to have been made in the area of seed transmission of the disease. Levels of infection in seeds was correlated with seed blemishes and discoloration but infection was also found in some seeds without blemishes or discoloration, especially among black beans.

   Results of research in the area of multiple disease resistance were highlighted by the release of the new variety of white bean, Anacaona. This variety shows field resistance to rust, WB and the whitefly vector of BGMV--all research goals for this year. Efforts have also continued with other beans, including red mottled beans which are the preferred type of bean in the DR.

   In evaluations of bean lines of Type I (determinate) and Type II (indeterminate) growth patterns, results of testing of fifteen genotypes of each showed no significant difference in yields. Progress in this area will allow this information to be included in the total data to help the program increase yield and disease resistance.

3. **Length of time project has been engaged in lines of research addressing these objectives:** Overall, the project has made good progress in attaining its objectives over its lifetime and continues to do so.

   a. **Progress in relation to log frame:** This appears to be on target.

   b. **Reasons for delay, if any:** Delay during FY 93 has primarily been a result of administrative changes and challenges requiring an inordinate amount of time from the PIs. The administrative issues related to HC management appear to have been well solved with the management transition to the Fundacion de Desarrollo Agropecuario, Inc. At the same time, the constraints connected with the lack of dependable transportation will be alleviated by the addition of a pick-up truck that is due to go through customs in the DR.

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** The level of research interaction within the HC and internationally between the CRSP researchers and their counterparts is excellent. In the DR, however, because the CRSP project is by far doing the majority of the work on beans, interaction is more in the areas of dissemination of research results and outreach efforts.

   Special mention of interactior among the CRSP projects in the Caribbean and Central America is needed. This interaction has been excellent especially among the DR/UNL, Honduras/UPR, and Caribbean Basin/UWI projects.

   Interaction with the IARCs has been limited due to CIAT's discontinuance of some of its programs on disease resistance (WB in Central America) and their de-emphasis on bean breeding. Certainly, the CRSP efforts can be seen as complementary to CIAT's new focus on environmental and ecological issues.

   It is important to note that research on this project has been widely disseminated through publications and presentations, breeding materials and information have been shared widely, and the research and the researchers are strongly integrated into national and international research systems.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** Contributions to the HC are already apparent with introduction of cultural practices to increase production, and decrease production costs, varietal introductions that will increase production and efforts to insure dissemination of results to the farmers. The quality of ongoing research bodes well for future contributions in the area of resistance to bacterial and rust resistance.

D. **Evidence of Biological/Social Sciences Integration:** Research efforts during FY 93 included a socioeconomic survey of the impact of the project's technology transfer. The U.S. and HC researchers are anxiously awaiting the results of this study which are not yet available.

   1. **Identification of and attention to socioeconomic and WID-related constraints:** Pending the results of the socioeconomic study noted above, researchers in the DR are not merely sitting on their hands waiting for information. Important efforts have included special programs for women farmers including field testing of pre-commercial varieties, field days showing new varieties and cultural practices, and other technology transfer practices. Special evidence of the commitment to continuation of these efforts is seen in the appointment of Ms. Juana Moreno as the person with WID responsibilities for the project in the DR.

   2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** Although research has been conducted, specific inputs are lacking due to the lack of availability of the research results.

   3. **Progress in strengthening the social science/WID component:** The commitment to WID issues in the DR on the part of the PI and other CRSP personnel is clear. Plans are underway for additional efforts to assist women farmers in accessing the best technology and understanding the most advantageous cultural practices.

E. **Sufficiency of Baseline Data:** While it is doubtful that the data collection systems in the DR are any more efficient than those in any other HC, project personnel seem to have accepted, and in fact become enthusiastic about, the importance of baseline data in determining the ultimate success of their research efforts. To that end, they are continuing to gather data on yield losses due to bean diseases, variations in yield of introduced varieties versus previous varieties, and variations of yield due to cultural practices.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups not included in C.4. Above:** This project has always had an excellent record of collaboration with counterparts within the CRSP as well as with other researchers in the U.S. and abroad. This collaboration continues.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** All problems in this area appear to have been solved or are in the process of being solved.

B. **Adequacy of Current Management, Policies, and Procedures:** Appear to be excellent

C. **Activity Towards Buy-ins and Other Funding:** It is doubtful that the "current management" at the USAID Mission will ever be interested in the possibility of a CRSP buy-in. Their priorities are clearly elsewhere.

The project, however, has an excellent record of accessing additional funding for training and other activities at UNL, and there are encouraging possibilities of additional funding for specific program activities from the Fundacion de Desarrollo Agropecuario, Inc. During the EEP evaluation trip, discussion of funding for publications and for an analysis of consumer preferences regarding canned beans versus dried beans took place.

D. **Responsiveness to 50/50 Split Policy:** Excellent

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** As noted in section I.B.2. above, the returns of the project's investment in training to the HC research program are clear.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Collaboration is excellent. Researchers are to be congratulated on their ability to move from professor-student status to an excellent colleague relationship.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** All U.S. and HC institutions involved in the project are making significant and appropriate fiscal and management contributions to the project. Similarly, the researchers at UNL, UPR and in the DR are making significant and appropriate intellectual contributions. It is an excellent balance and the basic CRSP funding is being multiplied considerably by fiscal contributions and research commitment.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** This is non-existent; in fact, it seems that the USAID Mission has actively attempted to undermine the program.

E. **Evidence of Institutionalization in HC and U.S.:** Institutionalization at UNL and UPR are clear, and both institutions continue to support research efforts. Administrative support in the DR is excellent. However, it is not clear that the DR would be able to provide appropriate levels of fiscal support to maintain research activities should CRSP funding cease. Certainly, the success of the training conducted as a part of the project will contribute to the maintenance of bean research expertise in the DR.

1. **Faculty (researcher) recognition for international activities and awards:** This year's excellent results include professional recognition (travel grant and invited presentation), a distinguished achievement award and the U.S. Mayor's End Hunger Award to participating researchers.

2. **Integration of domestic program with CRSP project(s):** Integration at UNL and UPR appears to be excellent.

3. **Internal support for project management and institutional management:** Appears to be excellent at UNL, UPR and Fundacion de Desarrollo Agropecuario, Inc.

4. **Opportunities for and frequency of student/professor interactions:** The student/professor interactions on this project have always been excellent. Currently, the PI and Co-Principal Investigator in the DR are making a transition from students to colleagues. The transition seems to be going well. However, the continuing mention of Drs. Godoy and Arnaud-Santana as students in this part of the Annual Report is a noted holdover.

F. **Appropriateness of Activities to Goals of Global Plan:** Activities fit well and contribute to the Global Plan.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** Excellent balance--parallel progress is being made at UNL, UPR and in the DR. The collaboration is excellent, resulting in a symbiosis among the programs.

H. **Other Comments:** None

IV. **WORK PLAN CHANGES:** No specific work plan changes were noted in the Annual Report. Because of the administrative constraints noted above, however, not all goals were achieved completely.

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** Excellent publications with an excellent balance of input among all the scientists participating on the project.

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

A. **General Strengths**

1. Competence, productivity and collaboration of U.S. and HC scientists

2. Collaboration with other research projects, including within the CRSP, throughout the Caribbean and Central America as well as the U.S.

B. **General Weaknesses**

1. Lack of USAID/Santo Domingo understanding or appreciation of the impact of the project

2. Need for a long-term, stable solution to the research project's future in the DR beyond the life of USAID/W funding

C. **Recommendations:** None

ECUADOR/UNIVERSITY OF MINNESOTA/GRAHAM

Improving the Symbiotic Nitrogen Fixation of Cultivars of Phaseolus vulgaris Under Low-Resource Conditions

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. Improved cultivars, food products, inoculants, tests, methods and systems: The National Bean Program has included seven red-seeded, Cargobello-type lines identified by the project in advanced variety trials. Seed multiplication is underway. INIAP has released one new climbing bean cultivar and plans to release two more in FY 94.

Demonstrations of response to inoculation and zinc application have been initiated.

Local peat sources have proven satisfactory for inoculant preparation and small-scale inoculant production has been initiated.

b. Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use. Multiplication of the 100 best N_2 fixing bean lines has been completed. These are now stored in the Germplasm Bank of the Phytogenetic Resources Department in INIAP.

c. How new research findings address the needs of small-scale farmers and women or other beneficiaries: Availability of a locally produced inoculant and techniques for alleviating zinc deficiency at the smallholder level will surely benefit small-scale farmers, male and female. New varieties will offer a wider choice of superior materials for small-scale farmers.

2. Impact of research achievements in HC

a. On production/consumption of beans/cowpeas or new food products: It is still too early to expect such impacts, given the short time this project has been underway.

b. On technology needs/constraints facing small-scale farmers: The inoculant availability and zinc deficiency alleviation will have early impact on constraints to smallholder production.

c. On the developing and developed world: Availability of better N_2 fixing lines should benefit both developed and developing countries as scientists utilize them for bean improvement.

B. Evaluation of Institutional Development and Training

1. Personnel changes since FY 92: The reorganization of INIAP, following its gaining autonomy in 1992, is evidence of major institutional development in the HC. The planning workshop organized by INIAP and held in August demonstrates increasing institutional leadership.

2. Status of training program: One HC scientist completed a M.S. and has returned to INIAP. Two others are starting graduate programs. Three students completed egresado training using project support and one has joined the Grain Legume Program at INIAP. Three new egresados have begun work in bean pathology and entomology. The training program, although not thoroughly documented, seems to be on track.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan**

1. **U.S.:** Even a most cursory review of information in the project's Annual Report suggests major activity and good progress against most objectives in the FY 93 Work Plan. Work at Minnesota continues to advance knowledge of *Rhizobial* performance as impacted by host/strain interaction and environmental factors. The work also assists in identification of superior genetic materials with multiple disease resistance and N_2 fixing capability for incorporation in the INIAP and other breeding programs. Finally, the U.S. brings a wide perspective to the Ecuador program through involvement on the regional and international scientific front.

2. **HC:** It is evident that the project's staff as well as the total of INIAP is moving aggressively in grain legume research, both in the field and laboratory. The array of solid field experiments and the several laboratory studies in FY 93 addresses most of the objectives of the FY 93 Work Plan. Significant progress is reported in the breeding work and in the identification of soil and disease problems and methods and materials for their alleviation. Finally, the studies on women's roles in bean production and the control of storage pests attest to the willingness and ability of HC personnel to address new and challenging problems.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Most of the lines of work in the project have been underway since its initiation in 1989. Three objectives were more recently added as spin-offs from baseline studies. Progress in relation to the log frame has been excellent in most respects with no inordinate delays. With the return of trained personnel to the HC and the achieving of autonomy by INIAP the pace of activities in the HC clearly accelerated.

   b. **Reasons for delay, if any:** Lack of trained staff has delayed activities in some lines of work in the HC. This is gradually being dealt with in the training program and in the reorganization of INIAP.

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** This is the only CRSP project dealing with N_2 fixation and soil constraints and only one of a few dealing with large-seeded grain types. Given the modest scope of INIAP's total research program, this project has, for the first time, brought to bear a critical mass of research on beans and, in particular, on bean improvement in Ecuador. Likewise, the project has been instrumental in upgrading the technical competence in the bean program through training and equipment procurement.

   Regionally and internationally, the project collaborates closely with CIAT and with country programs in Mexico, Brazil and Egypt to their mutual benefit. The U.S. PI has been, and is increasingly, a focal point in BNF research in the U.S. and internationally.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** The research is already starting to contribute to HC constraints through improved plant materials, and availability of locally produced inoculant and material and techniques to alleviate zinc deficiency. More generally, in the U.S. and in terms of global constraints, the improved knowledge and biological materials to enhance biological nitrogen fixation in beans and other legumes will likely have major impact in both improved productivity and reduced malnutrition.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** The addition of a specific research objective dealing with the role of women in bean production is perhaps the clearest documentation of attention to WID-related issues. The addition of an objective dealing with grain storage and seed conservation through insect control is clearly a socioeconomics response.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** The thesis research of Ms. Char Voight is continuing on the WID issue and further research on seed viability as related to heating has been accomplished.

