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A GRANT TO STRENGTHEN THE INSTITUTIONAL RESPONSE CAPABILITIES OF THE UNIVERSITY OF ILLINOIS IN IMPROVEMENT OF SOYBEANS FOR TROPICAL AND SUBTROPICAL AREAS

ANNUAL REPORT OF GRANT AID/CM/TA-G-73-49
OCTOBER 1, 1976 TO SEPTEMBER 30, 1977

SUBMITTED TO

THE AGENCY FOR INTERNATIONAL DEVELOPMENT
DEPARTMENT OF STATE
WASHINGTON, D.C.

BY

THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
COLLEGE OF AGRICULTURE
INTERNATIONAL SOYBEAN PROGRAM, INTSOY

A GRANT TO STRENGTHEN THE INSTITUTIONAL RESPONSE CAPABILITIES

OF THE

UNIVERSITY OF ILLINOIS

IN

IMPROVEMENT OF SOYBEANS FOR TROPICAL AND SUBTROPICAL AREAS

Annual Report of Grant AID/CM/ta-g-73-49

October 1, 1976 to September 30, 1977

Submitted to

The Agency for International Development
Department of State
Washington, D.C.

By
The University of Illinois at Urbana-Champaign
College of Agriculture
International Soybean Program, INTSOY

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A. Title Page

Grant Title: A Grant to Strengthen the Institutional Response Capabilities of the University of Illinois in Improvement of Soybeans for Tropical and Subtropical Areas

Grantee: University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

Grant Program Directors: Dr. William N. Thompson, INTSOY Director
Dr. Carl N. Hittle, Professor of Plant Breeding

AID Sponsoring Technical Office: TA/AGR

Statistical Summary:

Period of Grant:	October 1, 1973 to September 30, 1978
Amount of Grant:	$500,000
Expenditures for Report Year:	$130,687
Anticipated for Fifth Year:	$129,560

B. Narrative Summary

Special emphasis was placed on developing improved soybean genetic technology for small farmers in the tropics and subtropics. Grant staff, cooperating with UPR/Mayaguez and other collaborators, made possible primary research activities which included a crossing program, segregation of populations, germplasm evaluation, and a preliminary observation trial. Associated research was conducted in seed quality, storage, resistance to viral diseases and insects, soil fertility, and weed control.

Five graduate students serving as research assistants contributed to grant objectives during the report period. One completed a master's program and four others are continuing in doctoral programs. Graduate student research involved studies of the effects of daylength on nodule activity, inheritance of drought resistance, seed proteins, selection for seed oil and protein and effects of selected variables on intercropping of soybeans.

Two short courses were conducted: "Soybean Processing for Human Food" and "Technical and Economic Aspects of Soybean Production" with support from USDA, AID and other donors. Special soybean familiarization courses were designed for a team from the Iranian Oilseed Research and Development Company. In-country seminars were conducted in Ecuador and Peru under existing Task Order arrangements. A major workshop on soybean rust was held in Manila, The Philippines. Sponsorship included the Philippine Council for Agriculture and Resources Research (PCARR), the Asian Vegetable Research and Development Center (AVRDC), AID and INTSOY. Financial and other support was provided by these and other sources.

Development of advisory and consultation capacity was given significant impetus from nongrant sources. A series of Task or Purchase Orders issued under AID Basic Ordering Agreements provided opportunity to render advisory assistance in five LDCs--Peru, Ecuador, Ghana, Zaire and Panama. Problem identification and program planning advisory services were requested. INTSOY teams composed of core staff, UIUC personnel, associated institutions' personnel, and private organizations and individuals worked in close cooperation with host country and AID mission personnel to accomplish the tasks assigned. The opportunities for establishing new linkages, or strengthening the existing ties, were important aspects of this activity.

Continued support was given to the Soybean Insect Research Information Center, a computerized information storage and retrieval system for the worldwide literature of arthropods associated with soybeans. During the report period, 173 requests for services were filled in the form of computer printouts, literature searches and copies of documents to investigators in the following countries: Australia, Bolivia, Brasil, Canada, Colombia, El Salvador, Ecuador, Honduras, Iran, Israel, Korea, The Philippines, Sri Lanka, Sweden and Taiwan.

Domestic and international linkage formation made excellent progress. The primary domestic linkages with AID, UPR/MC and USDA/ARS were strengthened through consultation and coordination in program planning activities. Associated U.S. institutions and personnel cooperated in technical assistance activities and in general program planning. UIUC and UPR/MC sponsored an International Soybean Network Conference at Urbana, Illinois, May 25 and 26, 1977. Representatives from 16 institutions, governmental agencies and international organizations attended. Linkages with international centers and LDCs were advanced through a series of memoranda of understanding. The grant co-directors participated in consultations with representatives of international, national, and regional organizations to advance planning for an international network of organizations and individuals with interests in soybean research and educational work. The plant breeding program at UPR/MC participated significantly in linkage-building activities by providing seed for the International Soybean Variety Experiment and the Soybean Preliminary Observation Trial. These trial programs link directly to national soybean efforts in over 100 countries. The INTSOY Newsletter links the core staff with over 1,700 subscribers, more than half of whom are associated with foreign agricultural research education and development institutions. The INTSOY Publication Series provided the mechanism for linking scientists within the cross disciplines through a diverse series of monographs and conference proceedings.

C. Detailed Report

1. General Background and Description of the Problem

Soybeans offer a greater potential for lessening the LDC protein and calorie shortage than any other grain legume. Soybeans, averaging about 40 percent protein, with excellent nutritional balance and the capability of producing high yields, are the most promising potential source of vegetable protein, and also produce large quantities of useful edible fats. Furthermore, soybeans produce a high yield of protein per unit of energy expended in the production process. Experience in the International Soybean Variety Experiment (ISVEX) and various national soybean development programs indicate that the soybean is a far more widely adaptable legume than was previously thought; satisfactory yields can be obtained over a wide range of agro-climatic conditions following good management and cultural practices.

Presently, soybean culture is concentrated in the United States, Brasil, and Mainland China, with significant additional production in Indonesia, Mexico, and the Soviet Union. Most of the world's soybeans are grown at latitudes greater than 30^{o}. Recent evidence indicates that soybean cultivation is also practical under small farm conditions in tropical and subtropical areas, including many regions where protein shortage is presently acute. However, to accelerate the rate of expansion more information is needed on the cultural requirements of the crop in these latitudes and varieties are needed which are better adapted to short day-lengths and high temperatures. There is an acute need for a mechanism to disseminate information and seedstocks which will contribute to high production, and for training of technical personnel in modern techniques of growing soybeans in lower latitudes.

An analysis of institutional strengths to address the problems inherent in the development of a comprehensive international soybean program readily affirmed the grantee's capacity to undertake the task. The University of Illinois at Urbana-Champaign has played a leading role in soybean research since the 1920's, and has enjoyed international reputation for the excellence of its soybean program since the 1930's. For the past 20 years, Illinois has been heavily involved in institution-building and agricultural advisory activities in several developing countries, and since 1965 has given a particular emphasis to international assistance for soybean development.

The University of Illinois, through the cooperative International Soybean Program, INTSOY, has had a significant role in assisting local research personnel to undertake successful soybean trials in a number of tropical and subtropical countries. As a long-established center of excellence in soybean research, Illinois is in a unique position to further develop high competence in soybean improvement with special relation to the problems encountered in tropical and subtropical areas. The University of Illinois has outstanding staff, laboratories, research facilities, library support and the basic infra-structure needed for a major international program in soybean research, development and linkages. In its College of Agriculture, virtually all the departments are involved to some extent in research, extension and teaching activities related to soybeans.

The USDA/ARS Regional Soybean Laboratory, located on the UIUC campus, is the principal federal activity for research on soybean improvement. Activities on the project are closely coordinated with those of related university departments. All professional staff members of the Laboratory have joint university appointments and are available for consultation, cooperation, and supervision of graduate student research.

Outstanding library, laboratory and field facilities are utilized. Specialized equipment required for the most sophisticated research is available on the UIUC campus.

Cooperative arrangements with the University of Puerto Rico/Mayaguez Campus enhance the direct capabilities of the University of Illinois for field work on soybeans in tropical environments. This grant is complementary to a 211(d) grant administered by the University of Puerto Rico/Mayaguez whose focus is protection of the soybean plant.

2. Purpose of the Grant

The purpose of the grant, as stated in the original grant document, is to strengthen the competence of the University of Illinois in a collaborative program with the University of Puerto Rico, to provide needed research, training, research and information linkages, technical assistance, and consultation on major problems related to the improvement and development of production techniques for soybeans in tropical and subtropical areas. The developed competencies will be used to improve soybean production and utilization to provide protein in diets of low-income people throughout the world.

Following the scheduled 18-month review of the grant program in April 1975, the statement of purpose was modified. In the redesigned grant, the program purpose is to develop, mobilize and maintain a U.S. institutional response capability in soybean production, and use the competence, leadership and facilities of UIUC and the University of Puerto Rico/Mayaguez Campus in focusing on the solution of LDC problems, with emphasis on technology applicable to the small farmer and improving nutrition of the urban and rural poor.

Upon completion of the grant program, a core of experienced faculty will have been developed with supporting knowledge generating, storage, retrieval, and delivery systems. These provide the capacity to respond to the needs of the LDCs of the tropics and subtropics, in efforts to improve their capabilities to produce food protein and calories, and to market and use soybeans in direct economical forms acceptable and within the means of the urban and rural poor. As an outgrowth of the grant program, UIUC and its associated U.S. institutions can be expected to become the center of competence in all phases of soybean production, protection, marketing and use, and information systems for the tropical and subtropical regions of the world.

3. Objectives of the Grant

a. The objectives

The original grant objectives focused on the development of soybean genetic technology to assist tropical and subtropical LDCs in increasing their supply of protein. Other objectives included research and informational linkages to soybean improvement programs in other countries.

In the program redesign exercise, and with encouragement from AID, the objectives were refined and expanded to reflect a broadened programmatic approach to the problem. The objectives or program outputs, were designed to strengthen the competence of UIUC in selected areas and improve its communications with appropriate institutions in the U.S. and abroad so that an institutional response capability could be achieved in the areas of soybean production, protection, marketing, utilization and development of related information systems for tropical and subtropical regions of the world. Five major objectives (outputs) were to be addressed:

(1) An improved education and training capability. Improvement of educational capabilities at UIUC and associated U.S. universities and research and educational organizations make it possible for faculty and students to acquire greater knowledge, and also for a greater institutional response capability of production, protection, marketing, and use of soybeans in tropical and subtropical regions.

(2) An extended knowledge base and research capability. This includes development of soybean genetic technology for small farmers of the tropics and subtropics. Temperate zone genetic technology provides a base on which to build in developing high-yielding varieties, which are resistant to crop hazards, and neutral to farm sizes of the less-developed countries. With high yields, soybeans have the potential to out produce nearly all crops in terms of both high-quality protein and calories per unit of land area. Focus on improved genetic technology to maximize protein and energy production per unit of input provides a meaningful multidisciplinary, interdisciplinary and problem-solving orientation to which virtually all applied agricultural production disciplines can contribute. This approach also capitalizes on the complementarities of the UIUC and UPR/MC.

(3) An increased advisory and consulting capability. This concerns the development of mechanisms which facilitate effective interdisciplinary advisory and consulting capabilities relative to the production and utilization of soybeans in the tropic and subtropic regions.

(4) An improved and expanded information management capability. Development and maintenance of information systems to serve soybean research workers and educators (formal and nonformal) in tropical and subtropical areas, organizations and individuals in the U.S. and international agricultural development networks with interests in soybeans.

(5) An expanded and strengthened set of linkages and networks. The grantee is serving in the leadership role in developing a network of organizations with congruent interests in pursuing the goal of capitalizing on the potentials of soybeans as a low-cost, high-protein and high-energy food for the rural and urban poor of the tropics and subtropics.

b. Review of objectives

The development of selected technologies are important program outputs that are receiving attention and resources. However, the key elements in building a U.S. institutional response capability are those associated with the development of organizational and human resources. Those outputs stressing human resources development, dealing with graduate education and professional training, generation of knowledge and development of advisory capacity are the core of the redesigned program.

c. Review of critical assumptions

In the redesign, several assumptions were made that were important to the attainment of grant objectives. Should one or more prove to be invalid, grant program success would be adversely affected. These assumptions were listed in last year's report and do not need to be repeated here.

Generally speaking the assumptions have been sustained, but the levels of funding anticipated at the time of the grant redesign did not materialize for a number of reasons. This has had an inhibiting effect on attaining targets set in the redesign process and objective areas. In fact it was not until the time of the Fourth Year Review, in February 1977, that official recognition of the grant redesign was made by the AID review team.

D. Accomplishments

The activities for the report period are cast in the model of the grant redesign. These concentrate on (1) improvement of educational capabilities through graduate student education, (2) development of soybean genetic technology for small farmers of the tropics and subtropics, (3) development and maintenance of information systems to serve soybean research workers and educators, and (4) development of an international network of organizations and individuals linked in ways to provide means for (a) stimulating cooperation in, (b) ensuring utilization of, and (c) sustaining soybean development programs for the tropics and subtropics.

Because anticipated funding levels did not materialize, certain activities cited in last year's work plan could not be addressed. These include on-site short courses (I-3), employment of an editor to assist in information dissemination (IV-4) and analysis and improvement of flow of communications to soybean workers worldwide (V-4). Also, funding for on-campus short courses (I-2) was totally outside the grant, although the activity is mentioned in this report.

Output I. Improved Education and Training Capabilities in Soybean Production, Protection and Utilization

The primary objective is to build institutional response capability through strengthening of educational and training capabilities at both UIUC and UPR/MC. Participating institutions in the soybean development network were stimulated to join in an expanded role in education and training. Graduate studies, on-campus and on-site short courses and seminars, workshops and conferences are the primary means of addressing this objective.

1. Graduate Studies

Expansion of the supply of trained personnel is essential to developing institutional response capability of the international soybean network oriented toward the needs of the tropics and subtropics. Support of graduate students, under guidance of experienced soybean workers, is a means of simultaneously broadening and deepening the tropical soybean knowledge base and increasing the numbers of young applied scientists and educators to work on soybeans.

