PROJECT APPRAISAL REPORT (PAR)

Title: Improvement of Tropical Production of Beans and Cowpeas Through Disease and Insect Control

6. PROJECT DURATION: Began FY 73 Ends FY 78
7. DATE LATEST PROP 12/2/75
8. DATE LATEST PIP
9. DATE PRIOR PAR

Dr. J. H. Lopez-Rosa, University of Puerto Rico
AID/ta-c-73-26

I. NEW ACTIONS PROPOSED AND REQUESTED AS A RESULT OF THIS EVALUATION

1. Collect and evaluate results of 1975 & 1976 cultivar field trials by cooperating DCs.
   January 1977

2. Emphasize genetic and biological control of disease and insects while continuing to test new chemical agents as they become available. Once most destructive disease and insects are identified, control measures for these pests should have high priority.
   Life of contract

3. Develop cooperative testing of beans and cowpeas in the Caribbean area, particularly on those islands where they are important food crops.
   March 1977

4. Encourage the Extension Service to test promising new bean and cowpea lines to test them with growers in an effort to reintroduce their production in Puerto Rico.
   May 1977

5. Hold annual workshop of collaborators.
   August 1977

6. Greater cooperation should be encouraged between the project and CIAT, IITA, and U.S. universities on breeding procedures, pest resistance and nutritional quality.
   April 1977

7. On-the-job and on-campus training of DC scientists should be increased and involvement of DC graduate students in research activities stepped up.
   December 1977

8. Continue at the current level of work on wild Phaseolus species to broaden the genetic base and as a source of new insect and disease resistance.
   Life of contract

Date of Evaluation: January 1977

Leon F. Hesser, Director, TA/AG
TO : SEE DISTRIBUTION
FROM : TA/AGR, Leon F. Hesser

SUBJECT: Project Appraisal Report (PAR), Tropical Production of Beans and Cowpeas Through Disease and Insect Control, University of Puerto Rico

Attached is a copy of the recent project appraisal report that was developed for the project with the University of Puerto Rico titled "Improvement of Tropical Production of Beans and Cowpeas Through Disease and Insect Control" under AID Contract AID/ta-C-73-26. The report summarizes the work being done on the project and covers the areas being explored for further study.

It is distributed for your information.

Attachment

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AID Reference Center
University of Puerto Rico - Dr. Lopez Rosa
Dr. Raul Abrams
Dr. Nader Vakili
Dr. George Freytag

See attached list

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan
II. Four x four matrix.

III. Narrative

A. Utilization and Impact to Date

The main work at MITA consists of germplasm collection, screening and breeding for disease resistance. The program is also involved in a survey of tropical diseases, collaboration with various institutes and organizations concerned with tropical agricultural research, and some on-the-job training of cooperating technicians.

The Puerto Rico physical and biological environment, fraught with insects, diseases and climatic and soil variables comprising major legume production hazards, provides a special complex laboratory favorable to the goals of the project. Another favorable feature is the availability of research stations to enable workers to take advantage of the differing environments on the island.

1. Virology

The goal of the virus group within the project has been to study and characterize, in order of economic importance, the viruses affecting edible legumes (mainly beans, cowpeas, soybeans, and other legumes). Project has studied in some detail the following 9 viruses:

a. Bean golden yellow mosaic - affects beans in Tropical America

b. Rhynchosia mosaic - affects soybeans and beans in Tropical America

c. Merremia mosaic - affects beans and soybeans in Puerto Rico

d. Jacquemontia mosaic - same

e. Jatropha mosaic - affects beans

f. Sida mosaic - affects beans (not in Puerto Rico apparently)

g. Euphorbia mosaic - affects soybeans
h. Canavalia mosaic - affects beans and cowpeas, etc.

i. Bean cucumber mosaic - affects beans and musaceous crops in Puerto Rico, U. S., and other areas

Comparative studies (biological) have been conducted and the project has determined the relation of some viruses to the ones occurring in other parts of the world and has obtained highly satisfying results. The project's personnel are comparing notes and exchanging information with cooperators (Dr. Guillermo Galvez, CIAT, Dr. Rodrigo Gamex, University of Costa Rica, Dr. Robert Goodman, University of Illinois).

The virology program is making good progress in the area of white fly transmitted viruses. Few other groups are working on these diseases which with increased bean and cowpea acreages will become more important limiting factors in tropical bean production. The project should continue sound fundamental research working jointly with international centers, national programs in Latin America, and other other U. S. universities and research institutions. There should be more cooperation between the virology group and the breeders in screening for virus resistance and in developing procedures and resistant varieties.

