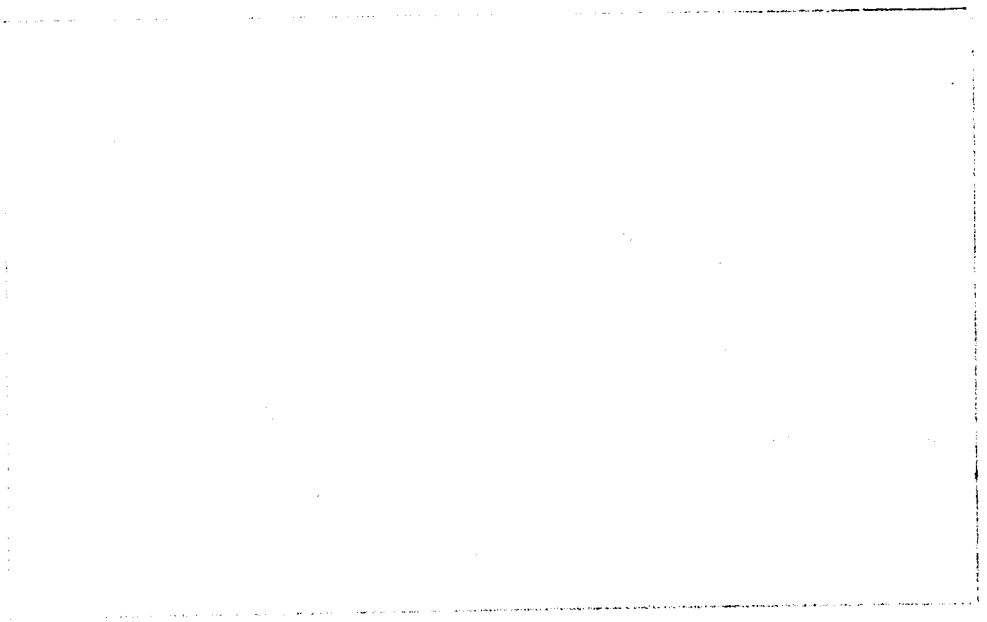
THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)



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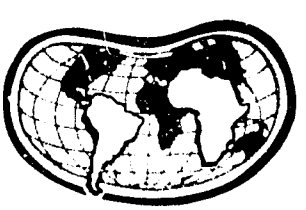

Funded through USAID/BIFAD Grant NO. AID/DSAN-XII-G-0261

THE LINKAGE EXPERIENCE OF THE BEAN/COWPEA CRSP

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June 23, 1986

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INTRODUCTION

Similar to the movement of several decades ago which established the network of International Agricultural Research Centers (IARCs), CRSPs were introduced into an evolving international agricultural research and development system as a new and needed component. According to extensive external reviews, they are a cost-effective model, a model that can perform a critical international role beyond the mandates and capabilities of other international agricultural research organizations. Critical among the model's characteristics, as demonstrated by the Bean/Cowpea CRSP, are:

1. The tremendous size of the resource base represented by the array of participating US universities, whose resources include the professional expertise, the related on-going research programs, the extensive research facilities and the administrative support structure of the US Land-Grant system;
2. The diversity of professional disciplines available to contribute to the problem-solving efforts;
3. The working partnerships of committed colleagues professionally rewarded for collaborating across national boundaries with other participating nations; and
4. The management structure, much of which is contributed by the participating institutions, whose sole function is the support of outstanding research throughout the CRSP with the integration and coordination of resources focused on overall program goals.

Thus, this CRSP, as well as the others, complements and supplements IARCs and other public and private research organizations by broadening and deepening the overall research support base and the linkages which reinforce the international agricultural research system. Performing in a highly acceptable, interactive mode for agricultural development, the CRSP brings the diverse, largely untapped resources of US centers of excellence into collaborative international research and training activities. Through these efforts, it is

extending the worldwide network of institutions and individuals cooperating in important bean- and cowpea-related research. More broadly over time, it will help fashion and strengthen enduring linkages throughout the international agricultural research and development system.

This document is organized to give an idea of the linkages generated, and subsequently reinforced, by the Bean/Cowpea CRSP. While comprehensive in that a range of such linkages are highlighted, the report is not all-inclusive. Rather, examples that are especially illustrative have been selected for presentation.

The categories to be addressed are CRSP linkages with national programs and, concurrently, the active regional and international linkages. Within each of these categories, this report focuses first on CRSP formal and informal linkage-related policies which facilitate this function, second on selected practices implementing those policies and third on pitfalls in the system and lessons learned.

NATIONAL PROGRAMS

Policies--

1. There are no free-standing CRSP projects in the US. All projects must have Host Country (HC) collaboration, with both US and HC partners participating in planning, sharing the budget and executing the programs.

2. No less than 50 percent of project funds, exclusive of indirect costs, are to be spent in or directly on behalf of the Host Country.