3. **Progress in strengthening the social science/WID component:** INIAP has expressed interest in strengthening the socioeconomics area and thus plans one graduate traineeship in this area. The fact that the HC PI and one of the U.S. Co-Principal Investigators is female portends continued attention to gender concerns.

E. **Sufficiency of Baseline Data:** This project is exemplary in terms of baseline data availability. The body of data from an earlier project has been substantially enhanced in the areas of soil fertility, *Rhizobium* distribution, and root rot incidence in farmer's fields.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** Most notable interactions with other CRSP projects have been with Cameroon (solar heating), with Tanzania (root rot differentials), with several unspecified projects and CIAT (varieties testing). The U.S. PI maintains close contact with peer groups in the U.S., in Central and South America and elsewhere. These interactions are commendable.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** Based on comments in the Annual Report, there appear to be problems in funding and fund reporting, both in Ecuador and at Minnesota. Though not a problem for the research *per se*, it may warrant further MO oversight. All budgets are tight and may get tighter, but increases in fringes and stipends for students and other cost increases are real. Something has to give somewhere.

B. **Adequacy of Current Management, Policies, and Procedures:** Although a senior agriculture administrator is deeply committed to the project, there remains evidence of problems at the U.S. institution in terms of the fiscal procedures.

C. **Activity Towards Buy-ins and Other Funding:** A buy-in for bean research in Egypt and support from the Parker Sanders Foundation for Sustainable Agriculture are in place. USAID/Quito has helped implement Peace Corp collaboration and support. The Kellogg Foundation has been petitioned for support for erosion and soil management research in Ecuador.

D. **Responsiveness to 50/50 Split Policy:** Direct costs appear to approach the 50/50 target.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** The training activities, both in Ecuador and the U.S., and the research implementation therein constitute more than 50 percent of the project's budget. Thus, the training program is a major force, both in terms of current activities and the research capacity of INIAP in the future. Training is indeed the guts of the program.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** All evidence suggests that the HC/U.S. collaboration has been excellent. Modern communications technology and continuity in contacts has paid-off.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** After a start up phase in which the lion's share of the activity was on the U.S. side, the HC now is a full partner in the program. Ecuador's specific problems are more often carried by INIAP while U.S. and international activities are more in the purview of the U.S. PI.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** Turnover of USAID personnel has resulted in a discontinuity of interaction. Staff are working to re-establish the excellent rapport previously enjoyed.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** The HC PI, Ing. Consuelo Estevez, serves as a member of the TC and in 1993 was nominated for an Outstanding Latin American Scientist award. The U.S. PI received an award from the Parker Sanders Foundation for Sustainable Agriculture. He along with Drs. Michael Sadowsky and C. P. Vance organized the 14th North American Symbiotic Nitrogen Fixation Conference, held in July 1993. Twenty-three countries were represented.

2. **Integration of domestic program with CRSP project(s):** The project has been very successful in bringing together faculty and students from several departments and disciplines.

3. **Internal support for project management and institutional management:** The Vice President for Agriculture has been highly supportive as have been the department heads and faculty of several departments.

4. **Opportunities for and frequency of student/professor interactions:** Opportunities have been excellent and, in most cases, on a daily basis. Students are clearly "team members."

F. **Appropriateness of Activities to Goals of Global Plan:** This reviewer could not identify a single activity that did not address directly, or indirectly, the goals of the Global Plan.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** The balance, both in terms of magnitude and technical objectives, between domestic and overseas activities seems quite appropriate.

H. **Other Comments:** None

IV. **WORK PLAN CHANGES:** I see no evidence of significant changes in the FY 93 work plan. The evolution from FY 90 to FY 93 with addition of three new objectives is commendable.

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** There appears to be somewhat of a hiatus in publishing activities in FY 93 (two refereed articles published and three submitted or in press). The Ecuadoran staff, on the other hand, was very active in terms of presentations, some of which will be published as either refereed or non-refereed articles.

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

A. **General Strengths**

1. An outstanding U.S. PI and team

2. A rapidly maturing HC team with strong leadership from an outstanding HC PI

3. Strong HC/U.S. collaboration

B. **General Weaknesses:** Fiscal management--timeliness

C. **Recommendations:** MO should work to resolve fiscal problems

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. **New research results from FY 93 disseminated and currently in use in HC and U.S.**

   a. **Improved cultivars, food products, inoculants, tests, methods and systems:** The release of the new cowpea variety Bettergro Blackeye was noted in the Annual Report. It is assumed that the development of this variety was underway prior to the inception of the CRSP project, so it is probably inaccurate to credit the CRSP with this advance. However, the introduction speaks to the integration of ongoing research with the new CRSP priorities and the value of the CRSP to the domestic program.

   Progress to be credited to the CRSP has primarily been in gaining better understanding of the pests that attack cowpeas as well as in the development of data collection and other research techniques. This has been excellent, especially for such a new project.

   b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** Again, the two cultivars that are being tested as part of the Regional Southernpea Cooperative Trials are testament to the integration of the CRSP research with ongoing research activities and the resultant leveraging of resources and results. Of additional and particular interest to the CRSP is the collection of cowpea landraces in South Carolina and Ghana. This focus of the research is moving forward.

   c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** The PIs' understanding of the potential impact of the research results of this project on small-scale farmers and women is excellent and represents what appears to be an excellent commitment to insure positive impacts upon those with the greatest need.

2. **Impact of research achievements in HC**

   a. **On production/consumption of beans/cowpeas or new food products:** Too early for results in this area

   b. **On technology needs/constraints facing small-scale farmers:** Again, the PIs appear to have an excellent grasp of the challenges facing small-scale farmers and the potential positive impact of research results on this group.

   c. **On the developing and developed world:** Too early for results in this area

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** The team is to be complimented for its swift action to replace Dr. Lucy Pearson, Human Ecologist, with Dr. Brenda Vander Mey, Sociologist, and Dr. Graydon Kingsland, Plant Pathologist, with Dr. Tony Keinath.

2. **Status of training program:** The training described in the Annual Report appears to be appropriate. It is important, however, to have an overall, specific training plan for this project. If such a plan exists, the EEP is not aware of it.

1. **U.S.:** Excellent, steady progress appears to be being made on all U.S. objectives. The combination of objectives ranging from ethnographic studies of cowpea production in South Carolina to identification and evaluation of pest-resistant germplasm to determination of crop losses and action thresholds fit together to result in a systematic understanding of the production of cowpeas. Since considerable emphasis is being placed in all these areas and progress is also being made, it is predictable that the project will be successful and will avoid the pitfalls of an extremely narrow focus that excludes factors of production that could prove to be the downfall of successful application of results.

2. **HC:** Excellent progress is being made on HC objectives, except in the case of the evaluation of future pilot IPM programs--an activity that is planned for later in the life of the project. The amount of information gained from work in this first full year of funding for the project is especially impressive in the HC where progress is being made toward greater understanding of production practices, identification and evaluation of germplasm, determination of crop losses and action thresholds, and development of crop surveillance methods.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Progress is on schedule with the log frame.

   b. **Reasons for delay, if any:** Not applicable

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** The PIs appear to be very successful in developing the U.S. and HC project research efforts to be complementary to ongoing research activities in both places. They also are actively involved in work toward integrating CRSP research with other U.S. and HC research. This success relates to all areas of research including that in the social sciences.

   Especially impressive is the integration of the planning process as noted in the Annual Report, "Annual planning sessions, involving personnel from the Crops Research Institute, the U.S., IITA, extension . . . , non-governmental organizations and selected farmers help to insure that work being carried out in both countries is complementary and relevant."

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** Likely contributions will increase productivity and decrease costs, certainly a plus locally or globally.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** This is one of the highlights of the project. The attention of the researchers to a variety of issues, biological and socioeconomic, in the planning and implementation of the project are excellent. The planning of this project allows for the development of a model of social and biological science integration. It will be extremely important to insure that the social science research is specifically focused on the issues and geographic areas that are directly relevant to cowpea production in Ghana. While social science research beyond these parameters is interesting, and perhaps lacking in Ghana, the priorities must be specifically supportive of the biological focus of the project. Perhaps the social science researchers on the projects could access funds from outside the CRSP for their broader interests.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** The research efforts in the social science areas are most impressive, and it appears that all the researchers are looking forward to the results in order to gain a greater understanding of the impact of social science issues on their own efforts.

3. **Progress in strengthening the social science/WID component:** This question is more appropriate to some of the other projects where the social sciences have been relegated to second-class citizenship at best. This project appears to have been systematically planned to include social science elements. The key to whether these plans have been successful will be whether future reports include social science research results and, more importantly, the integration of biological and social science efforts.

E. **Sufficiency of Baseline Data:** The collection of baseline data is still ongoing and appears to be an integral part of the research program.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups not included in C.4. Above:** The project seems to be moving forward in collaboration with the Ghana/UGA project and with the Cameroon/Purdue project. This is particularly appropriate because of content focus as well as geographic focus and the geographic locations of the three institutions.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** There is still a communication problem between the U.S. and the HC. Additionally, it seems that HC counterparts have not yet fully adopted an understanding of the need to deliver receipts for expenditures in a timely manner. There also is some concern regarding the distribution of funds in the HC. The Annual Report notes that they are optimistic that these problems can be solved.

These are the kind of fiscal management problems that can quickly overwhelm what would otherwise be an excellent and productive research project. The EEP recommends that the solution of these problems be a top priority.

B. **Adequacy of Current Management, Policies, and Procedures:** Again, there appear to be serious problems in the HC, and the Annual Report notes that efforts are being made to solve these problems. As noted above, the EEP recommends that this be a top priority.

C. **Activity Towards Buy-ins and Other Funding:** Efforts along these lines are, appropriately, planned for a little later in the life of the project--after the glitches of start-up have been handled.

D. **Responsiveness to 50/50 Split Policy:** This is acceptable.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** None to date

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** This appears to be excellent and PIs have made special plans to insure collegial collaboration such as plans for joint publications and presentations for the upcoming World Cowpea Conference.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:**

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** USAID Mission involvement appears to be acceptable although minimal.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** None

2. **Integration of domestic program with CRSP project(s):** This appears to be excellent both in the U.S. and the HC and probably accounts for the level of success attained in such a short time period by the project.

3. **Internal support for project management and institutional management:** The Annual Report addresses only the issue of fiscal support here. There is, therefore, not sufficient information available to the EEP to determine other types of support being offered by the institution.

4. **Opportunities for and frequency of student/professor interactions:** Too early to evaluate

F. **Appropriateness of Activities to Goals of Global Plan:** This project is particularly appropriate to the goals of the Global Plan, and the potential results could have a very positive impact on alleviating important constraints identified in that plan.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** This appears to be excellent at this time.

H. **Other Comments:** None

IV. **WORK PLAN CHANGES:** None

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** The listing of publications and presentations include well-respected journals. It is assumed, however, that these articles are the result of research that was ongoing prior to the beginning of the CRSP.

VI. **OVERALL RATING: 2a--Satisfactory Plus**

A. **General Strengths**

1. The quality and commitment of the U.S. and HC research teams

2. The planned integration of social science elements into the project

3. The complementarity of CRSP research efforts with ongoing research activities in the U.S. and HC

4. Collaboration with other CRSP projects

B. **General Weaknesses**

1. Lack of a training plan that addresses HC needs and suggests a timeline for short- and long-term training

2. Communications constraints between the U.S. and HC and the need to solve the fiscal management problems that seem to exist in the HC

C. **Recommendations:** This is the beginning of an excellent project. The EEP recommends the continuation of ongoing efforts with a special focus on ensuring that the social science elements of the project be specifically focused on the issues and geographic areas that are directly relevant to the biological research components of the project.