Chemical Control of Fungus and Bacterial Diseases

Foliar diseases of beans and cowpeas were effectively controlled by either commercial or newly developed fungicides. Diseases of cowpea such as powdery mildew (Erysiphe polygoni), leaf spot (Cercospora cruenta, C. canescens), and target spot (Corynespora cassiicola) were kept under control by foliar applications of the fungicides benomyl, dinocap, chlorothalonil, mancozeb, and the Macuprax complex (copper sulphate + ethylene-bisdithiocarbamate).

Benomyl, dinocap, mancozeb, and Macuprax at the rates of .28, .56, 1.12, and 2.24 kg/hectare, respectively, protected the foliage of cowpea plants against the powdery mildew pathogen. Yields as high as 2,150 kg/hectare were obtained from plots treated with some of these fungicides. In some instances, yields from plots treated with the above mentioned chemicals doubled those obtained from nonsprayed plots.

Both leaf and target spots of cowpea were controlled by dosages of benomyl as low as .28 kg/hectare on a biweekly basis. Mancozeb, as well as chlorothalonil, at the rate of 2.24 kg/hectare were as effective as benomyl in controlling leaf spots. However, lower benomyl dosages and fewer applications were needed to check the disease.
Rust of beans (*Uromyces appendiculatus*) was also effectively controlled by means of chemicals. The fungicides chlorothalonil and mancozeb at the rate of 2.24 kg/hectare and the systemics Plantvax (oxycarboxin) and Triforine at the rate of 1.12 kg/hectare protected the foliage of bean cultivar Bonita both at the Isabela and the Lajas Substations. Yield increases, as high as 32% for Lajas and as high as 37% for Isabela Substation, were obtained from plots treated with some of these fungicides when compared to the nonsprayed plots. Yields of bean cultivar Naranjito, highly resistant to rust, were significantly increased at the Lajas Substation in plots sprayed with either chlorothalonil or mancozeb at the rate of 2.24 kg/hectare.

Time and rate of applications should be determined for economical rate of chemical application. More emphasis should be placed on biological control and assessing in screening for genetic resistance.

**Entomology**

The most outstanding entomological findings to date have been (a) the identification of the most important noxious insects present on beans and cowpeas at the Isabela area; (b) the evidence of resistance in some cultivars to some of the major insect pests; (c) effective chemical control for some of the economic importance, and (d) the host range, biology, and natural control of the leafminer.

The insects recorded on beans, in descending order of importance, were:

1. **Leafhopper**  
   *Empoasca kraemeri* (Ross and Moore)  
   *E. milisi* (Ross)

2. **Dry-seed weevil**  
   *Acanthoscelides obtectus* (Say)

3. **Bean leaf beetle**  
   *Cerotoma ruficornis* (Olivier)

4. **Leafminer**  
   *Liriomyza sativae* (Blanchard)

5. **Leaf-tier**  
   *Hedylepta indicata* (Fabricius)

6. **Leafroller**  
   *Urbanus proteus* (Linnaeus)

7. **Stem borer**  
   *Elasmopalpus lignosellus* (Zeller)

8. **Sugarcane weevil**  
   *Diaprepes abbreviatus* (Linnaeus)
Those recorded on cowpeas, in the same order, were:

1. Cowpea curculio Chalco
dermus ebeninus (Boheman)

2. Dry-seed weevil Calloso
bruchus chinensis (Linnaeus)

3. Bean Beetle Cerotoma ruficornis (Olivier)

4. Leafminer Liriomyza sativa
ae (Blanchard)

5. Leafhopper Empoasca kraemer
i (Ross and Moore), E. Hillsi (Ross)

6. Podborers
   a. Maruca testulalis (Geyer)
   b. Etiella zinckenella (Treitschke)

7. Aphids and cutworms

Screening for resistance to insect damage was conducted on 97 cowpea cultivars and on 88 bean cultivars in several plantings throughout the year. Bean cultivars were evaluated for resistance to the most common pests in the area, such as the leafhopper, the bean beetle and to the leafminer. Cowpea cultivars were evaluated for resistance to the cowpea curculio, to the cowpea weevil and a preliminary evaluation for the bean beetle, the leafhopper, and for the leafminer.

Results with the insecticide trials showed that the most effective control for the cowpea weevil and for the cowpea curculio was Thiodan 2E (endosulfan) at the rate of 2 pints per acre, applied weekly in 100 gallons of water during pod development.

Economic levels of major insect infection are being studied to determine type, time, and rate of control measures.