3. Participating HC institutions are encouraged to join the US institutions in making contributions to their projects (e.g., matching) as a way of strengthening the long-term effects of their collaboration.

4. Because of the role of women in bean/cowpea production and utilization, a major commitment is made to WID, including concern for the participation of women and the impact of project research on family life.

5. Commitment to institution building is demonstrated through support for HC facilities and equipment costs, degree and non-degree HC training and the encouragement of Host Countries to include non-CRSP LDCs in their training initiatives where it is of mutual benefit.

Practices--

1. Of total research costs reported through FY 85 ($11M), exclusive of management and evaluation, the US institutions contributed 18 percent ($3M) and the HC institutions contributed 12 percent ($2M).

2. US and HC project personnel come together at one or the other site a minimum of once a year to share ideas and discuss progress of research and training, plan for the next year's work and agree to annual line item budget distributions.

3. CRSP-trained students strengthen national programs and are the US and HC professional resource pool for future AID assignments.

4. Project achievements because of the collaboration tend to be achievements which benefit both LDCs and US agriculture.

5. WID efforts concentrated first on extensive literature reviews and the subsequent development of comprehensive, country-specific Women-in-Agriculture Resource Guides. Currently, attention is focusing on building linkages among (a) selected WID groups at US lead institutions, (b) the CRSP projects at those institutions and (c) WID liaison persons in the Host Countries to be affiliated with the HC CRSP personnel.

6. Institution-building through limited-cost facilities such as screenhouses and rain-out shelters has advanced CRSP research. Critical, but previously unaffordable, equipment as well as basic supplies have made important HC research possible and HC collaboration viable. Institution-building via training through 1985 boasts among the degree students 36 at the Baccalaureate level, 88 at the Masters level and 55 Ph.D. level, for a total of 179 degree students. In the non-degree training, 739 students participated. Female representation in training efforts has been above average and steadily improving. Having French, Spanish and Portuguese speaking institutions involved has opened up CRSP resources to a wide and diverse audience.

Pitfalls and Lessons Learned--

1. A critical mass of professional, experienced collaborators increases the likelihood of project success. Where there is no full-fledged national working researcher as HC Principal Investigator (PI) or the person so designated is actually an administrator, research lags behind the more vigorous projects where there is active research collaboration. Training the needed minimal number is too long a process to rely on and is fraught with many potential problems which could seriously undermine the whole effort (one male HC student died just prior to graduation). The existence of senior HC researchers also increases the chances for sizeable HC institutional contributions and project institutionalization.

2. Graduates from CRSP-supported training efforts maintain their excitement and high morale and continue to contribute to CRSP research to the extent that CRSP resources make available to them the otherwise unobtainable research tools and support (e.g., up-to-date scientific information and a minimal operational budget).

3. Some HC PIs are unaccustomed to rigorous accounting procedures and money management. The involvement of the budget officer at the HC institution as well as other high-level administrators is very important. While the same may be true in the US institutions, their contracts offices are usually very familiar with AID requirements and provide important backstopping to the projects.

4. Budget reductions have long-range implications as serious losses of confidence can result. Host Countries stimulated to high levels of activity cannot be stopped and then expected to pick up again later where they left off. The lack of stability in support and training can reverse the new integrity which has evolved within the international research system as a result of CRSP contributions.

5. Religion and cultural mores sometimes influence the extent to which HC women can participate in the CRSP. The presence of women throughout the US team facilitates this process in the Host Countries.

REGIONAL AND INTERNATIONAL NETWORKS

Policies--

1. A mutually beneficial, open-door policy is maintained between the CRSP and identified IARCs.

2. MOUs have been signed by the CRSP with both CIAT and IITA pledging support and constant communication to insure the complementarity of each other's research efforts.

3. Coordination and participation with other international agencies and programs is encouraged where there is mutual benefit.

Practices--

1. The Bean/Cowpea CRSP has active linkages with many organizations, examples of which are:

   a. International Agricultural Research Centers--IITA, CIAT, IRRI (IITA and CIAT participated in the planning and development of the CRSP and have continuous representation on the CRSP Technical Committee).

   b. International Organizations--United Nations (International Atomic Energy Agency), EEC, French Tropical Crops Institute (GERDAT).

   c. Regional Organizations and Projects--INCAP, SAFGRAD, NIFTAL, Sahel USAID IPM Project.

   d. US Organizations--USDA, Bean Improvement Cooperative, Farming Systems Support Project (University of Florida).