Five graduate students were supported during the reporting period. One student completed a master's program and the other four are continuing doctoral programs. Brief summaries of each student's work follow:

a. Barry Glaz - Supervisors - Dr. D. K. Whigham and Dr. J. E. Harper. Research Area: Studies on the Effect of Date of Planting on the Source-Sink Relationship in Three Soybean Varieties and How this Affects Nodule Activity. (Completed)

This experiment was conducted at the Agronomy South Farm of the University of Illinois, Urbana-Champaign, during the 1976 growing season. Three different soybean varieties (Beeson, Corsoy, and Amsoy 71) were planted at three different planting dates (April 30, May 26, and June 22) in an effort to produce treatments with different seasonal nodule activities.

Measurements on certain characteristics were made at weekly intervals after flowering had commenced, and other characteristics were measured one time at harvest. The seasonal characteristics were measured: total nodule activity (TNA), specific nodule activity (SNA), nodule weight, whole plant nitrogen content, plant weight excluding pods, and pod weight. The characteristics measured at harvest were: grain yield, nitrogen yield, weight per 500 seeds, and seed plus pod weight.

With planting dates, the highest seed yield and seed nitrogen content occurred with the April 30 planting date and the lowest yield and nitrogen content occurred with the June 22 planting date. The first two planting dates were not significantly different for TNA when compared over the entire season, but the TNA during the middle part of podfilling was significantly highest for the May 26 planting date. The June 22 planting date resulted in the lowest TNA throughout the season. Seasonal whole plant nitrogen content was highest at the first planting date and lowest at the third planting date.

Corsoy was the highest yielding variety at all planting dates except for the third planting date when Beeson yielded as well as Corsoy. The only difference in seed nitrogen content among the three varieties was that Beeson was highest in this characteristic at the June 22 planting date. The TNA of Corsoy was not significantly different from that of Amsoy 71 except for one week during podfill when Amsoy 71 had a higher TNA. Beeson had the lowest TNA for the entire season and during podfill of all three varieties. Beeson also had the lowest plant nitrogen content, while plant nitrogen content was not significantly different between Corsoy and Amsoy 71.

The treatments had very little effect on SNA. Nodule weight tended to respond very much as TNA did to the different treatments, although significant increases in nodule weight did not always result in significant increases in TNA.

The highest seasonal plant weight excluding pods for planting dates occurred with the April 30 planting date. Among varieties, the highest seasonal plant weight excluding pods was with Amsoy 71. The highest seasonal pod weight, among planting dates, also occurred with the April 30 planting date, while among varieties, Corsoy and Amsoy 71 were not significantly different.

b. David J. Sammons - Supervisors - Dr. Theodore Hymowitz and Dr. Doyle B. Peters

Research Area: Screening for Drought Resistance and the Inheritance of Drought Resistance in Selected Soybean Cultivars.

Completed:

I. Seedling Screening Experiment (Fall/Winter 1975-1976)
II. Drought Box Experiment (Spring 1976)
III. Field Observations (Summer 1976)
IV. Production F_1 hybrid material (Summer 1976)
V. Grow out F_1 material to produce F_2 generation (Winter 1976-1977)
VI. Study of Ancestral Cultivars of Drought Resistant and Drought Susceptible Cultivars (Summer 1977)
VII. Test F_2 material in field (Summer 1977)

Soybean varieties included in the study are as follows: The starred (*) varieties are those selected as parents and used in crosses (step IV above):

Maturity Group	
0-00	Cayuga, *Grant, Manitoba Brown, *Pagoda
I	*A-100, *Blackhawk, Chippewa 64, Disoy, Earlyana
II	Amsoy, Black Eyebrow, Lindarin, *Magna, Mukden *Seneca
III-IV	*Adelphia, Chief, *Clark 63, Dunfield, Manchu

Work completed through the summer of 1976 (step IV above) is described in earlier copies of this annual report (1975-1976). The work will be reported here that has been completed since that time.

V. Grow out F_1 material to produce F_2 generation (Winter 1976-1977)

F_1 seed produced from the four reciprocal crosses made during the summer of 1976, was grown in the greenhouse and allowed to produce F_2 seed. Approximately 50 plants of each cross were grown. Artificial light, adequate water, and nutrients were provided to encourage vigorous growth and seed production. F_2 seed was harvested from the plants at maturity and saved for field work in the summer of 1977 (step VII).

VI. Study of Ancestral Cultivars of Drought Resistant and Drought Susceptible Cultivars (Summer 1977)

Yield data from the cultivars grown in the summer of 1976 suggested that specific cultivars were resistant or susceptible in terms of drought response. The drought resistant cultivars showed no significant decline in yield under the imposed drought. The drought susceptible cultivars showed a significant decline in yield under the imposed drought. The classification by yield response is tabulated below:

Drought Resistant	Drought Susceptible
Pagoda	Cayuga Grant Manitoba Brown
A100	
Amsoy Mukden Magna	Blackhawk Chippewa 64 Disoy Earlyana
Adelphia Chief Dunfield Manchu	Black Eyebrow Lindarin Seneca Clark 63

The pedigrees of the resistant and susceptible cultivars were inspected, looking for recurring cultivars in their ancestry. The hypothesis was that if certain cultivars occurred repeatedly in the pedigrees of either resistant or susceptible cultivars, then those ancestral cultivars might be themselves sources of drought resistance or drought susceptibility. These recurring cultivars were field grown in replicated trials under simulated drought in the summer of 1977 to test the hypothesis. Yield data are not yet available, but data analysis should be completed.

Ancestral cultivars frequent in pedigrees of drought resistant cultivars	Ancestral cultivars frequent in pedigrees of drought susceptible cultivars
A.K.	Richland
Illini	Clark
Adams	Mukden
A.K. (Harrow)	Lincoln
Capital	

Ancestral cultivars frequent in pedigrees of resistant and susceptible cultivars
Mandarin
Ottawa Mandarin
Manchu

During the summer of 1977, as part of this field test the parental material used in producing the F_2 plants tested (see Step VII) was entered into the replicated trials under simulated conditions of drought.

Parental Cultivars

Resistant	Susceptible
Pagoda	Grant
A100	Blackhawk
Magna	Seneca
Adelphia	Clark 63

In addition, the following four cultivars were tested under the simulated drought:

Beeson
Chief
Wayne
Williams

VII. Test F_2 Material in Field (Summer 1977)

F_2 plants from each of the four crosses made in the summer of 1976 were grown in the field under simulated drought. The blocks of F_2 plants were space-planted in hills 51 cm apart in each direction. During the summer, each individual plant was measured weekly for rate of increase in height, and at harvest the seed production was recorded. Within each block, 150 F_2's were grown with 15 plants of each of the two parents of the cross (12 rows x 15 plants). Two blocks of each cross were grown. Thus, a total of eight blocks were observed through the summer.

For comparative purposes, 60 plants of each parent were space-planted in hills 51 cm apart under optimal moisture. The data from these plants indicate the severity of the imposed drought when compared to the data from the parents under the drought treatment.

From the F_2 data, which are not yet available, heritability estimates for drought resistance will be computed. This analysis will be completed by January 1978. This will complete Mr. Sammon's Ph.D. dissertation research at the University of Illinois, however, the research will be continued. It is planned that the F_3 generation will be field grown in the summer of 1978 by a new graduate student.

c. <u>James H. Orf</u> - Supervisor - Dr. Theodore Hymowitz
<u>Research Area</u>: Studies on Soybean Seed Proteins

The soybean seed contains approximately forty percent crude protein. There are many different proteins and enzymes in the seed and a better understanding of these constituents and their inheritance may allow plant breeders and others to increase both the quality and quantity of protein in the soybean seed.

One of the techniques that can be used to study seed proteins in soybeans is polyacrylamide disc electrophoresis. In electrophoresis an electric current is applied across a polyacrylamide gel on which a crude protein sample has been placed. The proteins and enzymes in the sample are separated due to their differences in mobility. These differences result from protein having different sizes, shapes and charges. Once the proteins have been separated specific proteins or protein variants can be identified and their inheritance studied. These different variants can be used as genetic markers, aids in identifying cultivars, and as sources for breeding better cultivars.

Among the antinutritional factors present in soybeans is the trypsin inhibitor. One of the major trypsin inhibitors present in raw soybeans is the Kunitz trypsin inhibitor or SBTI-A_2. Three forms of SBTI-A_2 have been identified using polyacrylamide gel electrophoresis and are designated Ti^1, Ti^2 and Ti^3. Two accessions, P.I. 157440 and P.I. 196168, do not have the SBTI-A_2 protein. Analysis of F_2 seed from crosses between P.I. 157440 and lines having Ti^1, Ti^2 and Ti^3, indicates the lack of the SBTI-A_2 protein is inherited as a recessive allele.

The trypsin inhibiting activity of P.I. 157440 is lower than other lines when measured using spectrophotometric methods. A preliminary feeding trial with chicks using raw defatted meal of P.I. 157440 indicated it had a significantly greater feed efficiency (gain/feed intake) and significantly less pancreatic hypertrophy than raw defatted meal from Amsoy 71. Additional studies are being conducted using this line.

Soybean seeds also contain several proteins that cause the clumping of red blood cells. These proteins are called hemagglutinins or lectins. Several soybean lines lack a seed lectin with a molecular weight of 120,000 daltons. Analysis of F_2 seeds indicates the lack of this particular lectin is inherited as a recessive allele to the presence of the lectin.

d. Roger L. McBroom - Supervisor - Dr. H. H. Hadley
Research Areas: I. Selection for Seed Oil and Protein in Soybeans
II. Using Qualitative Characters to Improve Soybeans for Intercropping

I. Oil and Protein Selection

As the fall of 1978 is Mr. McBroom's first semester at the University of Illinois, the research is in the early planning stages. This semester, work has focused on a special problem that involves the use of single seed descent for the selection of oil and protein in soybeans. Approximately 1200 F_2 plants were harvested individually this fall, and data are being analyzed for yield per plant and weight per 100 seeds. Later these samples will be analyzed for protein and oil content.

A. Crosses made

1. HHP x Protana
2. Protana x Provar
3. Provar x HHP (a high protein derivative of *Glycine soja* x *G. max*)
4. HHP x Clark

B. F_1 grown

C. F_2 grown in field, space planted (Summer, 1977)

D. Data being taken and analyzed for seed yield, seed size, and oil and protein percentages

II. Effects of five genes on agronomic characters in intercropped (and double cropped) soybeans

Since the intercropping of soybeans in other crops has the potential for increasing land productivity both here and abroad, plans are being developed for a study to use different genes for qualitative characters in isogenic lines to determine if any of these characters gives an advantage to the soybeans in an intercrop situation. Most of these have been tested in regular field situations, but so far have not been used in intercrop situations or in double cropping.

Also under consideration is a study checking the performance of several current adapted varieties and a sampling of adapted introductions in both situations.

A. Genes and characters involved

1. $\underline{dt_1}$ determinate
2. $\underline{Dt_2}$ semi-determinate
3. $\underline{e_2}$ early
4. $\underline{Lf}$ five leaflet
5. $\underline{ln}$ narrow leaf

B. Lines to be used

Isogenic lines with Clark and Harosoy backgrounds. Total of 12 lines including "normal" Clark and Harosoy.

C. Planting plans

1. First year - one location, one date
2. Second year - two locations, 2 or 3 planting dates
   a. Intercropping in oats
   b. Double cropping after wheat included also

D. Agronomic characters to be measured

1. Seed yield
2. Lodging resistance
3. Height of Plant
4. Number of branches

e. Roger W. Elmore - Supervisor - Dr. J. A. Jackobs
Research Area: Intercropping With Soybeans--the Effects of Plant Architecture, Planting Dates, Varieties, and Nitrogen Fixation.

Intercropping soybeans is a long-established practice in some parts of the world. Generally, it is considered to be an economical alternative to monocultures especially in situations where land is limited and labor supply is sufficient to conduct intensive agricultural operations. Its value appears to be especially great in particular tropical and subtropical areas. This research is an attempt to study various factors influencing soybean production in intercropping systems.

During the summer of 1977, two intercropping experiments were conducted at the University of Illinois Agronomy South Farm. Both of these experiments were studies on the non-soybean species plant structure as well as their planting dates. In the first experiment soybeans were intercropped with sorghum of two different heights, 1.0m and 1.5m. Sorghum was planted at the same time as the soybeans as well as at weekly intervals for a total of four planting dates. The second experiment consisted of planting corn with and without ligules on three dates. Liguleless corn has very erect leaves.

Soybeans were again planted only on the first corn planting date. The data from these experiments have not been analyzed yet, however, sorghum height and corn leaf angles appear to have effects on soybean yields.

Based on observations from the experiments discussed above, a proposal for intercropping research in Puerto Rico has been drafted. The following two experiments are proposed:

(1) a soybean-sorghum intercrop:
This proposed experiment would be a follow-up of the 1977 experiment discussed above. It would be expanded however, to include four soybean cultivars representing a plant height continuum from short to tall planted with a tall and short sorghum.

(2) intercropping sorghum with a soybean cultivar and its non-nodulating isoline:
This experiment using a short sorghum and a soybean cultivar with its non-nodulating isoline could perhaps give a better understanding of the effects of soybean nodulation on the intercropped sorghum.

2. On-Campus Short Courses

Training students from many nations in the development of soybeans for human food has assumed a major role in the overall program. Although the short courses are non-grant funded, organization and the offering of the courses is an example of grantee efforts to serve the needs of developing countries through its increasingly effective institutional response capability. Other non-grant AID funds partially support the training effort which is an important component of the redesigned grant, and therefore the short courses are mentioned in this report. The training program offers several types of instruction including structured courses, informal workshops and assistance on an individual basis.

Since 1975, INTSOY has sponsored two short-term applied soybean training courses. The courses were developed in cooperation with the United States Department of Agriculture's Office of International Training, the U.S. Agency for International Development, the Food and Agriculture Organization, and other donor groups. Eighty-five persons from 50 countries have received training in the two courses, and both will be offered again in 1978.