GHANA/UNIVERSITY OF GEORGIA/PHILLIPS

Research Strategies to Increase the Utilization of Cowpea

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. **New research results from FY 93 disseminated and currently in use in HC and U.S.**

   a. **Improved cultivars, food products, inoculants, tests, methods and systems:** The Annual Report includes mention of the testing of akara prepared from cowpea flour in restaurants in California and Texas. However, it is unclear whether this is use of FY 93 research results or the culmination of earlier research.

   b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** The adaptation of technology and information gained from cowpea research was applied to problem solving to assist Southern Frozen Foods in Montezuma, Georgia. This application of information from CRSP efforts to assist the private sector in the U.S. bodes well for increasing U.S. understanding of potential returns of international research to U.S. interests.

   c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** It is unclear that either of the research findings noted above will have any particular impact on the needs of small-scale farmers or women. However, the potential results of this research project, if successful, would certainly have a positive impact on these groups both as producers and consumers.

2. **Impact of research achievements in HC**

   a. **On production/consumption of beans/cowpeas or new food products:** It is too early in the life of the project to have an impact.

   b. **On technology needs/constraints facing small-scale farmers:** Not applicable

   c. **On the developing and developed world:** The Ghana project is still too new.

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** The research team in Ghana seems to be growing with a dual focus on food science and nutrition.

2. **Status of training program:** Does the project not plan to provide U.S. training for any counterparts from Ghana? With $14,063 per year of CRSP funds spent on students from Taiwan and China, the EEP wonders if the training needs of the HC program have been addressed in the training plan or the training program.

C. Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan.

1. **U.S.:** U.S. research efforts show considerable success related to FY 93 plans. This includes both those objectives which are holdovers from the previous project and those which are being undertaken beginning with the new project. The similarities between the two research projects increase the expectations of this particular project.

2. **HC:** Excellent progress is being made on HC objectives. Significant results seem to be emerging on all objectives.

3. **Length of time project has been engaged in lines of research addressing these objectives:** While the project has been ongoing for two years, much of the research builds upon previous CRSP activities and ongoing research.

   a. **Progress in relation to log frame:** All objectives seem to be moving forward as planned.

   b. **Reasons for delay, if any:** None were noted.

4. **Relationships of project research to other research being conducted in HC, IARCs and elsewhere:** Research plans and activities appear to be complementary to other research being conducted at the Food Research Institute in Accra.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** The research is likely to contribute to the amelioration of the global constraints related to post-harvest and economics issues. Additionally, the focus on food science and nutrition allows for a more comprehensive CRSP-wide focus on cowpea production and consumption.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** Socioeconomic and WID-related issues are well integrated into the program.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** The project has begun, with the implementation of social science research, to collect baseline data related to cowpea production/consumption in Ghana. It will be important to insure that the information gained from this is incorporated into other research efforts throughout the project and, as the project continues, that other social science issues are addressed as needed.

3. **Progress in strengthening the social science/WID component:** Appears to be excellent

E. **Sufficiency of Baseline Data:** Baseline data is being collected.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups not included in C.4. Above:** Excellent collaboration appears to be developing between this project and the Ghana/Clemson project. This bodes well for the overall success of the CRSP in Ghana as well as for the ability of the two projects to leverage funds and resources. Important linkages have also been made with the Cameroon/Purdue, Senegal/UCR and Costa Rica/MSU projects.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** Former problems appear to have been solved.

B. **Adequacy of Current Management, Policies, and Procedures:** Appear to be adequate

C. **Activity Towards Buy-ins and Other Funding:** While there has been no progress made toward a USAID/Accra Mission buy-in, there is a possibility of a buy-in for the Cameroon/Purdue project in which the UGA team would participate. Additionally, some personnel funding is being provided through the United Nations University Program, and the Southern Frozen Foods Company may provide additional research funding at UGA.

D. **Responsiveness to 50/50 Split Policy:** Excellent

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** The training is seen as integral to the research effort and past reviews of work with the UGA team and have made it clear that graduate students are given excellent opportunities to take a strong research role.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Excellent

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** It is clear that both the U.S. and the HC institutions are active in their support of the project both through fiscal and in-kind contributions and through administrative support.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** Cooperation of the USAID Mission appears to be good.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** None

2. **Integration of domestic program with CRSP project(s):** This appears to be satisfactory both in the U.S. and HC.

3. **Internal support for project management and institutional management:** Appears to be excellent at both the U.S. and HC institution. Worth special mention is the recognition of the project in the 1993 Vice-Chancellor's Report at the University of Ghana.

4. **Opportunities for and frequency of student/professor interactions:** The scientists at UGA have an excellent track record of providing the highest quality of graduate training and research mentoring for students.

F. **Appropriateness of Activities to Goals of Global Plan:** Activities are most appropriate and, because of increasing collaboration with the other cowpea projects in the CRSP, can be part of a comprehensive approach to the Global Plan.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** Appears to be an excellent balance

H. **Other Comments:** None

IV. **WORK PLAN CHANGES:** None

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** Research results have been published in respected scientific journals and include those authored by both U.S. and HC scientists, although the latter is far more predominant.

VI. **OVERALL RATING:** 2a--Satisfactory Plus

A. **General Strengths**

1. Excellent, committed U.S. and HC research teams

2. Integration of social science elements into the project

3. Collaboration with other CRSP projects

4. U.S. and HC institutional support for the project

B. **General Weaknesses:** Lack of a training plan that addresses HC needs and suggests a timeline for short- and long-term training

C. **Recommendations:** None

HONDURAS/UNIVERSITY OF PUERTO RICO/BEAVER

Strategies for Breeding Beans with Enhanced Disease Resistance and Greater Tolerance to Heat and Drought Stress

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. Improved cultivars, food products, inoculants, tests, methods and systems: A new BGMV resistant line, Don Silvio, was released in 1993. In order to expedite the release, over 2,000 pounds of Don Silvio seed was produced as foundation seed for the National Bean Program and 4,000 pounds were sold directly to farmers as certified seed. Overall, EAP has produced and sold about 30,000 pounds of Dorado and Don Silvio seed. Some of these seeds were used in an artisan seed production project of the National Bean Program and PROFRIJOL. Total certified seed produced by EAP is expected to be near 80,000 pounds during this growing season. A major tropical storm (Gert) has affected national bean yields, which is expected to decrease available seeds for planting. Continued wet weather has resulted in overall low seed production and a general shortage of beans for consumption and planting in the region.

Two other lines (EAP10-88 and EAP12-88) which were selected for anthracnose and common blight resistance are being used by farmers at higher altitudes where BGMV is not a problem. EAP extension has been instrumental in this seed distribution. One of these lines is being considered for release in 1994.

A number of techniques and methods have been developed. Methodology for embryo rescue has been established at EAP to assist in the development of interspecific crosses between common and tepary beans. Techniques for screening BGMV and web blight resistance in a greenhouse setting have been developed at UPR. A misting system has been installed in outdoor screening plots for rust resistance at the EAP.

Management practices developed or recommended for control of BGMV, common blight and anthracnose are being used by farmers for on-farm trials in several areas in East Central Honduras.

b. Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use: New bean landraces (170) have been added to the germplasm collection and evaluated since last year and bring the three-year total to 495. Germplasm from this collection was sent to CIAT, the University of Honduras and the USDA/ARS at Mayaguez, Puerto Rico. The total germplasm collection includes over 1,000 small red bean accessions from Honduras and 2,000 accessions of common and tepary beans. A portion of the collection has been screened for resistance to BGMV and CB as well as their agronomic traits.

c. How new research findings address the needs of small-scale farmers and women or other beneficiaries: As noted previously, bean production in Honduras is primarily a function of small-scale farming. The development of multiple resistances in bean types that are grown and utilized by small-scale farmers will be a benefit to these growers. In addition, this project has supplied seeds to these farmers and small-scale producers. This should result in aiding economic development in rural areas.

2. **Impact of research achievements in HC**

   a. **On production/consumption of beans/cowpeas or new food products:** Government estimates of overall bean production in Honduras do not reveal major changes in bean production over the past decade and owing to the vagaries of weather the 1993-94 production may actually decline from previous production figures. The impact of the El Dorado release was blunted by drought because of the resultant lessening of BGMV disease in beans and overall poor production. However, 15-20 percent yield increases have been reported in areas where El Dorado is popular. The general weather-related decline in bean production also will lower seed availability for planting.

   On-farm trials have resulted in increased usage of CB- and anthracnose-resistant EAP10-88 and EAP12-88 by farmers growing beans at higher altitudes where BGMV is not present.

   Cooperation with the artisan program of PROFRIJOL and the National Bean Program is also resulting in usage of storage of beans in silos.

   Packaged refried beans are being produced in Tegucigalpa, indicating the potential for higher bean demand if this product is accepted by consumers in the region.

   b. **On technology needs/constraints facing small-scale farmers:** The development of small red varieties resistant to problems associated with bean production by small-scale farmers has resulted in the release of BGMV-resistant El Dorado and Don Silvio for use by small-scale farmers. There is evidence of increased production in areas when these releases are extensively being used. Multiple-resistant lines (EAP10-88 and EAP12-88) are doing well when grown at higher altitudes and one of these is planned to be released in 1994.

   c. **On the developing and developed world:** The development of multiple resistances and heat and drought tolerances of small red beans is of major importance to the region. The attempt to use interspecific crosses between tepary and common bean has potential for developing beans with high drought and heat tolerance as well as disease resistances. The basic information obtained in this research has wide application potential for other legumes in developed and developing countries.

B. **Evaluation of Institutional Development and Training**

1. **Personnel changes since FY 92:** In the HC, Dr. Jairo Castaño and a fourth-year EAP student (Mr. Edgardo Varela) have begun collaborating with the project on rust epidemiology. Mr. Varela completed his M.S. degree and has returned to the project in Honduras. Two researchers have initiated collaboration with the project regarding interspecific crosses, Dr. Wilfredo Colon and Dr. Juan Alan. A fourth-year EAP student will be working with Dr. Alan on embryo rescue. No other significant change or new collaborations were reported.

2. **Status of training program:** The training program appears to be well thought-out and extensive. A strategic plan was submitted as a supplement to the Annual Report with the goal to "complement the EAP's plans to develop and deliver technology that will promote agricultural development and improve the well being of rural families in the Americas." Two trainees completed their M.S. degree in 1992. One (Mr. Varela) has returned to EAP to work on the project. Unfortunately, Mr. Oswaldo Díaz was not able to negotiate a position with the Ministry of Natural Resources National Bean Program. Mr. Roberto Young is continuing to pursue a Ph.D. at MSU and Mr. Alfredo Robleto has begun M.S. studies at UMN and will work on interspecific bean hybrids. Two Honduran graduate students have just started M.S. degree programs at the University of Puerto Rico and have expressed interest in research on bean production.

   Three, fourth-year EAP students have conducted thesis research, one of which dealt with bean technology transfer to small-scale farmers. One of the students is being considered for graduate studies at the University of Florida for research on BGMV resistance. Mr. David

Erazo is continuing his M.S. degree studies at the University of Honduras in Sociology, specifically studying technology transfer systems for small-scale farmers. Recently, two females have joined the project research team at EAP and one is being considered for graduate training study in 1995.

Mr. Mohammed Meskine is doing Ph.D. research on bean rust at UNL and two students from the DR and Colombia are pursuing M.S. degrees in Crop Protection at UPR on rust and WB.

C. Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan

1. **U.S.:** Progress in relation to the FY 93 work plan has continued to be excellent. At UPR, greenhouse evaluation has indicated that BGMV resistance by A429 is conferred by a single recessive gene and that backcrossing should be effective. Molecular marking is a possible means of screening for resistant genotypes. Work in cooperation with USDA is utilizing RAPD marker for evaluation of inbred lines. The BGMV resistance of DOR 303 appears that one or two genes are involved. Pyramiding of genes of these two lines is being investigated.

   Resistance to WB using a greenhouse inoculation technique was identified in several genotypes and they have been sent to the DR for field tests. Research is underway to combine genes conferring WB resistances and identify lines with high degrees of resistance.

   Work has continued on the development of small red beans with multiple resistances including WB, CB, and BGMV. Resistance to rust and ashy stem blight is also being addressed. Tolerance to heat is important for beans grown in the lower coastal areas, and several lines have shown good performances in Puerto Rico. Some of these lines have BGMV, CB, and ashy stem blight resistance. The BNF capability of beans grown at higher temperatures was also investigated.