2. The CRSP has helped facilitate international/regional workshops and conferences. Most of the participants in these activities are HC nationals. Some examples include:

   a. Worldwide Cowpea Research Conference (1984)(IITA/CRSP)--A state-of-the-art book resulted from this conference. CRSP researchers are major contributors. A second publication from this conference is presently in press.

   b. Bean Rust Workshop (1983-Puerto Rico)(CIAT/USDA/UPR/CRSP)--Developed worldwide uniform bean rust grading scale and universal differentials for rust identification.

   c. Biological Nitrogen Fixation Workshop (1983)(CRSP/University of Wisconsin).

   d. MSTAT Computer Workshop (1984)(CRSP/Michigan State University).

e. Tepary Bean Workshop (1985)(CRSP/Government of Mexico).

f. Drought and Temperature Tolerance in Beans and Cowpeas (1985) (CRSP/Government of Mexico).

g. Socio-Agronomic Workshop (1985)(CRSP/MSU)

h. East African Bean Research Workshop (Held annually in Tanzania) (CRSP/Sokoine University of Agriculture).

3. Scientists from the IARCs have taken sabbaticals at CRSP institutions and CRSP researchers have taken sabbaticals at the IARCs. These complementary initiatives were generated by one partner based on institutional strengths in scientific areas proving especially troublesome in the research of the other. Complementary long-term research has been born from this collaboration. In some cases, IARC scientists have moved to faculty positions at participating US institutions, consolidating further both the linkages and the research. The CRSP co-sponsors training at the IARCs and other participating institutions.

4. The research findings from the CRSP which are published in books and journals provide another avenue of communication among scientists. Projects budget-in access to important publications for participating national programs where needed. Support for HC participants to attend international professional meetings is also important.

5. Utilization of research achievements across projects within the CRSP and by others outside of the CRSP is shown in the following examples:

   a. The bean common mosaic antisera and serodetection protocols developed by the CRSP at Washington State University are being used by the USDA to clean up the national bean seed collection. CIAT and other international bean programs are also interested in making use of these techniques.

   b. Germplasm developed in CRSP projects is shared with scientists across national programs and in international centers. Cultivars with disease and insect resistance, high nitrogen fixation capacity, improved cooking quality and stress tolerance are examples of materials shared with interested scientists. This process is facilitated by CRSP meetings and workshops where participants see one another's lines and ideas for their use are exchanged.

   c. The CRSP has provided technical assistance to Missions, i.e., the US PI from the University of California-Riverside/Senegal project has served as consultant to the Western Sudan. Technologies developed in one project are available for adaptation in other regions. The CRSP is at a stage now where it has several technologies/methodologies which would improve the research efforts in many countries.

Pitfalls and Lessons Learned--

1. Increasing budget reductions are likely to have the following negative impacts:

   a. Decreased collaborative research travel, isolating the partners' work from one another and eliminating the stimulation of institution-to-institution on-site sharing.

   b. Decline in degree training for HC students and a decline in the numbers and percentage of females among the degree students. More US and LDC students from non-CRSP countries (who had other support for travelling to the university) may replace the HC students.

   c. Weakened national research programs which used CRSP support to focus other resources on CRSP objectives. For example, foreign exchange is so important in one HC that the government agreed to a 100 percent match of each CRSP dollar brought into the country for the project.

2. Constant communication between the CRSP and IARCs is very important to avoid duplication and unproductive competition and to make maximum use of our respective comparative advantages especially in those regions where we are each working. The example given in the Conclusion of this report highlights the importance of this communication.

CONCLUSION

The CRSP has made an important contribution to the establishment of linkages between national programs, international research organizations and the US agricultural research system including USDA and private research institutes. The following example highlights this accomplishment. The head of the bean program at CIAT has recently spoken of the mutually enhancing features of the Bean/Cowpea CRSP and CIAT. Three of his points are especially illustrative:

1. CRSP basic research is making important contributions to the ability of CIAT to advance its program. The viral work of the Washington State University/Tanzania project, the BNF work of the University of Wisconsin/-Brazil project, the work on biological control of insects of the Boyce Thompson Institute/Brazil project and the heat and drought work of the University of California-Riverside/Senegal project are all examples of CRSP research whose output is being incorporated in the research of the international centers.

2. CRSP national program contributions strengthen CIAT's research effectiveness especially where the national programs were weak in terms of numbers of professional staff, infrastructure and operational research capacity. For example, in the Dominican Republic where the CRSP has trained well-prepared researchers, added critical infrastructure and provided support for on-going research activity, more CIAT materials are being tested, the work is superior and the materials coming out of that research are enriched by the inclusion of other lines developed through CRSP research as well as those from CIAT. Programs strengthened in this way are more receptive to participation in CIAT research and are more professionally confident. The materials generated are much improved and transferable to other CIAT efforts. Thus, CRSP-strengthened national programs have become a reinforced and increasingly dynamic link in the flow of professional interactions and subsequent research achievements in the total agricultural research system. This is in contrast to situations which often existed before the CRSP, where beleaguered national programs were the point at which things bog down.