4. Breeding

Manual Crossing: Using the scheme outlined for Population Improvement, 95 crosses were obtained in the first cycle from 11 original parents and 21 crosses were obtained in the second cycle.

The breeding program is largely dependent on use of carpenter bees for intercrossing; actual procedures should be better described to allow accurate appraisal of the effectiveness and perhaps, more important, to determine whether better approaches which also utilize the bees are available.
Hybrid generation testing: In the first cycle, 81 first generation hybrids have been efficiently tested in the field by use of a simple lattice design using hill plots (3 x 3) which require only two seeds for each hybrid tested. However, the hill plots are much more manageable for small semivine and bush types than for the long, vigorous vine types which are more appropriate for use in associated cropping systems.

The highest yielding beans are all black seeded types. The best of these, a Costa Rican black, #50600, was the most adaptable giving good yields over all 5 localities. La Vega, the second best variety, gave the highest yields in three localities but comparatively low yields in the Mayaguez and Isabela areas. The third highest yielding variety, Mex. 309, gave lower yields in Limani and Lajas, apparently due to disease susceptibility. The highest yields ranged around 2,000 kg/ha and could be increased considerably by reduction of the row spacing from the approximately one meter spacing used.

Research on associated cropping systems should not be included in this project - can depend on agronomic studies elsewhere such as CIAT. However, growing vine type beans in association with corn should be used as a standard procedure in studying yields.

Advanced materials were received from the bean breeding programs at CIAT, Wisconsin, and Michigan and have been field tested with MITA lines at the UPR-Fortuna Substation during the summer dry season when diseases and insects were not a major problem. Nine out of 14 of the MITA (disease resistant) lines, 4 out of 9 of the CIAT (high yield) lines, and 1 out of 29 of the Michigan (improved plant type) lines, and none of the Wisconsin (high yield and protein) lines surpassed a yield of 2,000 kg of grain per hectare using a one meter row spacing. Results may indicate that the MITA disease resistant materials are particularly well adapted to the area since they were selected under Puerto Rican conditions.

The Mayaguez project should center its efforts on P. vulgaris for intermediate altitudes; a P. coccineus mass selected population should be developed for the cool higher altitudes. A small group of P. acutifolius lines should be developed for the warmest and moisture stressed tropical areas.

The Mayaguez project should have little concern about any duplication of similar efforts at CIAT since multiple disease resistant lines are needed so urgently. Multiple resistance lines produced by both projects undoubtedly will be different and all of great value.
5. Outreach

Outreach in terms of providing new varietal releases, research data, etc. has been reasonably effective. Since the professionals on the project staff who are field oriented already are overcommitted and would have a difficult time making adequate visits to cooperators outside Puerto Rico it is questionable whether an extensive, effective outreach program could be conducted with the current staff.

Thirty-seven rust isolates obtained from diseased bean leaves collected from six different locations throughout the island are under study in the greenhouse. Most of the isolates have been purified and used to inoculate rust differential cultivars sent by rust researchers in Australia, United States, Brazil, Peru, and Colombia.

IV. Project Potential for DCs

Contractor has released seeds of legume varieties which offer promise either for direct use or for crossing with indigent lines. This type adaptive work will provide the payoff for the Puerto Rico research initiated under the project. Contractor should broaden the distribution of the field trials and become more persistent in obtaining the results of the trials. Increased research on legumes in the DCs is particularly crucial to be kept in balance with cereal crop production activities.

Progress, as judged by varietal or germplasm releases, has been substantial. While these materials appear to have considerable potential they must be tested in appropriate localities throughout Latin America to determine their direct value which calls for a better outreach program.

The contribution to good nutrition with modest cost protein sources which fit the cultural food patterns of the DC people is an important consideration where animal food products may be both in short supply and quite expensive.

While breeding beans for superior performance in mixed cropping systems deserves attention, the present project may not have enough resources to tackle this large, complex problem without other efforts suffering. This objective should be tied to a good outreach program which has ready access to small farmers in active production areas.

Target area for this project should primarily be the Caribbean and Central American area but promising disease and insect resistant lines should be made available to other active bean and cowpea research projects, upon request.
V. Plans for Utilization

Contractor should put added emphasis on promoting involvement of graduate students from DCs in the research activities and in developing closer linkages with DC institutions, international research centers, and U. S. universities.

It may be possible to form a linkage with Cornell University in collaborative genetic-breeding work toward resistance/tolerance in legumes to leafhopper inasmuch as Cornell has undertaken a study on leafhoppers in beans and is interested in the problem internationally.