   Rust research at the UNL has used polymerase chain reaction polymorphic DNA to study genetic diversity of rust and assess virulence. An international workshop on rust is scheduled for the fall of 1994 to update the results of rust research.

2. **HC:** In concert with the research on developing cultivars with multiple disease resistances, screening of germplasm has been ongoing in Honduras. In these efforts, four lines were selected for their resistance to at least three of the four diseases--anthracnose, CB, WB and BGMV. On-farm trials were then conducted in more than twenty different locations in Honduras. The two lines EAP10-88 and EAP12-88 were found to have greater yields and good disease resistance when grown at higher altitudes. One of the lines will be selected for possible release in 1994.

   The screening of the germplasm collection is being done by EAP including accessions from PROFRIJOL and CIAT. The National Bean Program is also evaluating promising lines. On-farm trials were also used in evaluating bean performance.

   Seed lines from interspecific crosses supplied to EAP have been increased in the EAP greenhouse and will be evaluated for CB resistance and drought tolerance.

   The EAP has established a system for selecting rust resistance lines using controlled misting, and screening is underway on genotypes supplied by Dr. Jim Steadman (UNL) and Dr. Rennie Stavely (USDA).

   Overall progress in achieving work plan objectives has been highly satisfactory.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Progress in relation to the log frame has been highly satisfactory. A line has been released (Don Silvio) and another is planned for 1994.

Development and screening of disease-resistant lines continues at a rapid pace. Interspecific crossing research has progressed using embryo rescue techniques.

b. **Reasons for delay, if any:** There were no delays.

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** One of the strengths of this project has been the extensive networking with other investigators, institutions, international organizations and various government agencies that have common areas of interest. Although the National Bean Program in Honduras is under budgetary pressure, strong collaboration exists. Common interests in disease resistance and heat and drought tolerance are apparent in PROFRIJOL, USDA, other Central American researchers and, although limited, CIAT.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** This project has made significant contributions to bean production in Honduras. Although not evident from bean production data available, release of two lines and the development of other lines will positively impact small-scale farmers and eventually consumers. The information obtained by research on multiple disease resistance, interspecific crosses, heat and drought tolerance has global implications. This research, in conjunction with utilization research, will contribute to the overall enhancement of the nutritional quality of diets in both developing and developed countries.

   During the site visit, the reviewer was informed that a major outbreak of BGMV had occurred in the snap bean growing areas of south Florida. This information was relayed to project personnel by Florida seed growers, University of Florida extensionists and Florida-stationed USDA researchers. Because of the work on BGMV resistance in this project and the networking that this project has developed, it is anticipated by project personnel that BGMV resistant germplasm will be made available to snap bean seed growers within the next twelve months.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** Mr. David Erazo is continuing his M.S. research in Sociology at the University of Honduras on technology transfer systems for small-scale farmers. On-field trials are also a vehicle for providing feedback from farmers, extensionists, bean buyers and consumers regarding bean acceptability. Dr. Rick Bernsten has been involved in planning impact studies and his graduate student from Honduras (Mr. Pedro Martel) will be evaluating a subsector of bean economics in Honduras.

   Although involvement of females in this project has been limited, two women have recently joined the project team as researchers at the EAP. One is being considered as a candidate for an advanced degree beginning in 1995.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** Dr. Bernsten is advising a Honduran Ph.D. candidate who will be evaluating constraints to increased productivity of beans in Honduras and established baseline data for impact assessment.

3. **Progress in strengthening the social science/WID component:** As noted in D.1., progress is being made. Hopefully at least one female will be in the training program for an advanced degree.

E. **Sufficiency of Baseline Data:** There appears to be reasonably good baseline data via Honduran figures on bean productivity. Additional baseline information accrual is planned via the economics assessment as noted in D.2.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** There is excellent linkage and networking with the other bean projects.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** No. problems are evident. A vehicle has been purchased, alleviating the difficulties in coordinating on-farm testing.

B. **Adequacy of Current Management, Policies, and Procedures:** They appear adequate in all participating entities.

C. **Activity Towards Buy-ins and Other Funding:** At the present time, the USAID Mission does not list agriculture as a priority; however, they have indicated data showing project impact would be very useful to them.

This project has utilized considerable leveraging via cooperation with PROFRIJOL, PRIAG, CIAT, USDA, UMN (interspecific crossing) and other bean/cowpea CRSP projects particularly DR/UNL, Caribbean Basin/UWI, Mexico/MSU and Tanzania/WSU/. In addition, EAP researchers have received funding from Program in Science Technology Cooperation/USAID and IBPGR/FAO.

D. **Responsiveness to 50/50 Split Policy:** This project addresses the split.

III.. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** As noted previously, the training program has been a major factor in the success of this project. The anticipated addition of females in the training component will further enhance its success.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** This project has and continues to have an outstanding record of collaboration, cooperation and networking.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** The collaboration of individuals and institutions has been a major factor in its success in attaining its objectives.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** The Mission has interest in the project but as noted in II.C. agriculture is not a Mission priority at this time.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** This project has an excellent record of institutionalization. The researchers and collaborators have established reputations and are well recognized in bean research.

2. **Integration of domestic program with CRSP project(s):** There has been a strong integration of this project with both Puerto Rico and EAP programs and, although under budgetary stress, the Honduran National Bean Program.

3. **Internal support for project management and institutional management:** Both UPR and EAP have had strong internal support for this project's management.

4. **Opportunities for and frequency of student/professor interactions:** Opportunities for student/professor interactions have been excellent.

F. **Appropriateness of Activities to Goals of Global Plan:** This project is a significant component of the Global Plan.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** Excellent balance

H. **Other Comments:** This project continues to have outstanding success.

IV. **WORK PLAN CHANGES:** No significant changes occurred from the FY 93 work plan. However, wet weather in Honduras has resulted in rust problems, and there are plans to intensify rust research in Honduras. A post-doctoral researcher from UNL is currently collecting rust specimens in Honduras.

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93**

Refereed Publications: 5
Non-Refereed Publications: 4
Presentations: 7
Abstracts: 3
M.S. Theses: 2
Four-year EAP student theses: 2

A higher output of refereed articles is expected in FY 94.

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

A. **General Strengths:** Strengths include exceptional progress in achieving objectives, maintaining focus, collaboration/networking and the strong bean program at EAP.

B. **General Weaknesses:** None are apparent. However, downsizing of the National Bean Program and lessening of CIAT involvement in bean research is unfortunate.

C. **Recommendations:** The project should continue to give attention to WID issues and keep up the good work.

MALAWI/UNIVERSITY OF CALIFORNIA-DAVIS/GEPTS

Bean Improvement, Genetic Diversity and Host/Pathogen Co-Adaptation

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. **New research results from FY 93 disseminated and currently in use in HC and U.S.**

   a. **Improved cultivars, food products, inoculants, tests, methods and systems:** Three improved cultivars were released in 1993 and are in the process of seed multiplication for general distribution. DNA probes and a dot blot assay for testing and differentiation of bean common and bean yellow mosaic potyviruses in bean leaves were developed. RAPD primers that distinguished between MesoAmerican and Andean strains of the angular leafspot pathogen were identified. These will be very useful in screening bean cultivars.

   b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** One thousand thirty-five accessions were grown out and evaluated for a range of descriptors. The data have been shared with researchers in most southern African countries. Fifty tons of certified seed were distributed in Mzuzu Agricultural Development District and neighboring areas.

   c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** Better yielding and disease-resistant varieties benefit rural and urban consumers through increased availability of beans, Malawi's chief plant protein source. Likewise, the producers, mostly small-scale and usually female, benefit through increased productivity and reduced seed costs.

2. **Impact of research achievements in HC**

   a. **On production/consumption of beans/cowpeas or new food products:** New variety releases are too new to impact production/consumption.

   b. **On technology needs/constraints facing small-scale farmers:** The new varieties will improve productivity and stabilize yields where BCMV, bean yellow mosaic virus and/or ALS now impact production.

   c. **On the developing and developed world:** The gene pools which have been collected and evaluated assist bean breeders in both developing and developed countries as they incorporate broad-based resistance, especially to ALS. Methodologies developed in the project are useful to researchers in other bean programs.

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** The project's sociologist at Bunda College left the project in 1992 and was replaced by Dr. Stanley Khaila, also a sociologist. The project agronomist, Dr. Henry Mloza-Banda, completed his Ph.D. at Iowa State University and returned to Bunda College. His interests are in germplasm, seed production and on-farm research.

2. **Status of training program:** Two Malawians are in training, one for an M.S. in agronomy and one for a Ph.D. in agricultural economics using CRSP funds. A Colombian and a U.S. person are supported by CRSP funds and doing CRSP research at UCD, one in plant pathology and one in genetics.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan.**

1. **U.S.:** Excellent progress was made in characterizing ALS strains and their interaction with site-of-origin gene pools of beans, i.e., MesoAmerican or Andean. These findings provide important guidance to breeders, both in Malawi and around the world.

   Detection and identification methodology work on BCMV and bean yellow mosaic virus has progressed well, but that on ALS has been less successful.

2. **HC:** The several field studies on both experimental and farmers' fields proved quite fruitful. The social science research was adversely impacted by the departure of the sociologist and by the limitations in time available to his replacement. Nonetheless, work has progressed in terms of farmer-managed trials and in seed production by artisans. Hopefully, the proposal to Rockefeller Foundation will bring needed support to these activities.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Both the biological and social science components of the project were redirected in the FY 92-97 extension so much of the work is relatively new. Generally, the project is making good progress and is on schedule.

   b. **Reasons for delay, if any:** Some slippage in the social science research was mentioned earlier and is due to personnel changes and to time and funding limitations.

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** The project has shared breeding responsibilities with CIAT, but, beginning in April 1994, the Agricultural Research Department will assign a breeder to the Chitedze Station. This person will be the Bean Program Leader, and the working relationship with the Bunda College team is yet to be clarified. The project carries lead responsibility for ALS research in the CRSP and collaborates closely with the Tanzania/WSU and Mexico/MSU projects in BCMV work.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** Improved cultivars will benefit the HC and other southern African countries. Technologies for disease identification and understanding will benefit worldwide and contribute to alleviation of global constraints.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** The project has identified and addressed social, cultural and gender issues in bean production and consumption. Current work is directed toward seed multiplication and dissemination in cooperation with Action AID, a British non-governmental organization.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** Surveys, interviews and discussions with farmers have yielded information that guided selection of bean varieties for improvement. The seed production and handling research has been guided by social science literature and sensitivity to gender issues.

3. **Progress in strengthening the social science/WID component:** An agricultural economist is in training at MSU to upgrade the Bunda College capacity and a food technologist at Bunda has taken up research on cooking time.

E. **Sufficiency of Baseline Data:** The baseline data is as good as in any of the CRSP bean projects.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** The project has developed linkages with non-government organizations in Malawi and Zimbabwe that are involved in germplasm collection and multiplication. These will be very helpful in carrying forward the seed multiplication efforts.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** None are evident except the need to "do more with less."

B. **Adequacy of Current Management, Policies, and Procedures:** The re-alignment of Malawian bean research in April 1994 will require a re-examination of management and reporting procedures in Malawi. This should not, however, alter Bunda/UCD relations within the CRSP-funded work. It is unfortunate that reporting requirements are ill-timed for research in the southern hemisphere and that the EEP site review in January 1994 was earlier than optimum to view field work.

C. **Activity Towards Buy-ins and Other Funding:** A small grant was received fr[illegible], and a larger program grant proposal was submitted, to the Rockefeller Foundation in FY 93.

D. **Responsiveness to 50/50 Split Policy:** Seems to be in conformance

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** A cadre of well-trained scientists working on beans in Malawi is the best documentation of project training impact. A plant breeder and an economist now in training will soon join the team.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** There appears to be full collaboration and excellent cooperation among the U.S. and HC researchers in planning, budgeting, reporting and publishing.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** There seems to be a good division of labor and responsibility among the scientists and the institutions involved. As the Malawi team matures, it would be expected that more of the highly technical work would be picked up there.