"Soybean Processing for Food Uses," a six-week course, is designed to give students the opportunity to learn the principles and processes involved in the use of soybeans and soybean products for human foods, the concepts and procedures involved in processing whole soybeans, and to apply their knowledge to development objectives in their own countries.

The other INTSOY short course, "Technical and Economic Aspects of Soybean Production," is of longer duration, lasting about four months. It spans the major part of the soybean growing season in the United States. The objectives of the course are to teach the technical and economic principles and practices of soybean production; to promote understanding of the potential use of soybeans to alleviate protein and calorie deficiencies; to increase students' knowledge of the soybean plant itself, the cultural practices required for its production, factors affecting seed quality, and methods of adapting technology to local conditions; and to study research, educational, and regulatory functions supportive of a soybean industry.

3. Soybean Rust Workshop

While short courses have provided formal training, INTSOY regional conferences have been useful in bringing together soybean scientists for exchanges of information and identification of research needs. During the third regional conference for soybean workers of Asia and Oceania, a working group on soybean rust was formed. After a year of planning and preparation, the Asia/Oceania Soybean Rust Workshop was convened in Manila, the Philippines, February 28 - March 4, 1977. Joining INTSOY in sponsoring and supporting the Workshop were the Government of the Philippines, the Asian Vegetable Research and Development Center (AVRDC) and the Philippine Council for Agriculture and Resources Research (PCARR). INTSOY, through the aegis of AID research contract ta-c-1294 was able to provide for the travel and transportation expenses of nine participants from five countries of the region.

It was not the intent of the Workshop to issue official proceedings, however, the papers presented constituted a very useful statement of the arts on soybean rust. INTSOY was prompted to publish the information presented in Manila as Number 12 in the INTSOY Series, because of the obvious importance of the disease to soybean production throughout the world, the ground swell of requests for information about soybean rust, the interest of workshop participants and the satisfaction of the sponsors with the outcome of the workshop. Grant personnel also assisted in planning and conducting a soybean rust conference for the Western hemisphere held in Mayaguez, Puerto Rico, November 14-17, 1976.

4. Addition of INTSOY Training and Communications Officer

The development of interest by soybean workers in tropical countries in the types of training offered by INTSOY, strengthened the desire of INTSOY to develop additional training programs and activities targeted to specific country or regional needs and conducted at on-site locations. Since the realization that such efforts demand close attention and coordination by a specialist in the development education process, INTSOY has conducted an extensive search to add expertise in training to the core staff.

Dr. John Santas, of the University of Wisconsin, will join INTSOY as Training and Communications Specialist and Assistant Professor of Agricultural Communications about January 1, 1978. A long time staff member of the University of Wisconsin's International Programs Office, he is currently a resident in Brasilia assigned as Program Coordinator of AID Loan 512-L-077 under which the Universities of Wisconsin and Purdue, cooperating with the Empresa Brasileira de Pesquisa Agropecuaria, EMBRAPA, are conducting a program of technical assistance and development training.

Output II. Extended Knowledge Base and Research Capability

This was the primary goal of the original grant design and it sustains its primacy in the redesigned grant. Special emphasis is placed on improving the response capability of UIUC and UPR/MC and associated organizations and individuals in providing improved soybean genetic technology for small farmers in the tropics and subtropics. The experience of international research centers shows that this program focus holds promise of high returns from relatively modest inputs.

Work under this output utilizes INTSOY's well-developed linkages with the University of Puerto Rico, Mayaguez campus and other collaborators. The basic thrust is varietal development and features a soybean crossing program, segregating populations, testing of hybrid lines, and a preliminary observation trial. Material developed from this process is available for inclusion in the worldwide International Soybean Variety Experiment (ISVEX), a dual mechanism for testing and distributing soybean varieties suited to various agro-climatic conditions.

The potential for interinstitutional multidisciplinary research is richly illustrated by the number of associated research projects, especially in the area of soybean protection, that have evolved from the basic breeding program. These include studies on soybean seed quality, differences of seed stored under simulated tropical conditions, cultivars resistant to soybean mosaic viruses (SMV), cowpea mosaic viruses (CMV) and insects, fertility/variety/spacing relationships and weed competition.

1. Varietal Development

a. Crossing program

A number of crosses were made during the 1977 season, many of which were made to initiate genetic studies to determine the mode of inheritance of important characters as well as to produce segregating populations from which superior lines might be selected.

The following crosses were made to study the inheritance of resistance to soybean mosaic virus and the allelic relationship among several sources of resistance:

Buffalo X HLS
Buffalo X Jupiter
Buffalo X Improved Pelican
Buffalo X PI 341.242
Buffalo X PI 324.068
PI 341.242 X HLS
PI 341.242 X Jupiter
PI 341.242 X PI 324.068
Improved Pelican X PI 341.242
PI 324.068 X HLS
PI 324.068 X Jupiter

The following crosses were made to study the inheritance of improved seed quality under tropical conditions and to produce populations from which tropically adapted, high yielding lines with good seed quality may be selected.

HLS X PI 219.653
HLS X PI 204.331
HLS X PI 205.908
PI 219.653 X Jupiter
PI 204.331 X Jupiter
PI 205.908 X Jupiter

Crosses made to study the inheritance of the hard seed coat character include the following:

PI 326.578 X PI 323.566
PI 326.578 X Barchet
PI 326.578 X PI 323.579
PI 326.578 X PI 174.867
PI 326.578 X PI 240.672
PI 326.578 X PI 205.911
PI 326.578 X Hardee
PI 326.578 X Jupiter
PI 326.578 X SJ-2
PI 323.566 X Barchet
PI 323.566 X PI 240.672
PI 323.566 X PI 346.304
PI 323.566 X Hardee
PI 323.566 X SJ-2
PI 163.453 X PI 240.672
PI 163.453 X SJ-2
Barchet X PI 323.579
Barchet X PI 174.867
Barchet X PI 240.672
Barchet X PI 205.911
Barchet X PI 346.304
Barchet X Hardee
Barchet X Jupiter
Barchet X SJ-2
PI 323.579 X PI 174.867
PI 323.579 X PI 240.672

PI 323.579 X PI 205.911
PI 323.579 X PI 346.304
PI 323.579 X Jupiter
PI 323.579 X SJ-2
PI 323.579 X Hardee
PI 174.867 X PI 346.304
PI 174.867 X Jupiter
PI 174.867 X PI 205.911
PI 174.867 X Hardee
PI 240.672 X PI 205.911
PI 240.672 X PI 346.304
PI 240.672 X Hardee
PI 240.672 X Jupiter
PI 240.672 X SJ-2
PI 205.911 X PI 346.304
PI 205.911 X Jupiter
PI 205.911 X SJ-2
PI 346.304 X Hardee
PI 346.304 X Jupiter
PI 346.304 X SJ-2
Hardee X Jupiter
Hardee X SJ-2
Jupiter X SJ-2

b. Segregating populations

Approximately 350 3 m plant rows in various stages of inbreeding and 1,050 6 m rows of F_2 populations were grown at Isabela in a May 1977 planting. From this material 950 individual plants were selected for progeny testing and evaluation. The parentage and stage of inbreeding of these lines and populations are given in Table 1.

Plant selections were made on the basis of visual yield evaluation, lodging resistance and plant type. Because the growing season was unusually dry, disease pressure was not adequate to make selections based on resistance to frogeye leafspot, downy mildew, and bacterial pustule, which are normally prevalent.

c. Hybrid line tests

Three replicated trials were grown in 1977 for the purpose of evaluating lines from the Puerto Rico breeding program as well as lines or varieties from other programs. These trials were grown at the Isabela and Lajas Substations. Three replications of three row plots, 6 m long were utilized. Five m of the center row of each plot were harvested for yield determination. The results of hybrid Line Test I are summarized in Table 2. The lines with "GH" designations were received from Dr. Kuell Hinson of the Agricultural Research Service, United States Department of Agriculture, Gainesville, Florida as F_4 and F_5 lines. They were advanced two generations and selected in Puerto Rico. Jupiter and HLS are the check varieties. HLS, a selection made within the variety Hardee, was the top yielding entry in the trials planted at Isabela in July 1976 and in the Lajas trial planted in May 1977. Many of the selections in this trial are too late maturing for May plantings in

Table 1. Lines and F_2 populations grown at Isabela, Puerto Rico, planted May 1977.

Parentage	State of inbreeding	Number of lines
Hardee X (Hill X PI 274.454	F_7	16
F66-1534 X F72-5514	F_5	17
UFV-1 X F72-5509	F_5	22
F66-1534 X F72-5514	F_5	18
F72-5532 X (Jup X F65-170)	F_5	4
F72-5532 X (Jup X F66-1534)	F_5	15
F72-5509 X (Jup X F65-170)	F_5	2
F72-5511 X (Jup X F65-170)	F_5	5
F72-5509 X (Jup X F66-1534)	F_5	21
F72-5514 X (Jup X F66-1534)	F_5	44
F72-5514 X (Jup X F67-1533)	F_5	28
F72-5511 X (Jup X F67-1533)	F_5	8
Natural outcross of UFV-1	F_5	11
Williams X. Jupiter	F_4	86
Hill X Williams	F_2	
Santa Rosa X Williams	F_2	
HLS X Williams	F_2	
Williams X. PI 382.181	F_2	
PI 317.334B X Williams	F_2	
Williams X Imp. Pelican	F_2	
Hill X Jupiter	F_2	
SJ-1 X Jupiter	F_2	
Calland X Jupiter	F_2	
Santa Rosa X Jupiter	F_2	
SJ-2 X Jupiter	F_2	
Imp. Pelican X Jupiter	F_2	
PI 317.334B X Jupiter	F_2	
Jupiter X UFV-1 (BP)	F_2	
Hardee X Jupiter	F_2	
Jupiter X Lee 68	F_2	
Bossier X Jupiter	F_2	
Jupiter X Bonus	F_2	
Santa Rosa X Imp. Pelican	F_2	
SJ-1 X Imp. Pelican	F_2	
Calland X Imp. Pelican	F_2	
CH 3 X Imp. Pelican	F_2	
HLS X Imp. Pelican	F_2	
Hill X Imp. Pelican	F_2	
Imp. Pelican X Bonus	F_2	
Imp. Pelican X Bossier	F_2	
Imp. Pelican X 317.334B	F_2	
Hardee X Imp. Pelican	F_2	
Hardee X G-103	F_2	
G-103 X Bonus	F_2	
Calland X G-103	F_2	
Santa Rosa X PI 382.181	F_2	
Hardee X PI 382.181	F_2	
PI 382.181 X Lee 68	F_2	
PI 382.181 X Bonus	F_2	
PI 382.181 X Calland	F_2	
PI 382.181 X Hill	F_2	
Hardee X PI 317.334B	F_2	
HLS X PI 317.334B	F_2	
Hardee X Santa Rosa	F_2	
Santa Rosa X Lee 68	F_2	
HLS X CH 3	F_2	
Hardee X CH 3	F_2	
Hardee X SJ-1	F_2	
HLS X Bossier	F_2	
PI 382.181 X Lee 68	F_2	

Table 2. Agronomic data from Hybrid Line Test I, 1976 and 1977 Plantings at Isabela and Lajas, Puerto Rico.

Entry	Location and Planting Date											
	Isabela		Lajas	Isabela		Lajas	Isabela		Lajas	Isabela		Lajas
	July 1976	May 1977	May 1977	July 1976	May 1977	May 1977	July 1976	May 1977	May 1977	July 1976	May 1977	May 1977
	Yield (Kg/ha)			Maturity (days after planting)			Height (cm)			Lodging Score[1/]		
GH18-10-2(2)	2227 (8)[2/]	1164 (12)	1492 (12)	113	156	160	102	77	113	2	1	2
GH-19-3-1(1)	2215 (1)	1183 (10)	1193 (17)	113	159	161	114	118	152	2	3	3
GH23-2-1(1)	2513 (2)	1321 (6)	1215 (16)	111	153	166	105	90	118	2	1	2
GH23-2-3(1)	2160 (11)	1604 (2)	1171 (18)	110	148	164	111	87	122	2	1	2
GH24-3-1(2)	1889 (22)	1035 (18)	1533 (11)	116	158	158	104	77	115	2	1	2
GH24-3-2(2)	2264 (7)	751 (21)	995 (20)	115	157	159	105	90	123	2	1	2
GH24-3-3(2)	2354 (4)	1154 (14)	1725 (8)	115	158	159	101	87	117	2	1	2
GH24-3-4(2)	2360 (3)	1050 (17)	1292 (13)	115	161	161	102	83	113	2	1	2
GH25-18-1(2)	1904 (21)	856 (20)	841 (22)	116	156	162	93	78	123	1	1	2
GH25-18-2(2)	2054 (15)	681 (22)	1280 (14)	116	161	160	90	83	112	1	1	1
GH25-18-4(2)	2317 (6)	1174 (11)	1240 (15)	116	156	159	97	78	118	1	1	2
GH26-1-1(1)	2218 (9)	1192 (9)	1777 (5)	114	154	154	103	70	113	2	1	1
GH28-3-1(1)	1944 (20)	972 (19)	1618 (10)	111	158	168	135	145	168	4	4	5
GH29-14-3(1)	2078 (14)	1728 (1)	1649 (9)	108	146	148	110	93	112	2	2	3
GH31-7-6(1)	1965 (19)	1261 (7)	2067 (3)	109	156	152	121	103	122	4	2	3
GH31-8-3(1)	2147 (12)	1353 (5)	2420 (2)	110	159	160	110	82	123	2	1	2
GH31-8-2(1)	1996 (17)	1421 (4)	980 (21)	109	161	166	118	92	115	3	1	2
GH31-11-2(1)	2049 (16)	1136 (16)	1008 (19)	111	158	164	105	82	117	2	1	2
GH31-11-4(1)	1989 (18)	1214 (8)	1732 (7)	108	156	159	106	87	113	2	1	2
GH31-11-5(1)	2095 (13)	1160 (13)	2059 (4)	109	157	157	104	82	120	2	1	2
Jupiter	2318 (5)	1145 (15)	1762 (6)	114	152	157	92	78	113	2	1	1
HLS	2732 (1)	1463 (3)	2435 (1)	111	146	161	97	77	102	1	1	2
LSD (.05)	378	350	759									

1/ Scored from 1-5, where 1 = erect and 5 = completely lodged.