3. CRSP training for HC students not only adds to the critical mass of professionals in national programs, those students also (a) work with specialists at the universities on bottleneck problems and (b) themselves move easily among the national programs, CRSP institutions and the IARCs, strengthening these linkages in the process of their training. Thus, not

only are they well-trained, they also do research highly relevant to the national programs and the IARCs where research progress had been blocked. In addition, they reinforce the inter-program linkages which will be mutually beneficial to all parties. The CIAT bean program leader cited the MSU/Malawi project in regard to this point. As CIAT moves more substantively into Africa, they see as one of their biggest challenges the vast genetic heterogeneity of bean mixtures common throughout certain regions of that continent. Because Western research has traditionally been based on pure lines, he feels the products of the MSU/Malawi project's research (genetic, agronomic and socio-cultural) will be an absolute must--the baseline data and understanding of the system are all requisites for CIAT's work being developed there.

Reinforcing this position, the following is the latest published report from the CRSP External Evaluation Panel which emphasizes the important and dynamic contributions from the linkages built by this collaborative model.

There is good evidence that:

1. The CRSP is a mechanism which supports better equity within research teams engaged in development activity. The model develops a pattern of interaction which is not hierarchical but collegial in nature, providing an important avenue for the active participation of HC professionals in the development process.

2. The CRSP provides one vehicle for the contribution to development of science and technology as a necessary but insufficient partner along with such factors as government pricing policy and extension. As such, the CRSP is an important component of the US bilateral assistance program contributing to the total AID effort to alleviate world hunger.

3. The CRSP has shown itself to be a rapid method of generating technology fitting the specific needs of Host Countries. It is an effective way to transfer and build greater capacity to solve problems and generate new knowledge.

4. The CRSP is a catalyst for specific CRSP-related scientific work without which, in many countries, the work could not be done.

5. The CRSP is a catalyst for scientific activity beyond the purview of the CRSP itself as both the research and the professional relationships stimulate energy and initiatives that ripple farther than the original mandate.

6. The actual research, involving the collaboration of scientists cross-nationally, and the training of new professionals effectively supports the institution-building components of this CRSP. Both within the African and Latin American regions and across regional lines, professional networks are evolving which strengthen the institutional capacities of participating organizations.

7. The CRSP training resources effectively utilize a variety of training modes (degree/non-degree, formal/informal, domestic/international) directly geared and linked to the needs of the countries. Further, HC students have the opportunity to study in the US with US professors who are working on behalf of the students' own countries and frequently are working intermittently in these countries.

8. The CRSP has attracted a remarkable number of US and HC scientists. In the US it has strengthened interest and capability of US institutions to understand and participate in development.

9. The CRSP supports attention to the role of women in agriculture and the involvement of women in its projects. It has improved the attitude of male professionals toward working with professional women. Attention is being paid to efforts to advance women through the system.

10. The CRSP, in evolving a problem-solving network, has developed a community of US and HC scientists for scientific and technological development which should prove itself productive over the long term.

In addition, there are specific contributions to US agriculture from this model which were noted in the EEP report.

1. Bean/Cowpea CRSP projects/activities are concentrated largely on producing superior bean and cowpea cultivars and supporting production technologies (e.g., enhanced N-fixation). Predictably, these cultivars and technologies will contribute directly and indirectly to the development of superior cultivars and production technologies for the United States.

2. An important related activity of most CRSP projects is the collecting, describing, cataloguing and conserving of bean and cowpea germplasm. These irreplaceable genetic resources will become available over time to the United States and to other bean and cowpea growing

nations and, therefore, will increase the range and diversity of genetic stocks available for improvement programs.

3. New resources and procedures for the control of pests and diseases in bean and cowpea production are emerging, i.e., insect pathogens, antiserum procedures to assess virus strains in transported plant material. These new technologies will not only support legume improvement programs in the US and other legume-producing countries, but they will also expedite the ability of nations to utilize one another's plant material in adaptation trials and improvement programs across national boundaries.

4. The Bean/Cowpea CRSP has a limited, but highly important, focus on improving the human nutritional characteristics of beans and cowpeas through breeding, processing and food science programs. This focus can be expected to have a salutory impact on bean/cowpea production research, as well as home and commercial processing which ultimately will contribute to United States industrial interests.

5. The Bean/Cowpea CRSP helps to build and support effectively functioning international agricultural research networks. These networks are made up of individual professionals, many of whom will have studied together under CRSP sponsorship, as well as an array of research institutions which will have been strengthened through their CRSP involvement. Such global networks serve US agricultural interests and can frequently pay handsome dividends in unexpected ways over the long term.

The fruits of these national, regional and international linkages are apparent in the examples of the major accomplishments of the Bean/Cowpea CRSP presented below. Experience-to-date suggests this process to be exponential as the achievements of one project contribute unexpected insights to another. Our present challenge is to maintain the excitement and viability of this dynamic program in the face of the impending additional budget reductions. Whatever the outcome, however, there is no question that CRSPs have already made significant contributions toward the alleviation of hunger and malnutrition far beyond the AID financial investment.