Materials and ideas should be exchanged more frequently with research programs in the U. S. and other areas that deal with virus research, breeding methodology, physiology of yield, and the food quality aspects of beans and cowpeas. Improved communication, coordination, and cooperation of members of the group should be implemented.

The program has been successful in identifying promising bean selections with resistance to a wide range of diseases and insects. Some of the rust resistant beans, for example, survive the races of this serious disease throughout the tropics as well as in the U. S. This material and selections for resistance to root rot, heat resistance, insect resistance, and plant type should prove valuable to breeders throughout the world.

Greater cooperation should be established between this project and

- CIAT for specific problems in Phaseolus research and to utilization of the CIAT outreach program;

- IITA in cowpea improvement in Latin America; and

- U. S. university programs dealing with breeding procedures, disease resistance, and nutritional quality.

In bean hybridization work, the project should restrict the number of parental lines perhaps to the best four multiple resistance lines. The program should involve only those diseases for which a high level of resistance or tolerance has been identified and for which an effective test site exists in Puerto Rico. Original population synthesized from a few parental lines should carry bush, half runner, and vine types and be selected for day length neutrality at an early stage.
VI. General Management Matters

The research design remains valid and contractor's progress has been satisfactory. It is recommended that AID, in accordance with original plans, extend this contract for twenty-three months at this time and perhaps two additional years at a later date.

The edible legume research program is well planned and designed to utilize the extensive variation in environmental conditions. The energetic, enthusiastic, imaginative scientists on the project are well qualified and making good use of opportunities for advancement as they arise.

The project should undertake a comparison of results from the multi-disease recurrent selection program with selection against a single disease to determine if some good specific sources of disease resistance are being lost, continue the mass selection for a few more cycles and then move toward a more scientific approach to selection for specific disease or insect resistance.

The project has not had as its objective studies on nutritional quality. This is being accomplished by a special small research project on the nutritional quality of beans at the University of Wisconsin. Close coordination exists between UPR/MITA and the University of Wisconsin.

Project should standardize screening with technique used at other locations so that results are interchangeable. Obtain as many breeding materials from other areas as possible to widen the narrow base with which program now operates.

This research should result in significant improvements in yields and hopefully in availability of legume foods as well as the potential of decreased production costs.

A four-day planning seminar and evaluation of this project was held in Mayaguez, Puerto Rico in August, 1976. Included with this PAR is Attachment A which lists the participants and Attachment B which shows the program of events covered by this seminar/evaluation session.
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12 August 1976
University of Puerto Rico
Mayaguez Campus
College of Agricultural Sciences
Agricultural Experiment Station

LEGUME PROJECT PLANNING WORKSHOP
(10-13 AUGUST 1976)

TENTATIVE PROGRAM

Tuesday, 10

8:00-8:20  Registration
8:20-8:45  Welcome and introductory remarks  University of Puerto Rico; AID
8:45-9:00  General aspects of the legume project  Julio H. López-Rosa
9:00-14:00a/ Tour of experimental plots at Isabela Substation and MITA Farm  Project Staff
14:00-17:10b/ Presentation of research results  Nader G. Vakili
14:00-14:35  Diseases and disease resistance  Julio Bird
14:35-15:10  Virus diseases
15:10-15:25  Coffee Break  Pedro L. Meléndez
15:25-16:00  Chemical control of diseases  Carlos Cruz
16:00-16:35  Control of insect pests  George F. Freytag
16:35-17:10  Breeding for resistance; outreach

Wednesday, 11

7:00-18:00  Tour to experimental plots at Adjuntas, Fortuna and Lajas Substations

a/ Coffee and lunch at Isabela
b/ Thirty minutes for presentations by senior project staff members and 5 minutes for questions
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<tr>
<td>8:30-10:30</td>
<td>Tour of research facilities at University and MTA</td>
<td>Project Staff</td>
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<td>10:30-11:45</td>
<td>Projections and goals</td>
<td>Julio Bird</td>
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<tr>
<td>10:30-10:45</td>
<td>Virus diseases</td>
<td>Pedro L. Meléndez</td>
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**Thursday, 12**

**Friday, 13**

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<td>Discussion</td>
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<td>9:30-9:45</td>
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<td>Decisions and recommendations</td>
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<td>11:45-12:00</td>
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<td>12:30-14:30</td>
<td>Departure from Mayaguez and arrival at Río Piedras</td>
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<td>14:30-16:00</td>
<td>Tour of electron microscopy laboratory</td>
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