2/ Yield ranks within years and locations in parentheses.

Puerto Rico. Most of them were quite tall in the May plantings and lodging was a problem, especially at Lajas where moisture was adequate throughout the growing season. The unusually low yields of the trial planted at Isabela in May 1977 are due to lack of water. Rainfall was inadequate and irrigation was not possible because of water rationing.

Hybrid Line Test II (Table 3) was also grown at Isabela and Lajas in 1977. The lines designated "UFV-1 (BP)" are selections made in Puerto Rico form a naturally occurring outcross of UFV-1 and an unknown pollen source. The "IAC" lines are from the Instituto Agronomico de Campinas in the State of Sao Paulo, Brasil. Mineira and UFV-1 are varieties released by the Universidade Federal de Vicosa in Vicosa, Minas Gerais, Brasil. The UFV-1 (BP) selections seemed to perform better than the Brasilian lines when planted in July. The Brasilian lines, however, seemed to perform better in the May planting. At Lajas, the early planting date and abundance of moisture resulted in excessive vegetative growth and severe lodging in the UFV-1 (BP) selections. The shorter, earlier maturing entries were not so adversely affected.

Hybrid Line Test III was planted at Isabela and Lajas in 1977. The Lajas trial was lost, however, through heavy rains and flooding shortly after planting. Only results from the Isabela trial, planted in May 1977, are presented in Table 4. The "GH" and "F73" lines were selected in Puerto Rico. The origins of the other entries are as follows: IAC 73-2736, Brasil; ICA Caribe, Colombia; Local, Sri Lanka; Orba, Markomah, and Jagus, Indonesia; Acc 2120 Taiwan (AVRDC). The introduced varieties performed better than the local selections, mainly because of the early planting date. The taller, later local selections had excessive vegetative growth and lodging was increased.

Hybrid Line Tests I and II have been grown in three different environments. The better lines from these tests should be entered in the upcoming SPOT (Soybean Preliminary Observation Trials). Hybrid Line Test III should be repeated in at least two more locations before making any decisions on advancing the entries.

d. Soybean Preliminary Observation Trial (SPOT)

The Soybean Preliminary Observation Trial (SPOT) was grown at six locations in 1976. The results of these trials are summarized in Tables 5-10. The sites were selected as representative of a wide array of agroclimatic zones based primarily on latitude and altitude. SPOT was grown at the following locations.

Country	Latitude	Altitude (m)
Ecuador	2^{o}S	17
India	29^{o}N	761
Philippines	14^{o}N	15
Puerto Rico	18^{o}N	128
Rhodesia	17^{o}S	1,506
Taiwan	23^{o}N	8

Table 3. Agronomic data from Hybrid Line Test I, 1976 and 1977 Plantings at Isabela and Lajas, Puerto Rico.

Entry	Isabela July 1976	Isabela May 1977	Lajas May 1977	Isabela July 1976	Isabela May 1977	Lajas May 1977	Isabela July 1976	Isabela May 1977	Lajas May 1977	Isabela July 1976	Isabela May 1977	Lajas May 1977
	Yield (kg/ha)			Maturity (days after planting)			Height (cm)			Lodging Score[1/]		
UFV-1 (BP)-1	2486 (3)[2/]	1616 (15)	1607 (13)	116	159	156	112	102	145	2	2	4
UFV-1 (BP)-2	2446 (5)	1807 (10)	2041 (9)	110	149	156	110	115	163	2	2	4
UFV-1 (BP)-4	2452 (4)	1630 (14)	1574 (14)	111	154	159	109	108	150	2	1	4
UFV-1 (BP)-5	2489 (2)	1569 (16)	1121 (21)	116	159	167	117	108	155	1	2	4
UFV-1 (BP)-7	2268 (12)	1341 (19)	1414 (17)	114	157	164	110	110	158	2	1	4
UFV-1 (BP)-11	2385 (8)	1493 (17)	--	115	161	--	106	110	--	1	2	-
UFV-1 (BP)-16	2277 (11)	1914 (7)	1911 (11)	106	145	152	96	100	140	1	2	3
UFV-1 (BP)-19	2071 (20)	851 (22)	1437 (16)	113	156	160	109	117	155	1	2	4
UFV-1 (BP)-20	2671 (1)	1664 (12)	1367 (18)	116	159	166	117	115	152	2	2	4
UFV-1 (BP)-21	2363 (19)	2032 (3)	3079 (2)	109	152	154	102	100	142	2	2	3
UFV-1 (BP)-23	2403 (7)	1326 (20)	1261 (19)	115	159	164	120	128	153	2	3	4
UFV-1 (BP)-31	2222 (16)	1915 (6)	1488 (15)	113	155	159	105	105	153	2	2	4
UFV-1 (BP)-33	2342 (10)	1261 (21)	1133 (20)	114	159	164	110	120	167	1	2	4
IAC 73-4085	2215 (17)	1954 (4)	2851 (3)	108	139	148	88	70	107	1	1	1
IAC 2	1892 (22)	1650 (13)	2013 (10)	107	150	157	108	108	152	2	1	4
IAC 73-4013	2243 (13)	2040 (2)	2401 (5)	109	138	154	109	90	127	2	1	3
IAC 70-25	2074 (16)	2429 (1)	1719 (12)	106	140	147	96	95	147	1	2	4
IAC 1	1908 (21)	1786 (11)	2747 (4)	96	136	144	74	77	102	1	1	1
Mineira	2237 (15)	1946 (5)	3118 (1)	105	135	148	61	40	70	1	1	1
Jupiter	2129 (18)	1468 (18)	2325 (6)	111	149	156	90	68	110	2	1	1
UFV-1	2240 (14)	1843 (9)	2282 (7)	110	153	157	67	47	85	1	1	1
HLS	2406 (6)	1862 (8)	2053 (8)	111	145	156	90	60	108	1	1	2
LSD (.05)	298	597	721									

1/ Scored from 1-5, where 1 = erect and 5 = completely lodged.

2/ Yield ranks within years and locations in parentheses.

Table 4. Agronomic data from Hybrid Line Test III, planted May 1977 at Isabela, Puerto Rico

	Yield	Maturity	Height	Lodging[1/]
	kg/ha	Days	cm	Score
GH26-3-3(1)	915 (16)[2/]	153	58	1
GH29-14-3(2)	1489 (5)	152	92	1
GH31-7-5(1)	1058 (11)	153	87	1
F73-13-1-1(1)	864 (17)	168	117	2
F73-14-9-2(1)	1375 (8)	142	112	2
F73-13-9-5(1)	1005 (12)	147	102	3
GH19-3-1(1)-1(1)	551 (18)	157	130	2
GH19-3-2(1)-3(2)	969 (14)	159	137	1
GH22-16-6(1)-1(3)	1137 (10)	154	125	2
GH29-14-4(1)-3(1)	1376 (7)	148	109	2
IAC 73-2736	965 (15)	151	65	1
Jupiter	995 (13)	153	60	1
HLS	1568 (4)	146	67	1
ICA Caribe	135 (19)	165	115	2
Local	1606 (3)	138	93	1
Orba	1620 (2)	139	103	2
Acc 2120	1783 (1)	126	90	1
Markomah	1436 (6)	129	83	1
Jagus	1243 (9)	124	88	1
LSD (.05)	528			

[1/] Lodging scored 1-5, where 1 = erect and 5 = completely lodged.

[2/] Yield rank in parentheses.

Table 5. Results of Soybean Preliminary Observation Trial planted in Ecuador, Latitude 2°S, Altitude 17m, June 18, 1976.

Entry	Yield	Maturity	Height	Lodging[1/]	Seed Size
	kg/ha	days	cm	score	gms/100
Jupiter	4375	116	82	1.7	22.7
M-79	4234	111	78	2.3	14.4
HLS	3936	116	86	2.3	18.2
Buffalo	3735	104	42	1.0	21.8
CH-3	3605	109	107	2.7	15.6
INIAP-Jupiter	3605	116	93	2.7	22.4
M-216	3605	110	54	2.3	15.3
Santa Rosa	3547	73	47	1.0	19.5
SJ-2	3443	109	82	3.7	14.7
Rhosa	3310	96	60	1.0	19.9
Oribi	3293	103	43	1.0	20.9
M-98	3273	115	84	3.7	12.8
Manabi	3268	107	94	3.3	21.9
Bossier	3150	98	34	1.0	20.1
SJ-1	2759	96	95	2.7	14.4
Kanrich	2652	96	62	2.3	27.8
LSD (.05)	732	3	10	1.4	2.0

1/ Lodging scored from 1-5, where 1 = erect and 5 = completely lodged.

Table 6. Results of Soybean Preliminary Observation Trial planted in India, latitude 2°S, altitude 761m, July 6, 1976

Entry	Yield	Maturity	Height	Seed Size
	kg/ha	days	cm	gms/100
Bossier	1736	107	58	12.4
PK-71-21	1709	107	60	12.8
HLS	1389	122	70	12.1
SJ-1	1264	102	107	9.9
M-98	1236	122	85	9.6
Jupiter	1125	122	76	11.2
CH-3	1042	109	96	11.0
Santa Rosa	1042	94	54	12.5
M-79	972	121	74	9.6
SJ-2	889	108	68	8.6
M-216	792	122	78	10.1
Oribi	722	102	59	11.0
Rhosa	558	94	68	12.2
Kanrich	347	86	50	14.7
Buffalo	333	108	51	11.6
LSD (.05)	395	1	11	1.0

Table 7. Results of Soybean Preliminary Observation Trial planted in the Philippines, latitude 14°N, altitude 15 m, June 17, 1976.

Entry	Yield	Maturity	Height	Lodging	Seed Size
	kg/ha	days	cm	score[1/]	gms/100
UPL SY-2	1402	96	87	2.7	14.3
SJ-1	1369	89	134	2.3	10.7
Clark 63	1363	91	77	2.7	13.8
SJ-2	1232	94	113	4.7	10.9
Bossier	1209	87	32	1.0	12.7
Rhosa	959	89	73	3.3	16.6
Santa Rosa	753	82	43	1.7	12.8
CH-3	668	105	134	3.3	13.0
HLS	599	103	94	4.3	9.4
Oribi	521	82	39	1.3	9.8
Buffalo	458	89	59	1.0	10.0
Kanrich	448	74	51	2.0	16.6
Jupiter	421	103	80	2.7	8.7
M-98	316	106	94	3.3	8.9
M-79	238	106	99	2.3	8.1
M-216	149	106	64	3.0	7.6
LSD (.05)	383	5	15	1.0	1.3

1/ Scored from 1-5, where 1 = erect and 5 = completely lodged.

Table 8. Results of Soybean Preliminary Observation Trial planted in Puerto Rico, latitude 18°N, altitude 128 m, July 6, 1976.

	Yield	Maturity	Height	Lodging	Seed Size
	kg/ha	days	cm	score[1/]	gms/100
HLS	2108	107	96	1.7	13.0
Santa Rosa	1921	89	54	1.3	13.9
SJ-2	1850	99	89	2.3	10.8
SJ-1	1816	87	87	1.3	11.3
Jupiter	1785	97	90	2.7	13.2
Bossier	1706	98	63	2.7	12.1
CH-3	1635	98	99	2.7	11.8
M-79	1635	106	90	2.3	10.9
M-98	1558	107	99	2.7	11.0
M-216	1527	105	68	2.3	11.4
Oribi	1417	98	46	1.0	12.4
Buffalo	1237	89	54	1.3	10.8
Rhosa	1226	90	53	1.7	14.6
Kanrich	780	86	47	1.7	22.8
LSD (.05)	254	9	8	1.0	1.1

1/ Lodging scored from 1-5, where 1 = erect and 5 = completely lodged.

Table 9. Results of Soybean Preliminary Observation Trial planted in Rhodesia, latitude 17°S, altitude 1.506 m, December 10, 1976.

Entry	Yield	Maturity	Height	Lodging	Seed Size
	kg/ha	days	cm	score[1/]	gms/100
Oribi	2888	126	91	1.3	19.4
105/6/51	2888	123	89	1.0	21.8
Bossier	2743	123	67	1.3	20.0
Rhosa	2694	123	88	2.3	17.8
Buffalo	2368	133	97	4.0	16.8
Santa Rosa	2201	123	78	3.7	17.1
CH-3	1882	144	128	5.0	13.5
SJ-1	1736	126	140	5.0	15.7
SJ-2	1639	145	160	4.0	13.0
HLS	1500	160	106	4.0	11.6
Kanrich	1305	99	57	1.3	28.4
M-79	542	166	157	5.0	8.6
M-98	465	166	158	4.7	8.6
M-216	236	152	113	5.0	7.1
LSD (.05)	441	1	7	1.0	1.6

1/ Lodging scored from 1-5, where 1 = erect and 5 = completely lodged.

Table 10. Results of Soybean Preliminary Observation Trial planted in Taiwan, latitude 23°N, altitude 8 m, September 21, 1976.

Entry	Yield	Maturity	Height	Lodging	Seed Size
	kg/ha	days	cm	score[1/]	gms/100
HLS	1484	93	52	3.7	13.1
CH-3	1201	86	62	3.0	11.4
SJ-1	1134	84	50	1.3	9.4
SJ-2	952	83	54	2.0	11.3
KS #3	892	82	39	1.3	14.6
M-98	761	91	65	3.0	8.8
Buffalo	683	81	36	1.3	12.5
Shih Shih	660	81	35	1.0	13.5
Jupiter	614	91	53	2.3	11.9
Rhosa	552	82	34	1.0	11.1
M-216	519	83	49	1.7	8.0
M-79	504	90	68	3.0	8.9
Santa Rosa	446	81	27	1.0	10.4
Bossier	333	82	25	1.0	11.1
Oribi	313	82	34	1.0	10.6
Kanrich	304	83	29	1.0	18.6
LSD (.05)	286	4	6	1.0	1.1

[1/] Scored from 1-5, where 1 = erect and 5 = completely lodged.