Support of USDA and the California Dry Bean Advisory Board and Crop Improvement Association is gratefully acknowledged.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** USAID/Lilongwe is focussed on policy issues and thus there is little opportunity for other than moral support. Discussions with the Agricultural Officer indicated in-depth knowledge and appreciation of the Bunda College bean research.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** None apparent other than peer recognition

2. **Integration of domestic program with CRSP project(s):** Both the BCMV testing and the genetic manipulation work is tightly integrated with California work.

3. **Internal support for project management and institutional management:** The Bunda College Principal and the Chief Agricultural Research Officer at the Ministry of Agriculture in Malawi have been very supportive as have been administrators at UCD.

4. **Opportunities for and frequency of student/professor interactions:** Student faculty interaction seems to be quite adequate.

F. **Appropriateness of Activities to Goals of Global Plan:** Given the importance of the diseases under investigation and the need for stable seed production enterprises in developing countries, the research seems highly relevant to the Global Plan.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** As noted earlier, the division of responsibility seems appropriate.

H. **Other Comments:** The upcoming split in bean improvement responsibilities in Malawi is of concern and should be closely monitored by the MO. This reviewer thinks the new arrangement can work but is dependent on the early resolution of working relationships among the partners.

IV. **WORK PLAN CHANGES:** Given time and resource limits in the social science area, the decision to limit farmer participatory research efforts seems appropriate. This area should not be foreclosed but re-evaluated based on experience in Tanzania.

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** The level of publication and presentation activity seems adequate. Especially commendable is the participation in regional, national and international meetings by the U.S. principals. The lack of HC participation is questioned.

VI. **OVERALL RATING: 2a--Satisfactory Plus**

A. **General Strengths:** Well-trained and effective teams in both the HC and the U.S.

B. **General Weaknesses:** None noted

C. **Recommendations:** Early clarification of policies, procedures and responsibilities within the restructured bean program is an urgent need.

MEXICO/MICHIGAN STATE UNIVERSITY/KELLY

Breeding Beans for Yield and Adaptation Under Drought

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. **Improved cultivars, food products, inoculants, tests, methods and systems:** Approximately 33,000 hectares of three recently released varieties (Pinto Villa, Bayo Victoria and Negro Durango) were planted for seed in 1993. The majority planted (26,000 hectares) was Pinto Villa, which has been well received in Chihuahua, Zacatecas, Queretaro and Hidalgo.

A fourth new variety of the Flora de Mayo seed class is in process of release through combined efforts of INIFAP, MSU and CIAT. It has consistently out-yielded the current commercial check by about 30 percent, is larger seeded, and tolerant to rust, common blight and mosaic virus.

Cooking time was shown to be dramatically reduced (from 245 minutes to 63 minutes for Bayo Victoria and from 93 minutes to 38 minutes for Flora de Mayo) when soaked overnight in saline solution (.5 percent sodium bicarbonate and 1 percent sodium chloride).

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** No information available

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** The new varieties both increase production and provide added income to producers as well as added food security to both rural and urban populations. The reduction in cooking time through the very cheap saline treatment provides a dramatic reduction in fuel consumption.

2. Impact of research achievements in HC

a. **On production/consumption of beans/cowpeas or new food products:** The new varieties are not yet in commercial production to any great extent so no measure is possible. The seed produced in 1993 could provide up to 50 percent of the Pinto hectareage in 1994.

b. **On technology needs/constraints facing small-scale farmers:** The new varieties should improve the availability of beans for consumption and in the market. Reduction in cooking time relieves the stress on fuel supplies and household budgets.

c. **On the developing and developed world:** The superior genetic materials identified will help breeders in both developing and developed countries.

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** Dr. Francisco Ibarra Perez completed doctoral studies at UCR and has taken up responsibility as breeder/geneticist at Durango. Mr. Jesus Munoz Ramos has returned to Durango with a Masters in agronomy and will head up validation trials in farmers' fields. Ings. Dora Maria Aguilera and G. Garcia E. left the project to take up additional studies at the Universidad Nacional Autonomo de Mexico in Saltillo, Mexico.

2. **Status of training program:** Ms. Maria de la Paz continues her M.S. studies at the Postgraduate College at Chapingo. Ms. Mmasera Manthe is concluding her Ph.D. program and Mr. Ahmed Jama is continuing his at MSU.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan.**

1. **U.S.:** A variety of field, rainshelter and laboratory studies were reported for 1992 and many were continued in 1993. Those directed toward drought tolerance attempt to identify easily measurable parameters associated with tolerance that can be used in screening. As was always apparent, drought tolerance is a very complex phenomenon with plant physiological, phenological and physical variants responsive to a complex of environmental factors. It is not moisture dependency alone, but a whole complex of plant and environmental parameters that determine the outcome. It is not surprising, therefore, that progress is slow and the work tedious. No breakthroughs have occurred or appear on the horizon. Rather, the problem is only incrementally yielding to the partitioned approach being employed.

2. **HC:** Extensive field studies were continued in the breeding program and in attempts to elucidate drought tolerance. Unfortunately, Mother Nature displayed her fickle behavior with early frost in 1992 and an extremely unusual rainfall pattern and associated pest problems in 1993. Useful results were obtained in 1992 at Chapingo and Jalisco. One conclusion regarding drought tolerance gained from the field studies was "the basis of drought tolerance in most regions lies in local adaption since screening conducted outside a region rarely identifies germplasm directly useful for drought tolerance." It is notable that significant research is now underway on the potentially confounding root rot problem in Mexico. Though in early stages, it will surely prove useful in identifying resistant germplasm as well as avoiding confounding effects in assessing drought tolerance in the field.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** Good progress is evident in the breeding program where work is at or ahead of schedule. Having four superior varieties moving in to production and several others in advanced trials in a bit over ten years is a good outcome. Detailed physiological, phenological and environmental work on the drought tolerance phenomenon is newer as is the work on cooking time. The former is fraught with great complexity and must be viewed as a long-term effort. Results will be incremental and slow in coming. The latter is yielding good results and is a most useful adjunct to the breeding program.

   b. **Reasons for delay, if any:** The vagaries of climate often play havoc with field experiments, especially in semiarid regions. This has been a factor in the work, especially in the highlands. Disease infestations likewise have been a factor, again not surprisingly, but a confounding one in the drought work.

4. **Relationships of project research to other research being conducted in HC/IARCs/elsewhere:** The project collaborates closely with other INIFAP researchers, with scientists at CIAT, and with other bean researchers in the U.S., in Latin America and elsewhere. It is one of the lead efforts internationally in attempting to sort out the drought tolerance phenomenon in beans.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** The project has already contributed to bean producers and consumers in the HC via the new varieties and cooking techniques developed, and there will be more to come as work progresses.

   The U.S. will likewise benefit from the superior germplasm identified and made available to U.S. scientists and from the elucidation of the drought tolerance phenomenon, a problem of importance to U.S. and other countries where semiarid agriculture is practiced. Since limited and erratic rainfall is such an important constraint in so many regions, this work takes on even greater importance than its impact in just this HC or on just this commodity.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** Work is progressing by a food scientist to determine urban consumer preferences. Ongoing organoleptic testing is a part of the advanced line evaluations. It is not clear who performed

the cooking time studies but assumably food science was involved. All of these have socio-economic and/or WID constraint relationships.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** See above item.

3. **Progress in strengthening the social science/WID component:** See above item.

E. **Sufficiency of Baseline Data:** Aside from on-site soil, climatic, yield, quality, etc., the project relies on government data--probably better than most but one wishes it were better.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** The project has ties with the Honduras/UPR, Ecuador/UMN and Caribbean Basin/UWI projects in addition to the HC, CIAT and other collaboration identified earlier. This is considered appropriate.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** It is apparent that there are problems in distribution of funds and in funds control by the Durango administration. Apparently the new Director at Durango is withholding and redirecting funds in a manner inconsistent with agreements reached between the HC and the U.S. PIs. It may be necessary to re-centralize fund control to the HC PI in order to maintain integrity in funds management. This would require discussions with INIFAP administration.

B. **Adequacy of Current Management, Policies, and Procedures:** No problems are apparent on the U.S. side. As noted in A. above, there are problems on the HC side.

C. **Activity Towards Buy-ins and Other Funding:** None reported

D. **Responsiveness to 50/50 Split Policy:** No substantial deviation is noted.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** Though not funded by the CRSP, there is significant attention to training by INIFAP in response to project needs. As noted in I.B.2., training is impacting positively and will increasingly do so. CRSP-supported trainees at MSU further the research through their dissertation work.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** There seems to be good communications and cooperation between the U.S. and HC scientists. As noted earlier, there is an administrative problem with funds control.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** The distribution of responsibility between institutions and individuals seems to make sense. The ability to test, under field conditions, the concepts and principles derived in laboratory and growth controlled facilities at MSU is a key factor in attempts to unravel the drought tolerance phenomenon.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** Briefing of the U.S. Agriculture Attache was well received. No tangible support is anticipated.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** Two HC team members were promoted to station manager positions in 1992. The U.S. and HC PIs were invited to present concepts and findings at two major regional meetings in Latin America in 1993.

2. **Integration of domestic program with CRSP project(s):** Project activities are closely integrated with ongoing work at MSU and constitute an extension of concepts used in disease research to applications in drought tolerance.

3. **Internal support for project management and institutional management:** The support at both the department and higher administration levels has apparently been good.

4. **Opportunities for and frequency of student/professor interactions:** Interactions are on a daily/weekly basis and appear to be quite adequate.

F. **Appropriateness of Activities to Goals of Global Plan:** Since the preponderance of edible dry bean production worldwide is in semiarid climates, drought tolerance is a major need in the genetic base of bean cultivars. Research in this project attempts to identify tolerant genetic bases and to develop reliable and workable test procedures for evaluating tolerance. The research is thus highly responsive to the Global Plan's goals.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** The distribution of responsibility for project objectives seems to be well thought-out and appropriate.

H. **Other Comments:** During an EEP site visit, it was noted that field facilities available to the Durango staff had some serious limitations. Heavy pressure on the field site has created an inordinate disease pressure that limits ability to evaluate drought tolerance in the field. Further, the vagaries of climate (i.e., inconsistent rain patterns from year to year) limit ability for continuity in evaluations from year to year.

This suggests a need for (1) additional field resources in the main bean producing area and (2) the availability of some irrigation water. These appear to be essential to future success of efforts of Durango station personnel.

IV. **WORK PLAN CHANGES:** Research on wild *Phaseolus* germplasm has been reduced in order to increase emphasis on disease resistance in Mexican materials. Work has also been increased on agronomic practices to provide better environments for improved cultivars. Both of these changes seem appropriate.

V. **PUBLICATIONS AND PRESENTATIONS IN FY 93:** The publication and presentation record in 1993 was quite good, both in quantity and quality. Especially noteworthy was participation of Mexican scientists in Central and South American technical meetings.

VI. **OVERALL RATING: 2a--Satisfactory Plus**

A. **General Strengths:** A technically competent and well-rounded HC team and the obvious rapport and mutual respect between the U.S. and HC scientists

B. **General Weaknesses:** See Item III.H.

C. **Recommendations:** The physical limitations in the Durango station's field resources need to be addressed (see III.H.). The funds management problem identified in II.A. needs to be resolved.

SENEGAL/UNIVERSITY OF CALIFORNIA-RIVERSIDE/HALL

Development of Improved Cowpea Varieties, Management Methods and Storage Practices for Semiarid Regions

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. **Improved cultivars, food products, inoculants, tests, methods and systems:** The cowpea cultivar Melekh was released in FY 93. Melekh has resistance to cowpea aphid-borne mosaic virus and cowpea aphid, and variable resistance to bacterial blight. It complements Mouride, which was released in FY 92, in terms of resistance to different biotic stresses, but flowers earlier and is better adapted to short growing seasons (55 days) than Mouride. In contrast Mouride is more widely adapted and has resistance to cowpea aphid-borne mosaic virus, bacterial blight, *Striga* and cowpea weevil. About five tons of seed of these two varieties were produced during the FY 93 off season and distributed through World Vision International to 1,200 growers in 247 villages.