SIGNIFICANT ACCOMPLISHMENTS

THE BEAN/COWPEA COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)
Michigan State University
April 4, 1986

The Bean/Cowpea CRSP held a five-year review at Michigan State University from January 19-24, 1986. Approximately seventy researchers gathered to discuss past activities and to plan future programs. Six major bean and cowpea constraints to production and utilization were addressed; (1) insects, (2) diseases, (3) plant responses, (4) physical environment, (5) nutrition, food preparation and health and (6) farming systems, production consumption economics and socio-cultural factors.

VIRTUALLY EVERY US BEAN PROGRAM, WHETHER PUBLIC OR PRIVATE, IS BEING HELPED DIRECTLY OR INDIRECTLY THROUGH RESEARCH EFFORTS OF ONE OR MORE OF THE CRSP-RELATED PROJECTS. These benefits are in the form of basic and applied information and new germplasm resources from around the world which will lead to improved US cultivars, better production practices and nutritional quality. Basic research in bean plant physiology and genetics is unlocking important doors leading to increased yield potential. CRSP activities have made available to researchers new sources of disease and insect resistance which have been incorporated into their breeding programs. Extensive efforts in germplasm collection and preservation have contributed valuable germplasm to the world collection. These efforts will help buffer the serious consequences of past genetic erosion of bean and cowpea germplasm. The Bean/Cowpea CRSP has had significant impact on the domestic bean/cowpea research programs as well as helping many developing country programs.

IN SPITE OF THE DROUGHT IN 1985, SENEGAL INCREASED COWPEA PRODUCTION FIVEFOLD UTILIZING RESEARCH FINDINGS OF THE BEAN/COWPEA CRSP. Researchers at the University of California-Riverside have been working with the national cowpea research in Senegal developing strategies and technologies to deal with the serious drought prevalent throughout the Sahel region. In early 1985 the CRSP project worked with the USAID Mission and European Economic Community delegation to solve a serious shortage of peanut and cowpea seed in Senegal. CRSP research had identified a cultivar which performed well in Senegal. Seven hundred tons of California Blackeye #5 seed were shipped from California to Senegal, arriving in June 1985. This seed provided approximately 100,000 farmers with seed to plant. With the introduction of this variety, cowpea production increased in Senegal from 16,000 tons in 1984 to 80,000 tons in 1985. During this serious food shortage period in Senegal, over one million were fed with this new variety. Early maturing cowpea varieties such as this one are important in the food balance equation for subsistence and low input farmers in the Sahelian region.

SEVERAL CRSP PROJECTS HAVE MADE SCIENTIFIC DISCOVERIES WHICH HAVE GLOBAL SIGNIFICANCE. THE BEAN COMMON MOSAIC VIRUS ANTISERA AND SERODETECTION PROTOCOLS DEVELOPED BY RESEARCHERS AT WASHINGTON STATE UNIVERSITY ARE BEING USED TO INSURE FARMERS OF DISEASE-FREE SEED AS WELL AS PREVENT THE SPREAD OF BEAN COMMON MOSAIC VIRUS TO NEW REGIONS. This methodology is rapid, inexpensive and does not require sophisticated training equipment or facilities. This

knowledge will greatly facilitate the correct choice of parents for breeding programs and will improve the efficiency of the screening segregating populations while developing new cultivars with virus resistance. This procedure is being used by USDA and International Agricultural Research Institute personnel.

The CRSP workers at the University of Wisconsin and Michigan State University have been collaborating with the national program in Brazil to improve the nitrogen fixation capability of beans. It was found that there are heritable differences for ability to fix increased amounts of nitrogen between common bean genotypes. CULTIVARS OF BLACK BEANS HAVE BEEN IDENTIFIED THAT FIX UP TO 60 KILOGRAMS OF NITROGEN PER HECTARE UNDER FIELD CONDITIONS. In addition to selecting superior bean cultivars, this project has also identified improved strains of the nitrogen fixing bacteria, rhizobia. In a trial in Cerrado using selected strains of rhizobia, yields were increased from 500 kg/ha to 1600 kg/ha following inoculation. The combination of superior cultivars with improved strains of rhizobia will enable low resource and subsistence farmers to maximize their nitrogen fertilization at very little expense. Methodologies developed in this project can also be used in other legume systems, both in the US and developing countries.