The 1976 SPOT consisted of 14 varieties grown in three replications of four-row plots 5 m in length. The center two rows of each plot were harvested for yield determination. SPOT is designed as a preliminary, wide scale screening device to test cultivars before entering them in the ISVEX trial.

The highest individual variety yield as well as the highest average yield for a specific location were obtained in Ecuador. Jupiter yielded 4,375 kg/ha in Ecuador and the average yield was 3,487 kg/ha. HLS, a tall, late selection from the variety Hardee, had the highest average yield across locations. The average yield of HLS, which was selected in Puerto Rico, was 1,836 kg/ha.

Day length played a significant role in the growth and development of the cultivars tested. The longest periods to flower and maturity (64 and 137 days, respectively, averaged over all varieties) were obtained from the site in Rhodesia. The September planting in Taiwan, on the other hand, resulted in the shortest day lengths of the trial and also in the least number of days to flowering and maturity (30 and 85, respectively, averaged over all varieties). Plant height exhibited a similar response with the shortest average plant height (45 cm) occurring in Taiwan and the tallest plant height (111 cm) in Rhodesia. Even though short day lengths hastened flowering and maturity and decreased plant height, the results from the Ecuador trial illustrate that soybeans can be successfully grown under short day lengths in the lowland tropics.

e. International Soybean Variety Evaluation Experiment (ISVEX)

Ultimate testing of improved cultivars is achieved in the ISVEX trial which has involved cooperators at over 260 locations in 105 countries. ISVEX not only serves as a testing mechanism but also as a means of distributing improved germplasm to cooperating institutions. Detailed results of ISVEX are published in the INTSOY Publication Series Numbers 8 and 11.

2. Associated Research

a. Seed quality evaluation

A major obstacle to the expansion of soybean production to new areas of the tropics is the difficulty in producing high quality planting seed. Tropical conditions of high temperature and relative humidity during the final stages of seed maturation are not conducive to the production of high quality planting seed necessary to establish an optimum plant density for the next crop.

Research has been initiated in Puerto Rico to improve the seed quality of tropically adapted soybean cultivars through multidisciplinary research in plant breeding and plant pathology. The objective of the research reported here was to determine the extent of genetic variation in the incidence of soybean seed infection by fungi and the accompanying loss of seed viability under tropical conditions.

On the basis of preliminary screenings performed in 1975 (see 1976 Annual Report), 24 cultivars of potential tropical adaptation and three check cultivars were selected for extensive testing. The cultivars and their origins are listed in Table 11. Three replicates of three-row plots were planted at the Isabela Substation on February 6, 1976 and on July 6, 1976. The plots were 6 m long with 65 cm between rows. Five m of the center row of each plot were harvested at maturity and used to measure yield and other agronomic characteristics. The border rows were harvested two and four weeks after maturity to provide seed samples for the determination of the incidence of seedborne fungi, as well as the incidence of Phomopsis, sand emergence, and field emergence.

Agronomic data from the experiment are summarized in Table 12. Averaged over the two seasons Jupiter, a maturity group IX cultivar developed in Guyana, was the highest yielding and latest maturing entry in the study. Hardee, a maturity group VIII commercial cultivar, normally yields well under tropical conditions, but failed to produce stands in this experiment. PI 240.672 was included, along with Jupiter and Hardee, as a check cultivar because of its apparent susceptibility to infection by seedborne fungi and the accompanied loss of seed viability. Although none of the cultivars selected from the preliminary screening yielded as well as Jupiter, yields of many were acceptable. This is a fact of considerable importance to the plant breeder when attempting to combine a good seed quality characteristics with acceptable agronomic type.

Delaying harvest date significantly reduced sand and field emergence (Table 13). Average sand emergence percentage was 95, 88 and 74 percent and field emergence percentage was 90, 77 and 57 percent for the nondelayed, 2-weeks delayed, and 4-weeks delayed harvests, respectively. The incidence of internally seedborne Phomopsis increased significantly with harvest delay. Averaged over environments and cultivars, the incidence of fungi increased from 9 percent in the nondelayed harvest to 21 and 44 percent in the 2 and 4-weeks delayed harvest, respectively. The average incidence of Phomopsis in the nondelayed harvest was three percent and increased to eight and 20 percent in the 2 and 4-weeks delayed harvest, respectively. Other researchers have reported the relationship between reduced soybean seed viability and high incidence of seedborne Phomopsis in temperate areas. The results of this study tend to substantiate this relationship for tropical environments.

Sand emergence of four cultivars, PI 205.908, PI 205.912, PI 219.653 and PI 239.235, was not significantly reduced by delaying harvest four weeks after maturity, but that of the three check cultivars was reduced an average of 48 percent. Field emergence of all cultivars was significantly reduced by a four weeks delay in harvest, but the field emergence of six of the selected cultivars was not reduced by a two week delay in harvest. Marked differences in sand and field emergence were not noted from the nondelayed harvest seeds, except for the low field emergence of

Table 11. Origin or parentage of cultivars selected for seed quality evaluation.

Cultivar	Origin or Parentage
PI 133.226	Hawaii
PI 148.259	Hawaii
PI 181.699	Indonesia
PI 183.484	Brasil
PI 200.488	Japan
PI 204.331	Surinam
PI 204.332	Surinam
PI 205.907	Thailand
PI 205.908	Thailand
PI 205.912	Thailand
PI 219.653	Indonesia
PI 239.235	Thailand
PI 240.672	Philippines
PI 259.539	Brasil
PI 263.044	Guatemala
PI 265.498	Colombia
PI 279.088	Tanzania
PI 341.249	Australia
PI 341.250	Australia
PI 346.304	India
Arisoy	Japan
Hardee	(Roanoke X N45-645) X Imp. Pelican
Improved Pelican	Tanloxi X PI 60.406
Jupiter	D49-2491 X PI 240.664

Table 12. Agronomic characteristics of 24 soybean cultivars, selected for seed quality evaluation, planted in February and July, 1976 at Isabela, Puerto Rico.

Cultivar	Yield	Maturity	Height	Lodging	Seed Size	Seed Quality
	kg/ha	days after planting	cm	score	gm/100	score
PI 133.226	1948	101	68	2.1	15.5	2.0
PI 148.259	2320	120	100	2.4	6.8	1.5
PI 181.699	1674	98	55	1.5	16.5	2.5
PI 183.484	1843	103	59	1.4	16.3	2.5
PI 200.488	1757	100	41	1.2	18.6	3.0
PI 204.331	1769	98	70	2.6	11.2	1.8
PI 204.332	1797	105	70	2.3	14.5	2.2
PI 205.907	1911	111	92	2.7	10.4	2.0
PI 205.908	2194	115	89	2.5	11.2	1.8
PI 205.912	1840	108	79	2.3	9.3	1.8
PI 219.653	2529	119	99	2.5	7.4	1.5
PI 239.235	2058	108	81	2.0	9.5	1.5
PI 240.672	1465	114	69	1.6	23.5	2.7
PI 259.539	2431	119	91	2.3	7.4	1.0
PI 263.044	1772	100	72	1.3	13.0	1.2
PI 265.498	1686	98	75	3.3	11.0	2.2
PI 279.088	2338	114	87	2.0	8.2	1.0
PI 341.249	2443	106	88	2.6	9.3	1.7
PI 341.250	1963	105	90	3.0	9.6	2.7
PI 346.304	1788	92	56	1.8	12.2	1.8
Arisoy	2077	102	76	1.4	13.4	1.5
Hardee	1618	109	39	1.0	19.7	3.2
Improved Pelican	2111	101	76	1.3	13.5	1.0
Jupiter	2960	124	83	1.9	18.1	2.2
LSD(.05)	352	3	8	0.6	1.1	0.5

Table 13. Effect of harvest date on sand emergence, field emergence, and incidence of internally seedborne fungi and *Phomopsis* of 24 soybean cultivars planted in February and July, 1976 at Isabela, Puerto Rico.

Cultivar	Harvest Date [1/]			Harvest Date			Harvest Date			Harvest Date		
	0	2	4	0	2	4	0	2	4	0	2	4
	Sand Emergence (%)			Field Emergence (%)			Incidence of Fungi(%)			Incidence of Phomopsis(%)		
PI 133.226	98	92	83	94	84	59	9	25	43	2	9	16
PI 148.259	95	90	82	96	86	66	5	22	37	0	7	11
PI 181.699	86	84	72	90	84	58	9	14	50	0	7	15
PI 183.484	96	87	71	93	71	56	3	28	49	0	10	18
PI 200.488	86	58	32	68	47	14	10	30	59	9	19	37
PI 204.331	96	96	88	93	88	77	11	15	22	1	4	7
PI 204.332	94	90	72	88	72	51	4	27	70	1	15	31
PI 205.907	97	90	82	96	87	77	6	19	38	0	1	9
PI 205.908	98	96	93	94	91	76	2	9	25	0	1	8
PI 205.912	96	96	94	96	91	89	6	8	13	0	2	6
PI 219.653	96	92	92	95	89	81	2	10	43	0	1	7
PI 239.235	97	96	93	95	92	86	8	21	41	0	5	10
PI 240.672	90	85	52	85	61	29	21	55	85	9	22	48
PI 259.539	98	98	92	95	90	77	7	12	35	0	5	8
PI 263.044	97	93	82	93	87	54	2	6	49	1	3	20
PI 265.498	97	83	59	94	66	40	1	8	41	0	8	24
PI 279.088	98	94	91	92	90	84	2	4	15	0	0	4
PI 341.249	97	89	78	90	84	71	2	12	36	0	3	8
PI 341.250	96	83	69	88	74	42	5	19	51	1	10	33
PI 346.304	96	91	70	97	84	54	6	17	33	2	11	21
Arisoy	94	88	61	97	64	36	2	14	31	0	7	20
Hardee	89	64	26	60	30	14	59	67	87	31	36	57
Improved Pelican	97	83	76	89	78	50	4	9	51	0	2	30
Jupiter	94	84	64	92	54	32	30	47	67	7	18	40
LSD(.05)												
Variety means within a harvest date		6			7			5			3	
Harvest date means within a variety		6			6			5			3	

1/ Weeks after maturity.

Hardee. In the two weeks delayed harvest, however, field emergence percentages of all the selected cultivars were significantly greater than that of the better commercial check cultivar, Jupiter. These data emphasize the importance of timely harvest in the production of high quality planting seed. Marked differences between selected and check cultivars were noted in all harvest dates for the incidence of seedborne fungi and Phomopsis.

Field emergence was significantly and negatively correlated with the incidence of fungi and Phomopsis, seed size, and seed quality score in all three harvest dates (Table 14). These results indicate that internally seedborne fungi inhibit soybean seed germination. Maturity date, conversely, was not significantly correlated with any of the seed quality measurements except the incidence of fungi in the two weeks delayed harvest, and this correlation, although statistically significant at the .05 level, was small. Seed size was negatively correlated with field emergence and positively correlated with the incidence of fungi and the incidence of Phomopsis. The smaller seeded genotypes had higher emergence percentages and less internally seedborne fungi.

The findings of this study indicate that there is substantial variation in soybean seed quality characteristics under tropical conditions. Prospects for progress in improving seed quality of tropically adapted soybean cultivars are promising. Crosses have been made using superior seed quality lines PI 219.653, PI 204.331, and PI 205.908 in combination with HLS and Jupiter to study the inheritance of the seed quality characteristics measured in this study. F_1 and F_2 populations of these crosses have been produced. Another group of 84 cultivars which were outstanding in the preliminary screening initiated in 1975 were planted in a replicated trial at Isabela in May, 1977. Nondelayed and delayed harvest seed samples were taken to identify additional sources of germplasm to use in the hybridization selection program for improving soybean seed quality.

b. Cultivar differences in storability under simulated tropical conditions

High temperature and high moisture are detrimental to longevity of soybean seed in storage. Seeds are hygroscopic and achieve a moisture content which is in equilibrium with the ambient relative humidity. Because soybeans have been successfully cultivated for centuries in tropical areas where temperature and relative humidity are high, it was hypothesized that there might be substantial differences among genotypes in their ability to store well under conditions of high temperature and relative humidity. This study was initiated to determine the magnitude of variation in soybeans for storability under tropical conditions and to determine the relationship between some seed characteristics and storage life.

On February 6, 1976, 396 accessions of maturity groups VIII, IX, and X of the USDA soybean germplasm collection were planted in non-replicated 3 m long rows at the Isabela Substation. As each genotype reached the first bloom stage, and one week after, it was sprayed with the systemic fungicide, benomyl, at the rate of 1 kg/ha. The plots were harvested as they reached full maturity. A total of 235

Table 14. Correlation coefficients between six characters at three harvest dates.

Correlated characters	Harvest Date (weeks after maturity) 0	2	4
Field emergence vs.			
Incidence of fungi	-.600**	-.677**	-.691**
Incidence of *Phomopsis*	-.615**	-.744**	-.797**
Maturity	.030	-.057	.025
Seed size	-.214**	-.268**	-.399**
Seed quality	-.205*	-.253**	0.334**
Incidence of fungi vs.			
Incidence of *Phomopsis*	.853**	.810**	.819**
Maturity	.156	.183	.051
Seed size	.430**	.485**	.484**
Seed quality	.363**	.400**	.343**
Incidence of *Phomopsis* vs.			
Maturity	.147	.123	.013
Seed size	.515**	.552**	.499**
Seed quality	.422**	.476**	.331**

*, ** Significant at the .05 and .01 levels, respectively.

genotypes matured by June 30 and produced sufficient seed for inclusion in the storage study. Following harvest the seeds were air mailed to Urbana, Illinois, where they were treated with a fungicide and an antibiotic to ameliorate any differences due to pathogen load. The treated seeds of each genotype were separated into packets of 50 seeds each for the storage test and stored in a walk-in chamber with temperature and relative humidity maintained at 30^{o}C and 80 percent, respectively. These conditions were chosen to simulate a tropical storage environment. At the initiation of the storage period and at two week intervals, three 50-seed samples of each genotype were taken from the storage environment, rapid-aged for 24 hours at 40^{o}C and 90 percent relative humidity, and tested for germination on Kimpac. Germination counts were taken on the sixth day with classification of seeds made in accordance with criteria established by the Association of Official Seed Analysts. Tests were continued for 12 weeks.