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** During FY 93 a total of 1,156 new accessions were obtained from USDA (originally supplied by IITA), and two accessions were obtained from Australia. In addition, several wild species (mainly subspecies of *V. dekindtiana and V. tenuis*) were obtained from Purdue (27), University of Nairobi (60) and South Africa (5). Distribution of 71 breeding lines and other materials were made to CRSP projects at Auburn, Purdue and Wisconsin and to non-CRSP projects in England, India, Tennessee, and Mexico.

The UCR cowpea project now has a cowpea germplasm collection of 5,000 accessions--the second largest in the world.

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** The new cultivars, production practices and seed storage methods were designed specifically for minimal input cropping by small-scale farmers under conditions of several biotic stresses. The extension project by WVI and the mini-kit of farm experiments collaborate mainly with small farm families (led by men) in the peanut basin; but a special effort has recently been made to include groups of women (GIEs: Groupement d'Interet Economique). This effort has been spectacularly successful in involving women's village groups in evaluating new technology through the mini-kit on-farm experiments during the past two years.

2. Impact of research achievements in HC

a. **On production/consumption of beans/cowpeas or new food products:** Changing rainfall patterns, reduced soil fertility and other biotic factors have combined to greatly reduce crop production in the northern peanut basin of Senegal. Hardest hit are peanuts and pearl millet with substantially reduced areas planted to these crops in the region. Some of the food gap is being met by cowpeas although considerable reduction in the national production occurred during 1990-91 (e.g., 12.2 and 15.8 thousand tons for 1990-91) compared with the 1960-79 average (17.9 thousand tons). The crop in 1992 was a near failure in Northern Senegal, but 1993 may prove somewhat better. Fortunately, the new varieties, Mouride and Melekh, help stabilize production during famine years and may out-yield local cultivars by up to 100 percent when the rains terminate early.

Increasing quantities of cowpeas (ca. 20 percent) are consumed on farm or sold as "fresh peas" and are not included in national production data. These fresh, green peas make important contributions to both human nutrition and local cash flow during the traditional "hungry season" in August and September.

b. **On technology needs/constraints facing small-scale farmers:** Within the two major zones of cowpea production in Senegal (northern--Louga/St. Louis and central--Thies/Diourbel), minimal input cowpea systems are required. In the north, cowpea aphid, hairy caterpillar and drought are major problems. In the central zone, CAMV (an unknown potyvirus) and flower thrips (secondarily) are the primary biotic deterrents. *Striga* occurs everywhere in patches and the cowpea weevil is endemic in both regions. Virtually all farmers are unable to afford production inputs (fertilizers, plant protectants, machinery/tools or storage containers). Government extension services function very poorly, if at all. Cowpea prices are very low at harvest time but rise dramatically until the next season's harvest. Fresh green peas contribute substantially to the food supply and cash flow during the famine period. The new, earlier varieties have contributed markedly to the use of green peas. Cowpea hay is only of moderate importance. Potential solutions to many of the aforementioned constraints should become available in the future, but problems involving credit, input infrastructure and other non-technical impediments will remain until the national economic situation improves.

c. **On the developing and developed world:** This project is unique in its focus on the semiarid Sahelian zone. Therefore, the technology developed should be useful in other countries with similar environments and 200-400mm of annual rainfall (e.g., Mali, Burkino Faso, Niger, Chad and Sudan). Concurrently, advanced breeding lines have been developed for California incorporating heat tolerance and resistance to Fusarium wilt and root knot nematodes. The discovery of two flushes of flowering in California is changing the management of this crop. Farmers can now elect to harvest after the first flush or wait two weeks to catch the second flush as well--depending on growing conditions. It is likely this double flush of flowering occurs in other legumes as well as in cotton and tomato.

B. **Evaluation of Institutional Development and Training**

1. **Personnel changes since FY 92:** A WID replacement, who began work in Senegal in September 1993, has been found for Dr. Seynabou Tall.

2. **Status of training program:** Mr. Ndiaga Cisse is continuing his Ph.D. program in plant breeding at Purdue University under Dr. Gebisa Ejeta (until 1995 or 1996). Ms. Cristina Menendez, a Ph.D. candidate in botany at UCR, is studying DNA markers in cowpeas (RAPD and RFLPs) at UCD with Dr. Paul Gepts. In about 1996, it is reported that Mr. Samba Thiaw will initiate Ph.D. studies in agronomy in the U.S.

C. **Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan:** Previous reports as well as the present one attest to the solid progress made toward accomplishment of objectives. Highlights of these studies, particularly those relevant to the project's primary goals are briefly noted below.

1. **U.S.**

a. **Genetic linkage maps:** The project collaborated with other institutions and researchers in augmenting the limited cowpea map. Band length polymorphisms were detected in 13 out of 24 RFLPs and in 10 out of 40 RAPD primers. The information being obtained will be very useful in developing resistances to biotic stresses and in shuttle breeding.

b. **Delayed leaf senescence:** Conferring delayed leaf senescence can enhance mid-season drought resistance and yields in cowpeas. Crosses between Mouride (Senegal) and delayed leaf senescence line 8517 were advanced in both Riverside and Bambey.

c. **Carbon isotope discrimination:** Low CID is associated with improved water use efficiency, but high CID may confer general adaptation and therefore outweigh any disadvantages of low water use efficiency. Low CID is also associated with earliness and low harvest index. Moreover, low CID had low heritabilities and could be difficult to breed for.

d. **Breeding for heat tolerance:** Good progress for heat tolerance was made in both California (Coachella Valley) and CNRA Bambey. Recombinants from African lines, (e.g., Mouride and others including line 518 and TVx3236 have been selected in the greenhouse and field in California and at CNRA Bambey (F_3 generation).

e. **Cowpea resistance to California aphid:** This objective was largely completed and reported in 1992. Best sources of resistance to the aggressive California cowpea aphid were Tvu4936 and IT845-2049. These lines have been crossed and backcrossed with the best California breeding lines.

f. **Crossing wild and cultivated cowpeas:** The object is to increase hairiness of leaves and pods to confer insect resistance and to broaden the genetic base of cowpeas. Improved techniques have succeeded in producing 24 recombinants of *Vigna unguiculata* x *V. dekindtiana* and three recombinants of *V. unguiculata* x *V. tenuis*.

g. **Mutation breeding for earliness:** Earliness is a major objective in breeding for the African Sahelian zone. Since lateness is conferred by a few dominant genes, the use of mutation breeding (ethyl methanesulfonate or EMS) has proven successful in reducing maturities of otherwise adapted late varieties (Diongama, TVx3236, KN-1 and CNX04-34) by up to seven days.

h. **Studies in California not in work plan:** Eight new crosses were made to combine heat tolerance with delayed leaf senescence. Also, collaborative genetics/physiology studies were carried out with the University of Nairobi.

2. HC

a. **Mini-kit experiments:** In 1992, trials were conducted in six villages with five families in each village and with nine farm families in cooperation with the extension service (SODEVA). Drought affected all trials north of Thilmakka; but the new, early variety Melekh and broadly adapted Mouride were best and therefore entered into the seed extension project of World Vision International in 1993 trials.

b. **Impact studies:** Many factors precluded carrying out impact studies in FY 93, since it was not possible for ISRA to appoint a woman socioeconomist until late 1993.

c. **Collaboration with World Vision International:** The project collaborated with WVI on mini-kit trials (4 cvs + Bambey 21) in six villages in 1992. During FY 93, the project produced five tons of seeds of Mouride and Melekh to be distributed by WVI to 1,200 farmers in 247 villages.

d. **Varietal intercrops:** Results of interplanting an early-erect (Melekh) with a medium-cycle spreader (Ndiambour) at four different sites were inconclusive due, in part, to the severe drought in 1992.

e. **Control of hairy caterpillar:** This activity was deferred because there was no infestation of hairy caterpillars when expected.

f. **Carbon isotope discrimination:** There was a tendency for better adapted cultivars to have high CID in Senegal.

g. **Evaluating lines from UCR:** Lines derived from African cultivars (e.g., Mouride) crossed with delayed leaf senescence and heat tolerant strains look highly promising in CNRA Bambey evaluations.

h. **Main breeding and agronomy program:** An eight-entry multi-location trial at the three experiment stations demonstrated the superiority of Melekh and Mouride. However, several advanced medium cycle lines--some with aphid resistance--were equal to or better than Mouride. In two preliminary trials (48 and 80 entries), several lines were superior to the two released varieties. *Striga* resistance trials in pots and farmers' fields demonstrated that Mouride has high-level resistance, but Diongama, Melekh and lines 893, 911 and 915 have partial resistance to *Striga*.

i. **Research on cowpea diseases:** Mosaic symptom plants (66) from five regions were evaluated using enzyme-linked immunosorbent assay (ELISA) methods. About half the samples were infected with cowpea aphid-borne mosaic virus or as a mixed infection with cowpea severe mosaic virus or southern bean mosaic virus. About a third of the samples showed symptoms of an unknown potyvirus. Six cowpea lines were resistant to all potyvirus isolates.

3. **Length of time project has been engaged in lines of research addressing these objectives**

   a. **Progress in relation to log frame:** This is a "mature" project having been active in developing improved cowpea varieties for Senegal from the start of the Bean/Cowpea CRSP. Excellent progress has been made not only in developing and releasing two superior varieties for Senegal, but also (1) in training a relatively small but highly effective staff, (2) establishing an operational procedure for developing and testing a continuing stream of new cowpea technology for Senegalese conditions and (3) achieving excellent rapport between the HC, UCR, Senegalese administration, donors (like USAID) and volunteer organizations (like WVI). Like all good varietal improvement programs, this project is dynamic--constantly evolving better methods, using new techniques and adding new objectives as needed. For example, it has recently become necessary to incorporate potyvirus resistance, develop controls for hairy caterpillar and further enhance multiple stress tolerance in new strains.

   b. **Reasons for delay, if any:** None--except for new objectives like controlling hairy caterpillar. A major problem is the unpredictable nature of this pest--sometimes it may not occur for several reasons.

4. **Relationships of project research to other research being conducted in HC, IARCs and elsewhere:** The project is synonymous with Senegal's national cowpea research programs and it collaborates closely with other organizations like the Institut de Technologie Alimentaire (Food Technology Institute) in Dakar, World Vision International and others. It is the major program in Africa developing improved cowpeas for the Sahelian zone (200-400mm rain). It also maintains strong linkages with IITA and national cowpea programs in Niger and Mali.

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** This project has benefitted greatly from long-term continuity of effort and personnel, dating back to the inception of the Bean/Cowpea CRSP. The major contributions include not only development of two new varieties but also having put in place the trained personnel, certain infrastructure and mechanism for generating and testing a continuing flow of new technology to cowpea growers. However, one major objective remains, i.e., to develop improved varieties and management methods allowing farmers to produce good yields of cowpeas without insecticides.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** Progress achieved in "raising consciousness" about social science/WID-related issues has been spectacular during the past two years. Particularly impressive was the participation of women in carrying out mini-kit trials in 25 out of 55 sets of trials carried out in FY 93. Moreover, the project has greatly multiplied its impact through collaboration with World Vision International, which has a separate WID program led by Ms. Marie Therese Diouf. WVI is active in 386 villages and had 30 percent participation by women in FY 93.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** A new socioeconomist, Madame Mbene Faye joined the project late in 1993. She is expected to participate in WID issues and perhaps make a study of the emerging green cowpea market in north Senegal.

3. **Progress in strengthening the social science/WID component:** Exceptional progress has been made in strengthening the social science/WID component as evidenced by the inclusion of women-managed mini-kit trials, collaboration with WVI, and appointment of women socio-economists in project activities.

E. **Sufficiency of Baseline Data:** Baseline data are adequate for measuring success in increasing production of dry cowpea grain if the project can achieve the major increases in yield/area and national production that are projected. Some baseline data are being collected by other organizations.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** Cowpea germplasm is widely distributed to other researchers. The project collaborates closely with USDA in exchanging and growing out germplasm. Basic studies on cowpea linkage maps are being carried out jointly with the Malawi/UCD/Gepts and the Cameroon/Purdue/Murdock CRSP projects and with the University of Minnesota (Dr. Nevin Young).