RESEARCH AT THE INSTITUTE OF NUTRITION FOR CENTRAL AMERICA AND PANAMA (INCAP) AND WASHINGTON STATE UNIVERSITY LINKS BEAN PRODUCTION-ORIENTED RESEARCH WITH SCIENTIFIC IMPROVEMENTS IN CONSERVATION, ACCEPTABILITY, COOKING QUALITY AND NUTRITION. The research programs address factors responsible for bean quality, nutritional quality, processing and food product development. Considerable effort has been focused on the hard-to-cook phenomena which renders beans unduly firm after cooking, lowers the nutritive value and requires more fuel for cooking. INCAP research shows that two processing treatments can minimize or control bean hardening. Genetic and environmental factors have been identified which cause the hard-to-cook problem. By incorporating germplasm which require less cooking time, firewood/fuel requirements in many areas can be greatly reduced. This factor alone will have significant impact on subsistence economies as well as reduce environmental degradation due to firewood collection.

WORK AT KANSAS STATE UNIVERSITY INDICATES THAT HARD-TO-COOK BEANS ARE PROBABLY NOT DUE TO UNGELATINIZED STARCH OR FAILURE OF THE RAW BEAN PROTEIN TO DENATURE. Water migration does not limit cooking time of beans. Studies at Washington State University showed that the interaction among phytate, proteins and minerals relate to the hard-to-cook phenomenon. Quantitative relationships among phytate, calcium and magnesium are predictive of cooking time.

WOMEN IN DEVELOPMENT (WID) HAS PLAYED AN IMPORTANT ROLE IN PROGRAM ACHIEVEMENTS OVER THE FIRST FIVE YEARS OF THE GRANT. Principal investigators in the agricultural sciences have been provided with ready access to information on the social and economic parameters of agricultural production and utilization in the Host Countries through the publication of a series of Women in Agriculture Resource Guides. This information has assisted in the development of research agendas that are socially as well as agronomically sound. For example, recognizing that lack of access to draft power represents an important constraint to timely planting for many of the one-third of rural households headed by women in Botswana, CRSP researchers are designing implements that reduce draft power requirements. In Cameroon, new and improved cowpea vari-

eties are being developed that take into account the multiplicity of uses of cowpea plants (for human consumption in the form of leaves, pods and dried cowpeas and for animal fodder) in the farming systems. In addition to its contributions in the area of research, WID has achieved significant results in the area of training, actively recruiting qualified women to participate in the CRSP's degree training program. Over one-third of those who received degrees under CRSP auspices during the first five years of the grant and almost half of those currently enrolled in degree programs are women.

A major objective of the CRSP is to insure sufficient human resources to promote bean and cowpea production and utilization throughout the world. The Bean/Cowpea CRSP has a very impressive training record. OVER 80 RESEARCHERS HAVE COMPLETED DEGREE TRAINING (50 MALES AND 30 FEMALES) WHILE 739 HAVE COMPLETED NON-DEGREE TRAINING PROGRAMS (532 MALES AND 207 FEMALES). These "problem solvers" will be able to provide dynamic and innovative leadership necessary to identify and solve the problems which are before us.

THIS CRSP HAS BEEN ABLE TO ESTABLISH A NETWORK OF BEAN AND COWPEA RESEARCHERS THROUGH CONFERENCES, SUMMER WORKSHOPS AND RESEARCH PROGRAMS. This network has provided the linkages necessary to address the important issues and to develop strategies pertaining to bean and cowpea production and utilization. This network has also accessed other agricultural programs in the pursuit of scientific understanding as well as applied agriculture. It has also given many scientists in developing countries the opportunity to work collaboratively with scientists in the United States, gain exposure to current techniques and research methodologies and have access to sophisticated equipment and supplies which would otherwise be unavailable to them. The CRSP has been very effective in getting the involvement of basic scientists in international development activities.

THE DEPLOYMENT OF NEW TECHNOLOGIES AND METHODOLOGIES BY THIS NETWORK OF RESEARCHERS IS VERY IMPORTANT. Twenty-three students and researchers completed an intensive microcomputer workshop which showed how the researchers could utilize microcomputer technology in their research programs. The CRSP has provided microcomputers to many programs which will maximize the efficiency of trained personnel. Other workshops included (1) Biological Nitrogen Fixation, (2) Dry Bean Quality and Women and Food Concerns, (3) Socio-Agronomic, (4) Tepary Bean, (5) Drought and Temperature Tolerance and (6) Utilization of Grain Legumes and Grain.

THE CRSP HAS MADE SEVERAL CONTRIBUTIONS TO THE COWPEA BREEDING PROGRAM IN CALIFORNIA WHICH DEPENDS MAINLY ON A CULTIVAR DEVELOPED MORE THAN 40 YEARS AGO. New varieties are needed because the present cultivar is sensitive to heat and to a major disease--fusarium wilt. The CRSP made possible the discovery of heat-tolerant germplasm which is now being used to develop improved varieties for California. Heat tolerant genes identified by this CRSP research are just one of the new sources of important germplasm needed for the development of improved new cultivars.