In the initial tests, the range of germination percentages of the 235 genotypes was 61.3 to 99.3. However, 96 percent of all genotypes had germination percentages of 80 or greater, and the mean germination percentage was 88.8. After two weeks of storage and at all subsequent periods, germination results of individual genotypes were expressed as a percentage of their initial mean germination. Using this transformation, each genotype had a relative germination percentage of 100 initially, and results in subsequent periods reflected change in germination relative to that initial value rather than in absolute terms. After two weeks storage, 89 percent of all the genotypes in the study germinated at least 90 percent as well as before storage under simulated tropical conditions. The relative germination percentage of a small number of the genotypes did decrease rapidly.

Average germination percentage of the 235 seedlots remained somewhat stable for the first four weeks of storage, then declined rapidly and approached 0 percent by the eighth week. Storage half-life is the time, in weeks, required for half of the seeds of a particular genotype to lose their viability. Genotype half-lives ranged from 3.7 to 15.5 weeks. Only four of the 235 genotypes had half-lives of eight weeks or longer. These were Barchet (15.5 weeks), PI 283.326 (9.1 weeks), PI 205.911 (9.0 weeks), and PI 194.773 (8.0 weeks). The characteristic which most distinguished them was the frequency of hard seed as counted at the end of the six-day germination period. Barchet had 60 percent hard seed initially, while PI 283.326 and PI 194.773 had 26.0 and 15.5 percent, respectively. PI 205.911, although it had a relatively long storage half-life, had no hard seed. Barchet was the only cultivar that had an appreciable frequency of hard seed after 12 weeks of storage. The storage study with this genotype was extended to 22 weeks, at which time the supply of seed in storage was exhausted.

There was a highly significant positive correlation between storage half-life and frequency of hard seed (r=0.49). Half-life was also significantly correlated with initial germination percentage, seed size, and days from planting to maturity. The positive correlation between half-life and initial germination indicate that those genotypes with high initial germination tended to lose viability less rapidly than those which had low initial germination. The negative correlations between half-life and seed size and half-life and maturity indicate that the longest half-lives were associated with small seeds and early maturity. One advantage of small seeds is that they are less susceptible to mechanical damage during threshing and other pre-storage operations than are large seeds.

Of the seedcoat characteristics studies, seedcoat impermeability appears to offer the most promise for use in the improvement of soybean storability under conditions of high temperature and high relative humidity.

In view of the potential utility of the hard seedcoat characteristic in soybeans, a series of experiments have been initiated to: (1) perform more extensive storage studies with genotypes that have different percentages of hard seedcoat, (2) determine the effect of relative humidity on the formation of hard seedcoat, (3) determine within plant positional effects on hard seedcoat, and (4) determine the effect of hard seedcoat on invasion by seedborne pathogens.

A series of crosses were made in 1977 to initiate inheritance studies of the hard seedcoat characteristic. These crosses are listed in an earlier section of this report. A range of parents were used having high, intermediate, and low frequencies of hard seedcoat, as well as non-hard seedcoat parents.

c. Development of soybean cultivars resistant to soybean mosaic virus

Soybean mosaic virus (SMV) is the most widespread soybean virus. It is transmitted to healthy plants in the field by aphids that feed on infected plants arising from SMV-infected seeds. Several lines and a few named varieties have been reported by others as having a degree of resistance to SMV, but experience has shown that all resistance available in named soybean varieties can be broken down by SMV isolates other than those used to develop the resistant variety. No SMV resistance has been reported previously in tropically adapted soybean germplasm.

In 1976, six randomized replications of the germplasm collection for maturity groups VIII, IX, and X, consisting of 400 lines, were planted at Isabela. Five replications were inoculated by hand with SMV in an attempt to determine which lines, if any, were resistant to SMV infection and to study the variability of the rates of seed transmission of the virus in soybeans. A program of stringent roguing coupled with resistance to seed transmission of SMV would eliminate the virus as a problem. All plots were examined and data were taken on the prevalence of SMV symptoms. In hills that had infected and noninfected plants, those showing no symptoms were removed. Plots in which no plants appeared infected were not rogued. The non-inoculated replication was examined for SMV prevalence, but no plants were removed. The plots were harvested as they matured, and seeds from entries free of virus symptoms in all replications were selected for later testing in the greenhouse. Four plant introductions (PI 341.242, PI 324.068, PI 374.193, and PI 238.109) and the varieties Majos, Nela, Yelnanda, and Buffalo were apparently resistant to infection by the SMV isolate used. Subsequent tests showed that only PI 341.242, PI 324.068, and Buffalo possessed the desired level of resistance. Results are incomplete with the plant introductions, but Buffalo has been tested with more than 100 isolates of SMV. These isolates are from seven different classes based on their virulence. Only one of the seven classes infected Buffalo, and this class has two isolates. All other known sources of putative resistance are also susceptible to this class of isolates that infects Buffalo.

Apparently, Buffalo represents a new source of resistance to a wide range of SMV isolates. Further tests are in progress to confirm this tentative conclusion, as are tests with the other seemingly resistant lines. A series of crosses have been made and F_1 plants grown of the resistant lines crossed with susceptible cultivars such as Improved Pelican, Jupiter, and HLS. Several F_1 plants of the cross HLS X Buffalo were inoculated with SMV in the field at Isabela in July, 1977. No symptoms appeared, indicating that the resistance is controlled by a dominant allele or alleles.

The seeds harvested from SMV infected plants of the 1976 SMV experiment were used to test for rates of SMV seed transmission. First they were examined for seedcoat mottling. Two hundred seeds from each line were planted in greenhouse sand benches, and the seedlings that emerged were inspected for evidence of SMV infection. In cases where no seedlings had symptoms, they were tested by indexing on detached leaves of the green bean variety Top Crop to determine if the virus was present.

The results of these tests indicated that several of the tropically adapted lines have low rates of seed transmission (less than 1 percent) from fully infected plants. Ninety-eight lines with low rates of SMV seed transmission and two check cultivars were planted in June, 1977 at the Isabela Substation. Five of the six replications were hand inoculated with the same SMV isolate used in the previous year's experiment. Larger plots were used than in 1976 in an attempt to produce larger quantities of seed from SMV-infected plants which would allow a more accurate measurement of the seed transmission rates of the selected lines. The plots have been harvested and the seeds have been sent to the University of Illinois for testing.

Genetic studies have been initiated to determine the mode of inheritance of the SMV resistance identified in this study and to study the allelic relationships of the different sources of resistance.

d. Development of soybean cultivars resistant to cowpea mosaic virus

Research was initiated in 1976 to study various aspects of infection of soybeans by cowpea mosaic virus (CPMV). The objectives of this work are to: (1) assess the potential yield loss in soybeans from infection by DPMV, (2) study the spread of CPMV under field conditions from the primary host, cowpeas, to soybeans, and (3) search for sources of resistance in soybeans to CPMV.

A series of experiments was conducted at the Isabela Substation in 1976 and 1977. A severe subgroup isolate of CPMV first isolated from soybeans in Puerto Rico was used in all experiments. The experiments were repeated several times to evaluate the role of environmental variation.

To assess yield loss from CPMV, three repeated experiments were performed, with plantings December 29, 1976, May 13, 1977 and July 1, 1977. The design was a split plot with four replications. Time of inoculation (primary leaf or bloom stage) was the main plot and level of inoculation (100, 75, 50, 25, or 0 percent of the plants in the plot) was the subplot. In the 100 percent inoculation, every plant in the plot was inoculated, and three out of four, every other, and one out of four plants were inoculated to achieve the 75, 50, and 25 percent levels of inoculation, respectively. Of the three experiments, only the first has been analyzed. It was found that significant yield loss resulted when 25 percent of the plants were inoculated with CPMV. The relationship between percentage inoculation and yield was linear, and no harvestable yield was obtained when all plants in a plot were infected with CPMV.

To study the field spread of CPMV, cowpeas were planted and every other row was inoculated with CPMV when the plants were in the primary leaf stage. Two weeks later the non-inoculated cowpea rows were removed and planted with soybeans. The purpose of seeding all the rows with cowpeas at first was to attract populations of the bean leaf beetle, Ceratoma ruficornis, the vector of CPMV. This timing permitted the soybeans to be in the early trifoliate leaf stage when the inoculated cowpeas were fully infected. Soybean plants with CPMV symptoms were observed between the inoculated cowpea rows, indicating natural spread of the virus from cowpeas to soybeans. Beetle activity was estimated from the amount of feeding damage. Very little beetle activity was observed in the first experiment planted in December 1976. There were only traces of injury due to beetle feeding, and as a result only one infected soybean plant was found and confirmed by serological tests. The CPMV-infected cowpeas were also severely infected with powdery mildew, making the plants less attractive to the beetles. The experiment was repeated (May-July 1977 plantings) and in this experiment a considerable amount of beetle damage was observed. Approximately 10 to 20 percent defoliation was caused by beetle feeding. In spite of the presence of the beetles, none of the interplanted soybean plants was found to be infected with CPMV. At this stage the transmission phenomenon is not well understood, although preliminary tests indicate lower transmission rates from cowpeas to soybeans than from cowpeas to cowpeas.

One hundred soybean cultivars randomly selected from maturity groups V to X were screened in the field for resistance to CPMV. Six replications of hill plots were used, with five of the replications inoculated with CPMV at the primary leaf stage and again at the first trifoliate stage to assure complete infection of every plant. At least some plants of all varieties became infected after inoculation. There were variations, however. Fifty-five of the varieties had some symptomless plants. Seeds from the apparently healthy plants were harvested and sent to the University of Illinois for further tests in the greenhouse to see if the observed variations were due to resistance. Progenies from symptomless plants of the 55 varieties were inoculated at the primary leaf stage. All inoculated plants in this stage became infected, indicating that the observed variations were not due to genetic resistance. It was not determined, however, whether these same varieties will exhibit variations in the reactions to inoculation with CPMV under field conditions. The information obtained in this experiment serves as a guide to the type of reactions that can be expected in future screenings for resistance to CPMV in soybeans.

e. Development of soybean cultivars resistant to insects

In May, 1977 two replications of 300 soybean lines were planted at Isabela to screen for resistance to leaf feeding insects such as velvet bean caterpillar, bean leaf beetle, and leaf rollers. The plots were single rows, 3 m in length and bordered on each side by rows of the variety, Improved Pelican. In August a severe infestation of velvet bean caterpillar occurred and the lines were scored using the following scale:

Score	Defoliation
1	0 to 50 percent of the defoliation of the adjacent Improved Pelican rows
2	50 to 100 percent of the defoliation of the adjacent Improved Pelican rows
3	same amount of defoliation as the adjacent Improved Pelican rows
4	0 to 50 percent more defoliation than the adjacent Improved Pelican rows
5	50 to 100 percent more defoliation than the adjacent Improved Pelican rows

Defoliation scores were recorded at two dates, August 2 and 8, 1977. Twenty-two lines had average scores of less than 3.0 at both dates. These lines, their origins, and their average scores are listed in Table 15. Entry numbers 10 through 36 are lines selected in Brasil from crosses made in the United States using adapted types and Mexican bean beetle resistant cultivars as parents.

f. Fertility/population/variety study

In September, 1976 research was initiated to study the effects of soil phosphorus level, plant population density, and variety on yield and other agronomic characteristics. A split plot design with three replications was used. Phosphorus levels were the main plots, and the population density/variety treatment combinations were randomized within these. Three phosphorus levels of 99, 201, and 298 kg/ha P were established by incorporating the appropriate amount of triple super phosphate into each main plot. The plant populations were 150,000; 300,000; and 450,000 plants per hectare. Varieties were HLS, Jupiter, and Improved Pelican. The experiment was repeated by planting an identical trial at Isabela in July, 1977. These data, however, are still being analyzed, and will not be reported here.

Table 15. Results of Insect Resistance Screening planted at Isabela May, 1977.

Entry No.	Entry Designation	Origin of Selection	Defoliation Score August 2	Defoliation Score August 8
10	72/14	Brasil	2.5	2.0
11	091/-2/5	Brasil	2.5	2.0
15	091-30/4	Brasil	2.0	1.0
23	102-8/4	Brasil	2.5	2.0
24	102-38/9	Brasil	2.0	1.5
26	199/1	Brasil	2.5	2.0
28	611/3	Brasil	2.5	2.0
29	611/4	Brasil	2.5	2.0
30	612/1	Brasil	2.5	2.0
31	612/2	Brasil	2.5	2.0
36	1528/II	Brasil	2.5	1.5
64	PI 171.451	Japan	1.0	1.5
134	PI 204.334	Surinam	2.5	2.5
191	PI 238.108	Ryukyu	2.5	2.5
198	PI 240.663	Philippines	2.5	2.5
199	PI 240.664	Philippines	2.0	2.5
202	PI 240.667	Philippines	2.0	2.0
225	PI 274.453	Okinawa	2.5	2.5
228	PI 274.506	Taiwan	2.5	2.5
229	PI 274.507	Taiwan	2.5	2.5
264	PI 285.097	Venezuela	2.5	2.5
277	PI 307.858	India	2.5	2.5

The yield results of the experiment planted in September, 1976 are summarized in Table 16. The analysis of variance revealed that the only factor which significantly affected yield was plant population. The 300,000 plants per hectare treatment yielded significantly more at 1,791 kg/ha than the 150,000 plants per hectare treatment which yielded an average of 1,600 kg/ha. The other main effects, varieties and phosphorus levels, were not significant, nor were any of the interaction effects significant.

g. Weed competition study

Investigations were initiated in 1976 to study varietal differences involved in weed competition under different systems of weed control. The study was conducted at the Isabela Substation using a randomized complete block design, eight soybean cultivars with a range of maturities and growth habits, and three weed control treatments: hand weeding; chemical weed control with Sencor, a preemergence herbicide; and no weeding. The first field experiment was planted in July, 1976 and the second in May, 1977. The results of the 1977 experiment are being analyzed at this time; only 1976 results will be reported here (Table 17).