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** Overspending in FY 92 was mainly solved through curtailing project expenses in FY 93 and the more favorable currency exchange rate. The University of California, however, is under severe budgetary constraints.

B. **Adequacy of Current Management, Policies, and Procedures:** Financial reports from Senegal need to be submitted promptly to UCR.

C. **Activity Towards Buy-ins and Other Funding:** A small additional grant was obtained from USDA for propagating, multiplying and characterizing cowpea germplasm in California.

World Vision International obtained a $60,000 in-house grant to help fund the WVI/ISRA cowpea seed multiplication and extension project.

Cowpea germplasm development was supported by a USDA/ARS and UCR cooperative agreement for the three-year period September 15, 1991 to September 14, 1994. This project has helped implement maintenance, evaluation, conservation and distribution of germplasm.

The commodity production group of California cowpea growers provides funding at a level of $20,000/year which partially pays Dr. Ehlers' salary.

The scholarship grant from the Foreign Fulbright Programs Division supported Ms. Cristina Menendez (from Spain) in studying the heritability of carbon isotope discrimination and the DNA marker linkage map.

D. **Responsiveness to 50/50 Split Policy:** The funding balance appears appropriate.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** The principal long-term training activity at present is Mr. Ndiaga Cisse's pursuing a Ph.D. in plant breeding at Purdue University. The HC does not have sufficient funds for additional formal training, although ISRA plans to send Mr. Thiaw for Ph.D. training in 1996 after Mr. Cisse returns in 1995.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Collaboration and cooperation between the principals/institution in this project have been outstanding. The project annual meeting held at UCR in March 1993 included the participation of both Mr. Cisse and Mr. Thiaw as well as Dr. Tony Hall (U.S. PI) and Dr. Jeff Ehlers (UCR cowpea breeder). In September-October 1993, Drs. Hall and Ehlers also participated in collaborative research and planning with ISRA colleagues in Senegal.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** This project represents an optimal model for sharing responsibilities and receiving credit for accomplishments. Moreover, the several partners enjoy mutual trust and respect in a highly effective research partnership.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** The USAID Mission in Dakar has always been highly supportive of the project. Current budgetary constraints however largely preclude any direct in-country project funding at this time.

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** Dr. Hall has been nominated to fellowship in both the Crop Science Society of America and the American Society of Agronomy. He has also become an international authority on cowpea improvement and has been invited to speak at international symposia in Taiwan, at UCR, Rome (Italy) and the First International Crop Science Congress at Ames, Iowa, and serves as technical editor for *Crop Science*, *Field Crops Research* and *Irrigation Science*.

2. **Integration of domestic program with CRSP project(s):** The project is fully integrated with the PI's other research at UCR, and with the California cowpeas farmers as well as the national cowpea program in Senegal.

3. **Internal support for project management and institutional management:** The project receives strong support from both UCR and ISRA.

4. **Opportunities for and frequency of student/professor interactions:** Support to the project from UCR academicians in botany and plant sciences, entomology and soil and environmental sciences has been exceptional. The project also benefits from support by Dr. Paul Gepts (UCD) to Ms. Menendez and from Professor Gebisa Ejeta and colleagues at Purdue University to Mr. Cisse.

F. **Appropriateness of Activities to Goals of Global Plan:** Project activities are highly relevant and appropriate to goals of the Global Plan. The multidisciplinary approach to difficult problem solving is a strategy that might well be emulated by other crop improvers. This approach (particularly appropriate in less-developed country programs for developing widely-adapted, multiple stress tolerant, agronomically desirable and acceptable quality seed types) has served both this project and the Bean/Cowpea CRSP very well indeed.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** Balance is about right. It is obvious that the HC operations would be seriously compromised if external support is curtailed during the next three to four years.

H. **Other Comments:** This project is the only comprehensive cowpea improvement program in the CRSP. Moreover, it is the only significant cowpea research in the Sahelian Region (200-400mm annual rainfall) at present. For these reasons and because this project has become eminently successful in virtually all aspects, any abrupt withdrawal of support in the next few years could be disastrous. Above all, the present coordinated, multidisciplinary cowpea research activities must be sustained; higher degree training completed for the cowpea breeder (Mr. Cisse) and agronomist (Mr. Thiaw); and dynamic socioeconomics research activities initiated.

The programs in California and Senegal are indicative of the highest level of excellence in planning coordination and execution. Even the more basic objectives complement the urgency for deeper insight into intractable problems. However, the results from carbon isotope discrimination studies are somewhat disappointing in terms of using this procedure as a cowpea breeding tool.

IV. WORK PLAN CHANGES: None

V. PUBLICATIONS AND PRESENTATIONS IN FY 93

Refereed Publications: 8
Non-Refereed Publications: 5
Presentations: 2

Publications submitted accurately reflect supporting research on which the project's cowpea improvement is based. These as well as previous writings are indicative of a highly effective, closely integrated program in two disparate regions of the world.

VI. OVERALL RATING: 1--Highly Satisfactory

A. **General Strengths:** Good overall balance in most activities; excellent collaboration in planning and execution in both HC and U.S.

B. **General Weaknesses:** Lack of a socioeconomic component (to 1993) and the delay in training the agronomist

C. **Recommendations:** Continue support for at least three years, especially to the HC; complete training goal (agronomy Ph.D.); and carry out needed socioeconomic studies

TANZANIA/WASHINGTON STATE UNIVERSITY/BUTLER

A Participatory Research Approach to Breeding and Evaluating High-Yielding Disease- and Insect-Resistant Beans for Low-Input Sustainable Farming Systems in Which Women Are Major Contributors

I. EVALUATION OF PROGRESS DURING FY 93

A. Evaluation of Specific Research Contributions in FY 93

1. New research results from FY 93 disseminated and currently in use in HC and U.S.

a. **Improved cultivars, food products, inoculants, tests, methods and systems:** Pod straw from CRSP-developed SUA 90 was tested and found to be a good source of energy and protein for ruminants. Pinto breeding lines were screened and found resistant to fusarium wilt. The resistant lines will have use in both Tanzania and the U.S. The insect vector for the disease was provisionally identified. A computer-based program helped to identify seed-borne bacterial disease, at SUA and in the field. Antisera and dot blot assay methods were furnished to Tanzania; other antisera were furnished to U.S. researchers. Antibodies developed in Germany were used to identify specific epitopes on BCMV. This work may help subgroup the serotype B viruses. A video of Tanzania Farmer Participatory Research was completed and used at the 1993 Bean Research Workshop.

b. **Accessions collected/acquired/in storage, and kinds and amounts distributed domestically/internationally, and any new technologies in use:** Two U.S. and four HC investigators collected virus, herbarium and seed samples of beans and wild legumes in northeast and north central Tanzania in May 1993. Also, 202 herbarium specimens, 28 collections of wild legume seed and several collections of cultivated bean varieties from the market place were obtained. Materials were deposited in the Host Country and in the U.S. Regional exchanges of germplasm were made with the National Bean Program, CIAT-Colombia and SADCC/CIAT-Arusha. BCMV technology achievements are in use by breeders and plant pathologists in Tanzania and the U.S.

c. **How new research findings address the needs of small-scale farmers and women or other beneficiaries:** Participatory research is used to involve small-scale farmers in the breeding and selection of new varieties. Breeders are beginning to use farmers' criteria for seed and plant acceptability. Taste, cookability, digestibility and storage qualities are important criteria. Women define many of the criteria in their roles as farmers and food preparers. Genetic resistance to virus diseases is an important aid to small-scale farmers who cannot take advantage of other methods of control.

2. Impact of research achievements in HC

a. **On production/consumption of beans/cowpeas or new food products:** Although SUA 90 has been released in Tanzania, delays in increasing seed of the variety have hindered its widespread distribution and use. Impact studies will be made in 1994. BCMV technology achievements are in use by breeders and plant pathologists in Tanzania and the U.S., but as yet they have had no direct impact on production.

b. **On technology needs/constraints facing small-scale farmers:** Participatory research points up the need to involve smallholders (particularly women) in the activity of developing new bean varieties. Newly released SUA 90, genetically resistant to BCMV, aids these small-scale farmers, for they usually have no other way to control this disease.

c. **On the developing and developed world:** Demand continues in neighboring countries as well as in Tanzania for SUA 90 and NITROSUA, the rhizobium inoculum developed by the team. Serological results have led to a proposal, to be presented to the International

Committee of Taxonomy of Viruses, that will establish criteria for defining virus species within the Potyviridae, the taxon that includes all the BCMV viruses.

B. Evaluation of Institutional Development and Training

1. **Personnel changes since FY 92:** Dr. Robert Mabagala became Acting HC PI in October 1992.

2. **Status of training program:** Twenty-two people from Tanzania were given training. Nine were graduate students, seven were undergraduates, six were technical specialists in computer operations, communications, or virus identification. Particulars and names are listed in the Annual Report.

C. Evaluation of Progress Relative to Objectives Stated in the FY 93 Work Plan.

1. **U.S.**

University of Idaho and WSU Prosser: Another set of backcrosses has been made between donor parents and the recurrent parent for development of improved BCMV differentials. No linkages between morphological markers and BCMV resistance genes have as yet been detected, probably because few markers are available. Work is in progress to develop cDNA probes for the new BCMV resistance genes (after they are identified), using PCR equipment for performing RAPD analysis.

WSU (Mink): Work continues with antibodies, looking for specificity against BCMV isolates, epitope analysis of viral coat proteins and utilization of strain specific mono-clonal antibodies to study incidence and distribution of the strains in Tanzania and the Pacific Northwest. Findings from a survey (May 1993) in northeast Tanzania supported the hypothesis that wild legumes may serve as natural reservoirs for BCMV. Cooperative research with investigators at Braunschweig, Germany has developed monoclonal antibodies that serologically subdivide the serogroup B viruses of BCMV. The new antibodies will be used for epidemiological studies on distribution and movement of BCMV in Tanzania and the Pacific Northwest. They will be marketed commercially, and any income will be used to evaluate other BCMV-specific antibodies now on hand at Prosser.

USDA/ARS/WSU (Silbernagel): This component reclassified a type of BCMV as bean common mosaic necrosis virosis (BCMNV).

WSU-Puyallup (Butler): Program management was strengthened through visits to Tanzania, development of statement of program directions with HC PI, soliciting support from several United Nations' organizations, and development of a community-based seed scheme. Farmer evaluations were conducted. Participatory research video tapes were made; one tape of Farmer Participation in Bean Research in Tanzania has been completed.

2. **HC**

a. **Breeding:** Sixteen lines were tested for food preparation traits and the better ones were crossed to elite varieties. Thirty-six lines also are in test for storability. Studies continue on pod-fill and maturity relationships. Breeding is continued to incorporate arcelin protein into desirable germplasm. Multiplication of SUA 90 continues, but at an undesirably slow rate. Farmers evaluated eight bean varieties at maturity. Plans are to collaborate with one or more farmer non-governmental organizations as a more efficient way to increase the amount of farmer evaluation. An additional activity was the testing of 25 varieties from other countries in the Africa Bean Yield Adaptation Nursery for performance under lowland conditions. No progress noted on planned yield trials of promising advanced lines, on planned testing of advanced lines for yield, on planned preliminary trials of F_4 lines from Prosser, on planned multiplication of EP4-4, nor on proposing it for release in FY 93.

b. **Plant Pathology:** Nine promising lines were evaluated for resistance to common and halo blights. Eight lines were intermediate in resistance to common blight, no results noted for halo blight. Progress was noted in collecting and screening landraces for these diseases; some landraces showed promise. Progress was made in screening for root knot nematode resistance and management strategies, but no progress noted in diagnostic surveys of nematodes associated with beans. No progress noted on planned laboratory studies of *Xanthomonas campestris* pv. *phaseoli* or *Pseudomonas syringae* pv. phaseolicola; on planned development of proposal on CB research; on planned screening of segregating populations for ALS and rust resistance or in determining races of *Phaeoisariopsis griseola*; nor in planned evaluation of disease management practices in smallholder bean production.

c. **Entomology:** Studies were initiated on the use of natural products for bruchid control and on population dynamics of *Ootheca* spp. Insecticides were compared for control of pod-sucking bugs. No progress was noted on the study of competition between *Anthoscelides obtectus* and *Zabrotes subfaciatus* nor on planned screening for resistance.

d. **Farmer Participatory Research:** Farmers at Magole and Dumila evaluated eight bean varieties at maturity. Farmer evaluation criteria were analyzed, the most useful criteria were noted and results presented to the 1993 Bean Research Workshop. No further progress noted in planned development of findings for publication. A non-planned food science study indicates that sprouting improves protein quality and digestibility and other food qualities of red kidney beans. No progress noted on planned farmer evaluations at Ilonga Research Station; no farmer evaluation of SUA 90 due to flooding.

e. **Agronomy and Weed Management:** Studies were initiated on use of phosphate rock as fertilizer. Studies on growth habit of beans to control weeds in maize/bean intercropping showed that cropping system and growth habit affected seed yield and weeding frequency affected dry matter accumulation and seed yield. Detailed notes taken on morphological changes of four promising lines under drought. No progress noted on plans to relate these findings to yield or to multiple cropping systems; on planned collaboration with CIAT (Arusha) on breeding for drought tolerance; nor for planned studies on physiology of flowering, on source and sink relationships, on identification of difficult weeds, or on development of treatments for on-farm testing.