FROM 1500 BEAN LINES SCREENED ANNUALLY IN MEXICO, A NUMBER HAVE BEEN IDENTIFIED WITH DROUGHT TOLERANCE. Pinto Nocionel 1 was identified to have drought resistance and was recommended to farmers. Several drought tolerant lines were identified which were included as germplasm in crossing programs; these included N81017, Ags77, Ags41, Zacatecas 89-79 and Durango 5.

THE CRSP HAS FACILITATED MULTIDISCIPLINARY RESEARCH BY FOCUSING ATTENTION ON THE NEEDS OF SMALL-SCALE PRODUCERS OF BEANS AND COWPEAS. The CRSP has stimulated many bean and cowpea research programs throughout the world. "Practical lessons" and "scientific principles" learned from these expanded programs have been utilized in the United States as well as developing countries.

IN CAMEROOM THE CRSP HELPED TO IDENTIFY A HIGH YIELDING CULTIVAR, TVX 3236 FOR WHICH SEED DEMAND HAS GONE FROM FIVE METRIC TONS IN 1984 TO FORTY-SEVEN TONS IN 1986. With improved cultivars and pest management introduced by the CRSP project, farmers can expect average yields of 600-1200 kilograms per hectare compared to 300 kilograms before the CRSP project.

APPROXIMATELY 200 STRAINS OF INSECT PATHOGENIC FUNGI ARE NOW AVAILABLE TO THE SCIENTIFIC COMMUNITY FOR BIOLOGICAL INSECT CONTROL RESEARCH. Boyce Thompson Institute has conducted research on the biological control of cowpea and bean pests with insect pathogens. Since there was virtually no information on the diseases of insect pests of these crops before the CRSP, an initial objective was to survey fields for diseased pests. Cultures of disease agents were obtained, identified, and placed in liquid nitrogen storage. These pathogenic fungi are being tested for the control of several major cowpea pests.

AT BOYCE THOMPSON INSTITUTE FOUR OUT OF TWO HUNDRED COWPEA LINES FROM THE GEORGIA PLANT INTRODUCTION SHOWED AN ANTIBIOSIS RESISTANCE TO THE COWPEA APHID. It was also shown that aphid-resistant lines from IITA were not resistant to the Georgia population of the cowpea aphid. These findings show that breeding strategies need to consider biotype differences in their programs.

THE COLLABORATION OF CORNELL CRSP WORKERS WITH CIAT, ECUADOR AND GUATEMALA HAS IDENTIFIED VALUABLE GERMPLASM FOR THE NEW YORK BREEDING PROGRAM. Crosses are being made between New York bean cultivars and those identified as being later to flower with a mechanism other than sensitivity to long day length and high temperature. This later maturity caused by non-photoperiod sensitivity should facilitate higher yields of beans in the long summer days of New York.

THE CORNELL CRSP PROJECT INVOLVEMENT IN INTERNATIONAL TESTING HAS PROVEN VERY EFFECTIVE IN UNRAVELING THE PHOTOPERIOD REACTIONS IN BEANS. Tropical locations in Guatemala have proven more effective in assaying the control over day to flower and maturity of beans by day length and for high temperature than is the climate of New York State. This enhanced our ability to select for different maturities that are needed to maximize cultivar adaptation and bean yields for many different locations, including the temperate climate of New York State, the lowland tropics, moderate elevation tropics and the highland tropics.

CORNELL'S CRSP RESEARCH IN GUATEMALA HAS FOUND THAT ABILITY OF CLIMBING BEAN CULTIVARS TO COMPETE WITH THE ASSOCIATED CORN CROP IS CONDITIONED PRIMARILY BY THE CULTIVAR'S MATURITY AND THE POSITION ON THE STEM OF FLOWERS AND PODS. That is, early vs. late maturity plus vertical distribution of the pods along the stem constitute the primary genetic variability needed by plant breeders in climbing beans. This information is being utilized by Guatemala's Institute of Science and Technology of Agriculture in their program to breed climbing bean cultivars for the native Indian farmers of the highlands.

PRELIMINARY CRSP RESEARCH IN GUATEMALA HAS SHOWN THAT CHILDREN EATING SIGNIFICANT QUANTITIES OF BEAN BROTH REPORTED FEWER INCIDENCES OF DIARRHEA AND WERE TALLER AND HEAVIER THAN CHILDREN EATING LITTLE BEAN BROTH. The diets of children not fed bean foods contained significantly less protein and energy than diets containing bean foods. Research on digestibility of protein, water uptake, protein quality and quantity and antinutritional factors in beans will lead to the development of improved cultivars which can improve the diets of urban and rural populations.

THREE BEAN CULTIVARS WERE IDENTIFIED WITH RESISTANCE TO THE BEAN FLY, OPHIOMYIA PHASEOLI. These lines are being incorporated into the crossing programs in Tanzania and CIAT.