Yield: Hand weeded plots yielded significantly more (1,477 kg/ha, averaged over cultivars) than Sencor-treated plots (1,310 kg/ha), and both weeding treatments yielded significantly more than the non-weeded plots (1,023 kg/ha). Highest yields were obtained with the HLS variety in the hand weeded plots which yielded 2,140 kg/ha. Improved Pelican and PI 341.241, both tall indeterminate cultivars, exhibited no significant difference in yield with the weed control treatments.

Number of pods per plant: Both the Sencor-treated and hand weeded plots produced significantly more pods per plant (30.4 and 33.6, respectively) than the non-weeded plots which averaged 24.4 pods per plant. Improved Pelican and SJ-2 had significantly fewer pods per plant in the non-weeded than in the hand weeded plots. HLS produced significantly fewer pods per plant in the Sencor-treated and non-weeded plots compared to the hand weeded plots.

Number of seeds per pod: Weed control treatments had no significant effect on the number of seeds per pod. There were significant cultivar differences, but no definite trends within cultivars.

Seed size: Seed size was not affected by weed control treatments. The only significant effect was that of cultivars.

Maturity: Non-weeded plots averaged two days later in maturity than the hand weeded and Sencor plots. Maturity of Williams, the earliest and shortest cultivar tested, averaged seven and five days later in the non-weeded plots than in the hand weeded and Sencor plots, respectively.

Table 16. Effects of level of applied phosphorus and plant population on the yield of three soybean varieties planted at Isabela, Puerto Rico, September, 1976.

P	Variety	Plant Population	Yield
kg/ha		plants/ha X 1000	kg/ha
99	HLS	150	1429
		300	1844
		450	1755
	Jupiter	150	1766
		300	1714
		450	1657
	Improved Pelican	150	1772
		300	1586
		450	1383
201	HLS	150	1677
		300	1600
		450	1712
	Jupiter	150	1746
		300	1694
		450	1526
	Improved Pelican	150	1660
		300	1677
		450	1542
298	HLS	150	1823
		300	1988
		450	1646
	Jupiter	150	1925
		300	2118
		450	1546
	Improved Pelican	150	1825
		300	1898
		450	1628

Table 17. Results of Weed Competition Study planted at Isabela, Puerto Rico, July, 1976.

Cultivar	Weed control treatment[1/]	Yield	Pods per plant	Seeds per pod	Seed Size	Maturity	Height	Lodging[2/]	Nodes per plant	Branches per plant	Harvest index
		kg/ha			gm/100	days	cm	score			
Jupiter	S	1631	26.0	1.2	14.5	113	98	2.1	13.8	2.2	0.27
	H	1603	28.2	1.3	14.6	113	91	2.2	13.8	2.8	0.31
	N	843	21.2	1.2	15.0	115	91	2.5	14.5	1.8	0.26
Imp. Pelican	S	1666	29.5	1.7	10.8	105	98	1.4	15.9	1.7	0.36
	H	1808	36.7	1.6	11.2	106	95	1.5	16.4	2.4	0.34
	N	1490	25.6	1.6	11.4	106	99	1.4	15.9	1.4	0.34
Hardee	S	1762	34.2	1.3	13.0	104	54	1.0	12.3	2.4	0.37
	H	2031	33.0	1.4	13.5	104	51	1.1	11.8	2.5	0.42
	N	1593	31.9	1.4	14.2	105	53	1.0	11.6	2.0	0.42
HLS	S	1834	30.4	1.4	14.7	111	94	1.2	16.0	2.4	0.35
	H	2140	41.1	1.6	13.6	112	95	1.4	16.0	3.0	0.38
	N	1570	24.2	1.4	14.4	112	90	1.2	15.3	1.8	0.34
Williams	S	802	19.6	1.1	17.5	101	49	1.0	11.6	0.4	0.31
	H	957	19.9	1.2	17.8	99	50	1.0	11.2	0.2	0.34
	N	358	12.0	1.1	16.8	106	51	1.0	10.8	0.2	0.28
SJ-2	S	1323	37.2	1.5	10.8	105	87	1.8	16.2	2.5	0.38
	H	1665	42.5	1.6	10.8	105	90	2.0	15.5	2.8	0.38
	N	1126	31.6	1.4	11.6	106	94	2.5	15.2	2.2	0.34
PI 341.241	S	1337	38.8	1.6	10.2	103	90	2.4	17.6	3.3	0.32
	H	1393	34.6	1.7	9.8	106	111	2.6	16.6	3.0	0.30
	N	1234	31.0	1.9	9.8	106	102	2.6	17.1	2.8	0.30
CH-3	S	1165	27.9	1.2	12.4	106	98	2.5	17.7	2.5	0.30
	H	1390	32.8	1.4	12.3	106	109	1.9	18.1	3.1	0.30
	N	782	17.7	1.2	12.9	105	93	1.6	16.9	1.4	0.24
LSD (.05)		348	10.2	0.3	1.4	4	15	0.8	1.3	1.1	0.06

1/ S = Sencor, H = hand weeding, and N = no weeding.

2/ Lodging scored from 1 to 5, where 1 = erect and 5 = completely lodged.

Plant height: The only significant effect noted for plant height other than cultivar differences was the significant reduction of height of PI 341.241 in the Sencor and non-weeded plots compared to the hand weeded plots.

Lodging: Although CH-3 lodged significantly more in the Sencor plots than in the other two treatments, no other significant differences (other than cultivar differences) were apparent. Identical lodging scores of 1.7 were obtained from each of the weed control treatments when averaged over cultivars.

Number of nodes per plant: CH-3 had significantly fewer nodes per plant in the non-weeded plots compared to the hand weeded plots. There was a tendency for the Sencor treated plants to have slightly more nodes per plant (15.2 compared with 14.7 nodes per plant averaged over the eight cultivars).

Number of branches per plant: Averaged over the eight cultivars, the unweeded plots had significantly fewer branches per plant (1.7 compared with 2.5). HLS produced significantly fewer branches per plant in the unweeded than in the hand weeded plots, and CH-3 produced fewer in the unweeded than in the Sencor and hand weeded plots.

Harvest index: Harvest index is the ratio of seed weight to total above ground plant weight and is used as an indicator of the efficiency of partitioning of photosynthate. Williams and CH-3 had significantly smaller harvest indices in the non-weeded plots. The average harvest index of the hand weeded plots was greater than those of the other two treatments.

3. Graduate Student Research Guidance

Dr. Paschal has supervised the M.S. thesis research of Mr. Emiolo S. Salaues E., a Bolivian graduate student at UPR/MC. The thesis problem deals with the effects of photoperiod on phenological characters of soybean cultivars grown at planting dates in the tropics. Mr. Salaues is supported by 211(d) grant CM/ta-G-73-50 to the University of Puerto Rico, a companion grant to CM/ta-G-73-49. Mr. Salaues will return to a position in the soybean breeding program at the Instituto Boliviano de Technologia Agropecuaria upon completion of his degree program. An outline of his program follows.

Objectives -

1. Determine the effects of photoperiod on the vegetative and reproductive development of four soybean cultivars.
2. Quantify the phenology of the soybean cultivars, the dry matter accumulation in various plant parts, and the relationship between dry matter accumulation and seed yield.

Plan - Four planting dates were determined in order to obtain maximum photoperiodic effects. The plantings were made at the Isabela Substation on the following dates:

March 22, 1977
May 30, 1977
September 26, 1977
November 28, 1977

The first and third planting dates correspond approximately to the vernal and automnal equinoxes. The second planting date is 30 days before the summer solstice, so that the plants receive 60 days of maximum daylength. The last planting date provides minimum daylengths for 60 days.

Experimental Design - The experimental design utilized for the four planting dates was a randomized complete block with three replications. Each block contained four plots of seven rows. The rows were 7 m long and 65 cm apart.

The following varieties were used:

Variety	Maturity	Growth habit
CH-3	Intermediate	Determinant
Jupiter	Late	Determinant
HLS	Intermediate	Determinant
Williams	Early	Indeterminant

Samples - In order to quantify the effects of photoperiod on dry matter accumulation, plants were sampled from stages V-4, V-5, V-7, R-1, R-3, R-5, R-7, and R-8. The following data were recorded from each sample: plant height, number of nodes, number of branches, dry weight of branches and stem, dry weight of leaves and petioles, and dry weight of seeds. At maturity the following data were recorded: number of pods per plant, number of seeds per pod, seed size (gm/100 seed), lodging, and seed yield.

Results - Only the first two planting dates have been harvested, but readily observable differences have been noted in the effects of photoperiod on the four cultivars. The different planting dates have resulted in differences in the duration of the various stages and the elapsed time from emergence to the occurrence of the various stages.

Output III. Expanded Advisory and Consultation Capability

The general objective of this output is to develop and expand competence among core staff and others to respond to a variety of requests for expert advice or assistance in a number of problem areas including problem identification and analysis, project design and operation, and program evaluation.

Progress toward this output goal during the report period was made from nongrant sources. The primary source was an AID-funded Basic Ordering Agreement through which several task orders to provide specific services to country missions were issued. They were:

1. BOA-1109 Task Order #2 Peru (completed)

   The objective was to assist the Government of Peru to improve the management of human and financial resources for more effective performance in a program of soybean research, marketing and utilization. This project used core staff, county-based extension staff and private industry scientists as members of the team. The project commenced January 1975 and extended through June 1977. Work on this task order assisted in evolving a program of research and educational assistance to Peru under an AID contract.

2. BOA-1109 Task Order #6 Zaire (completed)

The objective was to provide technical assistance in the development and planning of the technical aspects in the fields of agronomy, soils science and agricultural engineering for a Project Paper on National Institute of Agricultural Research (INERA) Support. This was a follow-up activity to Task Order #4 in which INTSOY provided one member of a three-person feasibility study team. Under Task Order #6 INTSOY provided three senior staff to assist an AID officer in developing a project design. Field work was conducted in Zaire in November and the project was completed by December 1976. Follow-up assistance is under consideration at the country level.

3. BOA-1109 Task Order #7 Ghana (completed)

The objective was to assist the Government of Ghana to design a five year national soybean production, processing and utilization program. A four person team (agronomist, agricultural engineer, food processing specialist and an agricultural economist) assessed the potential for soybean production in Ghana, studied the economic and technical problems involved and made recommendations for the development of a soybean industry from production through utilization. The team submitted its report in March 1977.

4. Other Country Projects

By the end of the report period two additional mini-projects were at or near implementation stage. Under direct support from the U. S. Agency for International Development Mission to Panama, a four person team was prepared to assist the Faculty of Agronomy, University of Panama, in developing applied research programs in soybeans. This project utilizes staff of the University of Illinois and Puerto Rico in the areas of weed control, insect control, disease control and production technology. UPR/MC also is to provide the services of a plant pathologist (seed quality) working in conjunction with a seed specialist from the Mississippi State University Seed Technology Laboratory. Completion is expected by December.

A second project was organized under sponsorship of the Food and Agriculture Organization of the United Nations for the purpose of providing a soybean research and educational service to the Government of Iraq. A team consisting of an agronomist and a mechanization specialist is to review the existing soybean situation, taking into account research, production, manpower, mechanization and input supplies, recommend work needed for the introduction of soybean production and formulate an appropriate project for expanded soybean production through the Iraqi Trust Fund. The project is to be completed by January 1978.

A central feature of INTSOY participation in country project activities has been the ability to assemble teams of high qualified personnel from among the developing network of soybean scientists. Our capability to respond to requests for advisory services has been enhanced. Of the projects listed above INTSOY core staff served with colleagues from UIUC, University of Puerto Rico/Mayaguez Campus, Mississippi State University, Cooperative Extension Service and Central Iowa Bean Mill, Inc. to apply a wide array of experiences to specific problems. This pattern of operation, which has worked well to date, will continue to provide an expanding manpower base from which special purpose INTSOY teams can be assembled.

5. Language Training

Increasingly, language competence is becoming an important qualification for advisory effectiveness. Major projects of technical assistance or collaborative research are contemplated in countries whose primary language is Spanish or French. An AID contract to assist the Government of Peru in a soy and rice improvement and utilization project is in final stages of negotiation. INTSOY staff assigned to this project are required to command a working knowledge of Spanish. To provide this response capability grant funds will be used to begin intensive Spanish training at the Cuernavaca Language School, Cuernavaca, Mexico, for two staff. Minimal language training support was provided for a research assistant anticipating his association with this project. Additional staff may be trained there, at other Latin American based intensive language instruction institutions. Contact will be made with the Foreign Service Institute School of Language Studies to see if Spanish or French instruction can be made available for INTSOY grant or contract personnel.

Output IV. Improve and Expand Information Management Capability

This output goal seeks to develop and expand the knowledge base and increase capability to provide advisory and consulting services by the orderly and systematic collection, analysis and distribution of information, data and materials relative to soybean development and use. Four systems were contemplated in the redesigned grant:

1. Soybean germplasm data bank.
2. Reference collections of soybean pests.
3. INTSOY publications series.
4. Soybean literature compilation, retrieval and delivery.

While some progress was made on nos. 1, 2, and 3 from other sources, primarily an AID research contract, grant funds supported only number four, the system known by the acronym SIRIC, i.e. The Soybean Insect Research Information Center. A brief report on progress in the SIRIC system, prepared by Mrs. Jenny Kogan, INTSOY Research Assistant, follows.

The Soybean Insect Research Information Center (SIRIC) is a computerized information storage and retrieval system for the world wide literature of arthropods associated with soybeans. SIRIC is primarily a service oriented unit, operating in close cooperation with the Soybean Entomology Research Team of the Illinois Natural History Survey and the University of Illinois.

Created in 1969 SIRIC was originally designed as a manually operated system capable of handling a few thousand citations. In 1969 there was only a small number of entomologists working full time on soybean insect pests in the United States. In 1976, however, more than a dozen different centers, especially in the Midwest and Southeast, had entomologists working in multi-disciplinary soybean research programs. A sharp increase in the numbers of published papers (Figure 1) was a direct result of the research conducted in these institutions. With the expansion of the data base SIRIC developed into a computerized system to better respond to requests and more efficiently handle this expanded literature. Because SIRIC was established at the time at which soybean entomology was growing so much, the establishment of this Information Center was a very timely decision.

Objectives

The main objectives of the center are periodically reassessed in response to changing information needs of researchers.