3. **Length of time project has been engaged in lines of research addressing these objectives**

a. **Progress in relation to log frame:** Present objectives were established in 1992. Work on BCMV is on schedule, except for one project that was delayed because of late arrival of a Tanzanian student to WSU. Participatory research is more or less on schedule but plans are being revised due to difficulty in reaching and evaluating results from sufficiently large numbers of farmers. SUA 90 seed multiplication is behind schedule. Intended impact studies have been delayed by lack of sufficient seed multiplication of SUA 90. The promising line EP4-4 will be proposed for release in FY 94, if additional on-farm evaluation is completed.

b. **Reasons for delay, if any:** Progress in studying entomological problems has been slow because of lack of Ph.D. researchers in entomology.

4. **Relationships of project research to other research being conducted in HC, IARCs and elsewhere:** HC research on BCMV ecology is complementary to that in the U.S. Collaboration continues with national bean researchers, SADCC/CIAT at Arusha and other Africa-based CIAT researchers. Participatory farmer research uses female and male extension agents, SADCC/CIAT and the SUA/Tuskegee linkage program. However, reduced SADCC/CIAT activities in Tanzania will hinder future collaboration with them and will thrust greater responsibility on the project. Collaborations with Michigan State University and the University of Florida are intended to develop molecular markers for important genes. Collaboration is also planned with the Netherlands (Wageningen).

5. **Likely contribution of research to HC, U.S. and the amelioration of global constraints:** The several virus projects will benefit efforts to track and control spread of virus diseases in Tanzania and its neighbors, in the U.S. and in any countries involved in bean import and export. In the end, this will facilitate movement of bean seed and commercial beans globally and will make control and elimination of important virus diseases easier, thus benefitting commercial production. In addition, basic knowledge will be enhanced regarding the ecology of the viruses, the genetics of resistance to them and their taxonomic relationships. Such increase in basic knowledge eventually will be translated into more practical benefits to all countries involved in breeding and commercial production of beans.

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

1. **Identification of and attention to socioeconomic and WID-related constraints:** The present thrust to participatory research gives strong involvement and control of research to women, since they both grow and process much of the bean crop. Data are gathered in ways that will allow identification of needs and powers of women in relation to the CRSP goals. As well, women scientists, administrators and extension personnel are involved in the CRSP. Smallholder acceptance of the products remains central in importance; the goal is to produce results at the village household level. By-product utilization (bean straw for animal feed) is also a topic of study and recommendation.

2. **Specific inputs into FY 93 research by social scientists in addressing these constraints:** Participatory research results were analyzed and presented to the annual SUA/WSU Bean Workshop to ensure use by other national bean researchers. This topic gets particular attention by the U.S. PI, a social scientist with specialty in this area of research.

3. **Progress in strengthening the social science/WID component:** Current emphasis on participatory research uses social science techniques and represents major strengthening of the social science component. As noted above, women naturally will take the lead in this research since it involves those areas of production and use in which they are the major actors.

E. **Sufficiency of Baseline Data:** In the coming year, socioeconomic impact studies are planned, based on belief that sufficient baseline data are now on hand. However, initiation of the study will hinge on whether or not sufficient seed of SUA 90 has been distributed.

F. **Evaluation of Collaboration with Other Bean/Cowpea CRSP Projects, Linkages with Other CRSPs, and Other External Groups Not Included in C.4. Above:** Discussions with the Malawi CRSP project may lead to collaboration with them in ways that would balance relative strengths and weaknesses of the two programs. Other collaborations are mentioned in earlier sections.

II. EVALUATION OF FUNDING/FISCAL MANAGEMENT IN FY 93

A. **Problems Regarding Funding, Budgeting, Release of Funds, Procurement and Other:** Increasing costs for participants is a concern. The Accounts Office in the HC was late in releasing funds for research and in preparing statements of expenditures. The cost of the Bean Workshop continues as a major problem.

B. **Adequacy of Current Management, Policies, and Procedures:** Communication between U.S. and HC PIs and team members has been improved through a scheduled monthly telephone call. The U.S. PI also spent four weeks in the HC where she worked with team members on program planning and management.

C. **Activity Towards Buy-ins and Other Funding:** No buy-in is possible with USAID because its priorities in Tanzania do not include agriculture. The two PIs are discussing funding of the proposed community-based seed system with United Nations Development Programme, United Nations International Children's Emergency Fund, FAO and World Bank. The HC PI is preparing a proposal to the SUA Director of Research and Publications regarding possible support for the workshop proceedings, *Bean Research*. Nine HC team members received grants from various sources for research and/or travel to scientific meetings.

D. **Responsiveness to 50/50 Split Policy:** The current budget is split 47/53 percent U.S./HC.

III. EVALUATION OF STATUS IN FY 93

A. **Impact of Training Program:** Increasing costs for training in the U.S. drain the funds for research in the HC. Training is needed to produce an entomologist at the Ph.D. level. Three HC-trained participants continue to take the lead in the CRSP program. Three HC researchers are training in the U.S.

B. **Collaboration/Cooperation Between U.S. and HC Institutions and Personnel:** Collaboration was strong in FY 93 in such areas as proposal development, workshop presentations, disease field survey, video preparation and preparation of bean breeding plans.

C. **Contributions of Collaborating Institutions and Individuals Towards Accomplishment of Objectives:** The HC and U.S. have each contributed in-kind and cash. A U.S. team member is to support research on potential hybridization of certain viruses; the work could help to prevent or alleviate future problems in the HC and the U.S. SADCC/CIAT, SUA/Tuskegee, the African Development Foundation, the Rockefeller Foundation and the Technical Centre of Agricultural and Rural Cooperation (Netherlands) each made small grants to team members for study, research and/or travel.

D. **Interest, Involvement, and Support of USAID Mission and/or U.S. Embassy:** HC and U.S. team members maintain regular contact with the Dar es Salaam Mission. Support is as in the past (see II.C.).

E. **Evidence of Institutionalization in HC and U.S.**

1. **Faculty (researcher) recognition for international activities and awards:** HC team members were appointed to national plant science committees, received commendation for excellence in research, served on faculty committees and as department chair. U.S. team members presented invited papers in the U.S. on their work in Tanzania.

2. **Integration of domestic program with CRSP project(s):** The project continues to maintain credibility and support at SUA. The University of Idaho-Kimberly breeding program is highly integrated with the CRSP BCMV research because of the need for BCMV resistant varieties in Idaho. It also is involved with participatory research as it works with HC seed dealers to evaluate varieties in both field and laboratory. The U.S. PI's domestic research in participatory research meshes closely with the same kind of activity in Tanzania, even though country-specific topics are not the same.

3. **Internal support for project management and institutional management:** Continues in the U.S. and HC as in the past

4. **Opportunities for and frequency of student/professor interactions:** Collaboration between SUA students and CRSP team members is good, as evidenced by CRSP support of seven undergraduate student projects, HC team members giving guidance and support for six graduate students, and presentation of a student project to the 1993 Bean Research Workshop. Interest also continues among WSU graduate students for the CRSP participatory research model. The University of Wageningen is interested in placing a student intern with the CRSP in Tanzania.

F. **Appropriateness of Activities to Goals of Global Plan:** All aspects are appropriate and all of the general goals of the Global Plan are addressed by the activities of this program.

G. **Balance Between Domestic vs. Overseas Activities with Respect to Program Objectives:** General balance seems about equal, considering facilities, equipment and availability of trained personnel. In the future, there perhaps should be more HC research activity and more on-farm products from HC research (e.g., improved bean varieties, improved technologies put to use at the village level) now that trained HC personnel are coming on line.

H. **Other Comments:** None

IV. WORK PLAN CHANGES

A. **Changes/Additions/Deletions**

Changes: A small-scale seed multiplication and distribution system will be developed to improve and speed up distribution of new cultivars to smallholders. As noted earlier, due to late arrival of a researcher in the U.S. study of the biological and serological variability of BCMV isolates has been delayed.

Additions: Study on effect of sprouting on nutritive quality of red beans; development of a proposal for a community-based seed system; and RAPDs to be used where applicable for development of molecular markers were added.

Deletions: Several HC research plans were not carried out, or at least the results were not mentioned in the Annual Report.

B. **Reasons for Changes:** The present seed multiplication system is slow and inefficient; user surveys indicated the need for nutrition manipulation; seed system proposal responds to donor interest and also may help to raise money for the Bean Research Workshop; and new molecular marker technology gives new opportunities for virus classification and manipulation Reasons for lack of HC completion of action plans are not known.

C. **Appropriateness of Changes:** All additions were appropriate. It seems likely that lack of completion of HC plans is because too many tasks were designed, but there may be other reasons.

V. PUBLICATIONS AND PRESENTATIONS IN FY 93

Refereed Publications: 4
Non-Refereed Publications: 29 were in *Bean Research* (the 1991 Bean Workshop Proceedings), of which 25 were authored by HC scientists
Presentations: 33 (made by both HC and U.S. members, all on subjects related to the project)

VI. OVERALL RATING: 2a--Satisfactory Plus

A. **General Strengths:** Good depth in virus classification and ecology; developing strength in host plant disease resistance; evidence of developing strength in HC scientists; HC/U.S. collaboration good and probably will be further deepened and strengthened as the participatory research program is developed

B. **General Weaknesses:** Need better HC follow-through on the work plans, or perhaps team should scale the plans down to a more realistic size and timeframe

C. **Recommendations:** Continue efforts to find additional new sources of funding, using the new efforts in participatory research as an extra attraction; work hard to establish an orderly and effective bean breeding, variety release and seed multiplication program for Tanzania--this program must be appropriate to needs and capacities of the country and should be both designed and operated by Tanzanians

Insect Pathogens in Cowpea Pest Management Systems for Developing Nations

The final report of this project does quite a good job of summarizing the wide-ranging biological findings amassed over the decade of research and the training and institutional development achievements of the project. Both the U.S. and HC scientists are commended for their contributions to the field of insect pathology and for the special efforts in training and the attention to infrastructure development that were stimulated by this project.

The sustainability of the projects output can perhaps be best summarized by the following quotes from the Final Report:

> "An insect pathology resources center was established . . . (in Brazil) . . . including a research laboratory, training facility, entomopathogenic fungus collection and a literature and information center."
>
> "The awareness of insect diseases as alternatives or supplements to chemical insecticides was increased in Latin America through the research and training activities. . . ."
>
> "I think this project contributed considerably to the development of insect pathology in Brazil. The training of several researchers, the establishment of a fully equipped lab . . . and a small lab . . . were very important to initiate and improve our research. I am sure that in the future the use of pathogens will be completely integrated in IPM programs in different regions of Brazil as a result of this project."

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