STUDIES AT BOYCE THOMPSON INSTITUTE INDICATED A WIDE RANGE OF VEGETABLE AND MINERAL OILS PROVIDED SHORT-TERM PROTECTION OF THE SEED. The bruchid storage beetle causes serious post harvest losses. Efficacy of oils was greatly improved when containers were closed, indicating the potential for the use of sealed containers as a control strategy, replacing the costly and dangerous insecticides.

THE COLORADO STATE UNIVERSITY/BOTSWANA PROJECT HELPED TO DEVELOP AND TEST TWO NEW FIELD CULTIVATION IMPLEMENTS. The ridgeshaper/planter is suitable for soils with eight or more centimeters of friable surface soil and no compaction. It can be pulled by two donkeys in coarse-textured soils. It can be fabricated locally at very low cost. The cultivator/planter is capable of preparing a seedbed on plowed or unplowed land and planting at the same time. It is readily adaptable to strip tillage if desired. Draft requirements are two oxen or four donkeys.

RESULTS FROM EXPERIMENTS CONDUCTED AT THE UNIVERSITY OF GEORGIA DESIGNED TO ENUMERATE ASPERGILLUS FLAVUS IN COWPEAS AND IN COWPEA FLOUR REVEAL THAT A. FLAVUS AND A. PARASITICUS MEDIUM IS MOST SUITABLE. This medium is recommended for use by microbiologists interested in monitoring cowpeas for the presence of potentially aflatoxigenic strains of these molds.

A PROCESS WAS PERFECTED AND IS AVAILABLE FOR IMMEDIATE APPLICATION FOR LOOSENING COWPEA SEEDCOAT SO THAT THE GRAINS ARE EASILY AND EFFICIENTLY DEHULLED IN THE DRY FORM. The process involves wetting and dry-tempering.

IN GENETIC STUDIES AT MICHIGAN STATE UNIVERSITY IT WAS SHOWN THAT DOMINANCE IS GREATER THAN ADDITIVE VARIANCE FOR IMPORTANT CULINARY AND NUTRITIONAL TRAITS OF DRY EDIBLE BEANS. Studies have also shown that selection in early generations is possible for trait improvement. Protein and procyanidin were shown to be inherited quantitatively.

THE NEBRASKA/DOMINICAN REPUBLIC PROJECT OBTAINED INFORMATION ON THE INHERITANCE OF RESISTANCE TO COMMON BLIGHT AND RUST. They found that the reaction of leaves and pods to common blight were inherited quantitatively and that different genes controlled resistance reaction in different plant parts. A simply inherited hypersensitive reaction was detected in some sources of common blight resistance. Bacteriophage typing studies substantiated the wide variation among strains of common blight in the Dominican Republic and the distribution of strains was random.

POMPADOUR CHECA, A RED MOTTLED DRY BEAN, WAS IDENTIFIED AS RESISTANT TO ALL KNOWN STRAINS OF RUST IN THE DOMINICAN REPUBLIC AND NEBRASKA. The rust reaction was determined by two major genes with resistance being expressed in the presence of a major gene exhibiting epistasis.

THE UNIVERSITY OF WISCONSIN, WORKING WITH EMBRAPA IN BRAZIL, HAS DEVELOPED INOCULATION TECHNIQUES FOR THE SEQUENTIAL INOCULATION OF FOUR MAJOR BEAN DISEASES (RUST, COMMON BLIGHT, ANGULAR LEAF SPOT AND ANTHRACNOSE). This will expedite the development of multiple disease resistant bean cultivars which will help stabilize bean yields.

THE UNIVERSITY OF PUERTO RICO, IN COOPERATION WITH RESEARCHERS IN THE DOMINICAN REPUBLIC AND HONDURAS, HAVE DEVELOPED BEAN CULTIVARS WITH MULTIPLE DISEASE RESISTANCE. Several cultivars have been released by this program and are providing farmers with stable yields. The white-seeded cultivar, Arroyo Loro, has done well in both the Dominican Republic and Puerto Rico. Germplasm with disease resistance has also been identified and released for plant breeders to use in their breeding programs. These lines are important sources of resistance to rust, bean common mosaic virus, angular leaf spot, common blight and web blight.

THE UNIVERSITY OF CALIFORNIA-RIVERSIDE PRODUCED SEVERAL POPULATIONS OF INTERSPECIFIC HYBRIDS BETWEEN THE COMMON BEAN AND THE TEPARY BEAN. These progeny were evaluated for drought tolerance in Kenya.

RESEARCHERS AT MICHIGAN STATE UNIVERSITY ARE STUDYING THE ORIGIN AND MAINTENANCE OF GENETIC DIVERSITY IN MALAWI BEAN LANDRACES. They are looking at farmer practices as well as natural events which contribute to diversity. Farmer surveys, electrophoresis and other techniques are being utilized to understand diversity.

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