Basically these objectives are:

1. Compilation of the literature of soybean related arthropods and the establishment of a data bank for this literature.

2. Assistance to researchers on an international scale in the form of computer searches.

3. Assistance in special searches (usually manually done) for types of information not covered by the data base.

4. Assistance to researchers in securing copies of documents in SIRIC's holdings.

5. Compilation and publication of comprehensive bibliographies on key soybean insect pests.

6. Assistance to researchers by providing literature surveys leading to the production of review articles and monographs covering areas of key importance in soybean entomology.

Basic operations of SIRIC consist of: updating (input operations), computer searches, special searches, and system upgrading.

Bibliographic references are stored on tapes for retrieval on the new Cyber 175 Computer of the University of Illinois. Physical copies of all documents are kept on file.

Accomplishments

During the time covered by this report 173 requests for service were filled in the form of computer printouts, manual compilations, copies of documents, and referral services.

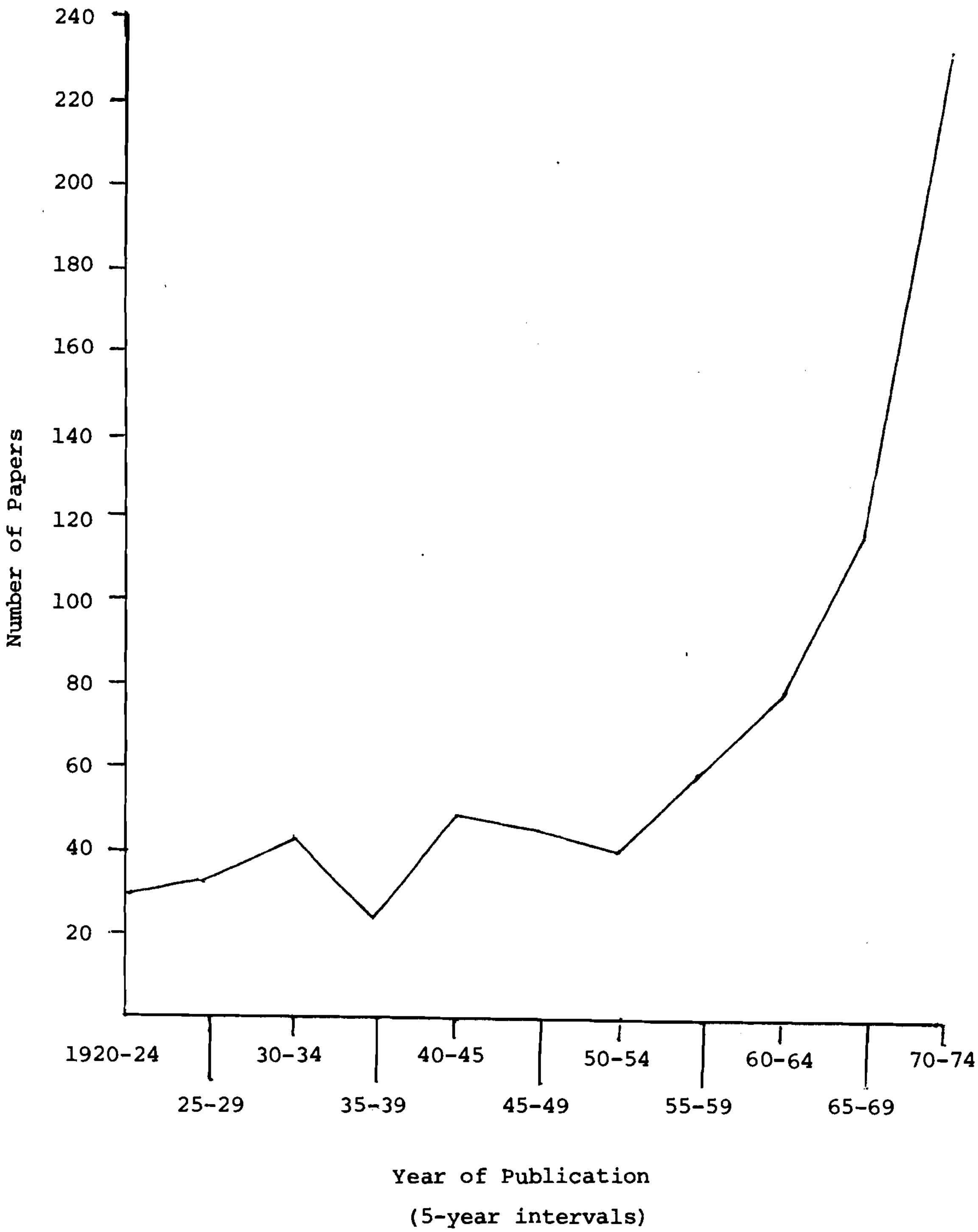

Figure 1. Publication Rate of Papers in Soybean Entomology

Sixty-five percent (112) of all requests for information or services came from researchers at the University of Illinois or their graduate students. The remaining thirty-five percent (61) were received from individuals in other institutions in the United States and abroad. SIRIC performed comprehensive bibliographic searches used in the production of review articles and special reports.

The literature of sampling methods for 18 soybean insect species was searched and sent to researchers participating in the publication of a book on sampling methods edited by entomologists of the University of Illinois with the cooperation of nearly 20 specialists from the United States, India, Japan, and Brasil. A survey of the literature on Plant Resistance - Chemical Factors published in the last 20 years was done in support of Dr. M. Kogan's studies in this field. A comprehensive survey of the literature of *Oris* spp. was done for Dr. M. Irwin, INTSOY Entomologist. A comprehensive search on the literature of insect nutrition was done in support of Dr. J. P. Parra, a post-doctoral researcher from Brasil working with Dr. M. Kogan.

In a recent computer search in response to a request for the literature on insects damaging soybeans, about 900 citations were found to be relevant. Printouts were sent to cooperators in Korea and Brasil.

SIRIC was contacted by the Empresa Brasileira de Pesquisa Agropecuaria - (EMBRAPA) Departamento de Informacao e Documentacao (Brasil) with the purpose of establishing a formal exchange of information services. Assistance was also provided in the literature search of *Epinotia aporema*, a serious soybean pest in Brasil.

In May of 1977 a display on the scope and services offered by SIRIC was prepared for the INTSOY Network Conference. Bibliographies and the brochure "What is SIRIC?" were distributed among the participants.

SIRIC librarians helped in training students and researchers in the use of reference tools and development of search strategies for literature surveys.

Bibliographies compiled and published within the framework of SIRIC have an importance that exceeds their value as mere guides to the literature of selected insect species. The information contained therein provides two kinds of access, bibliographic and physical. Bibliographic access translates into "knowing of the existence" of a work. Physical access, on the other hand, translates into having a physical copy of that particular work. Because SIRIC keeps copies of all works cited, physical as well as bibliographies, access to the works is available. This feature is particularly important for researchers in the developing countries working in institutions with inadequate library facilities.

Following the four bibliographies published so far on the Literature of Arthropods Associated with Soybeans, SIRIC is working in the compilation of a fifth bibliography of two *Heliothis* species (*Heliothis zea* and Heliothis virescens). This bibliography will contain over 5,000 citations and because of its volume and complexity careful examination of all documents is needed. During the process of compiling this bibliography mistakes were detected in the older indexes to the literature. Some of these mistakes (mispelled names, wrong paging, citation non-relevant to subject under which it was listed, etc...) have been perpetuated for many years, suggesting that compilers of more modern lists cited the older literature without examining the documents. Due to the economic importance of these species and to the volume of published literature, most of the Center's efforts were concentrated in the preparation of this bibliography. It should be ready for publication in early 1978.

New procedures in the input operations allow for proofreading of bibliographic data before it is loaded in permanent storage tapes. At the moment SIRIC files contain 16,200 citations, representing an increase of approximately 4,000 citations during the last year.

SIRIC provided literature searches and copies of documents to investigators in the following countries: Australia, Bolivia, Brasil, Canada, Colombia, El Salvador, Ecuador, Honduras, Iran, Israel, Korea, Philippines, Sri Lanka, Sweden, and Taiwan.

AUSTRALIA - Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra.

Request: Literature search on: Cerambycidae on soybeans.

BRASIL - Centro Nacional de Pesquisa da Soja, Londrina, Parana.

Request: Copies of documents and literature searches on:

1. Damage caused by chinch bugs.
2. Insects damaging soybeans.
3. Crop spacing.
4. Anticarsia gemmatalis.
5. Epinotia aporema.
6. Pathogens of soybean insects.

- Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), Brasilia.

Request: A special search on the literature of Epinotia aporema.

CANADA - Department of Entomology - MacDonald College.

Request: Sets of published bibliographies.

COLOMBIA - Instituto Colombiano Agropecuario (ICA), Espinal, Tolima.

Request: Literature searches on:

1. Heliothis spp., host range and survival.
2. Heliothis spp., parasites and predators.
3. European corn borer damage.

ECUADOR - Instituto Nacional de Investigaciones Agropecuarias (INIAP)
Guayaquil - Ecuador.

Request: Sets of published bibliographies and copies of documents.

EL SALVADOR - Centro Nacional de Tecnologia Agropecuaria, Santa Tecla.

Request: Copies of published bibliographies and literature searches on:

1. Diabrotica balteata.
2. Nezara viridula.
3. Cerotoma ruficornis.
4. Apion godmani.
5. Elasmopalpus lignosellus.
6. Phyllophaga.

HONDURAS - Department of Natural Sciences, Escuela Agricola Panamericana, Tegucigalpa.

Request: Literature search on the biology of Spodoptera frugiperda.

ISRAEL - Department of Entomology, University of Tel Aviv.

Request: Literature searches on:

1. Heliothis spp., H. armigera, H. virescens, and H. zea.
2. Heliothis spp., growth.
3. Heliothis spp., nutrition.
4. Heliothis spp., host selection.
5. Heliothis spp., life cycle.

NETHERLANDS - Center for Agricultural Publishing and Documentation, Wageningen.

Request: Literature search on Maruca spp.

NICARAGUA - Project Integrated Pest Control, FAO, Managua.

Request: Copies of papers listed in the bibliographies and computer searches on Spodoptera frugiperda.

PHILIPPINES - Department of Entomology, University of Philippines at Los Banos.

Request: Seed viability of field growing soybeans.

SRI LANKA - Ministry of Agriculture and Lands, Colombo.

Request: Sets of the published bibliographies.

SWEDEN - Entomology Department, University of Lund.

Request: Literature searches and copies of documents.

TAIWAN - Asian Vegetables Research and Development Center (AVRDC).

Request: Copies of papers and computer searches on:

1. Cultural control methods for soybeans.
2. Trap cropping methods.

The information center was visited by soybean specialists and administrators from the following countries: Brasil, Costa Rica, Iran, Israel, Mexico, Pakistan, Peru, Philippines, Sri Lanka, Taiwan, and by the participants of the 1977 INTSOY short course Technical and Economic Aspects of Soybean Production. A lecture on the activities of SIRIC is presented at these occasions to familiarize potential users with the services offered by the Center.

Throughout its eight years of existence SIRIC has operated with various levels of staffing. The quality and amount of service provided to searchers is directly proportional to the personnel available to the system. The needs of SIRIC are rather modest, if we exclude the work towards publication of bibliographies. A moderate expansion of the clerical staff would greatly increase the efficiency of the system. A preliminary feasibility study was conducted to expand SIRIC's services into a comprehensive Soybean Plant Protection Information Center. Contacts were made with specialists in plant pathology, nematology and weed science. Suggestions for an expanded Soybean Plant Protection Information Center were summarized and presented for administrative review. Approval and implementation are contingent on the appropriateness of the proposed Center's mission relative to the overall INTSOY mission and the availability of space and funds.

Expansion of SIRIC into a Soybean Plant Protection Information Center is suggested as a two-phase process. Chanelling of efforts and personnel requirements are distinctly different in the two phases that may be defined as: 1) establishment phase, and 2) operational phase.

Establishment phase. Version IV of SIRIC computer programs now being developed for the new Cyber 175 Computer of the University of Illinois will be used in the expanded system. The backbone of any information retrieval system is the controlled vocabulary of descriptors used for indexing the information for later retrieval. Based on the HCD (Hierarchical Code Descriptors) thesaurus developed for the entomological literature, similar vocabularies will be developed for plant pathology and weed science. Some segments of the thesaurus, such as the taxonomic list of plants, will be common to all three areas. Search strategies will be developed in accordance with the specific needs and characteristics of the three protection disciplines. During the establishment phase, close contact with the specialists in these areas is very important for the development of the controlled vocabularies and search strategies.

The key criterion for inclusion of works in the expanded data base will be the insect species, disease or weed species in its association with the soybean on a world-wide base. As a second criterion, the literature of major soybean pest species will be searched in depth to also include information on alternate hosts or alternate crop associations.

Operational phase. Once the supporting structure is established operations in the center will basically consist of updating, output requests, special searches, and upgrading the system.

Updating will be done by searching the major indexing and abstracting journals, Current Contents, and other computerized data bases to which SIRIC has access. The center should be available to fulfill requests for output searches contained in the data base as well as for special searches not covered by the data base but necessary for the development of research projects. Upgrading the system will be a continuous process because the controlled vocabularies must be flexible to accomodate new terms or changes that sometimes occur. Also the computer programs must be re-evaluated periodically for efficiency of performance. All these activities will proceed at a rate compatible with the resources available to operate the system.

SPACE: For the operations of the center under the conditions described above, adequate space should be provided. Based on our currently available space (243 n.a.s.f.), one or two rooms with a total of 720 n.a.s.f. should be adequate to accomodate four desks, one or two working tables, book shelves, and about 25 four-drawer filing cabinets.

PERSONNEL:	Entomology	Plant Pathology	Weed Science
Library researcher	1	1	1
*Computer programmer	0.5	-	-
*Key puncher	0.5	-	-
Typist	0.5	0.25	0.25
Clerical assistant	0.5	0.25	0.25
Hourly helpers	15 hrs/wk	15 hrs/wk	15 hrs/wk

Output V. Expanded and Strengthened Linkages and Activities

The objective of this output goal is to develop UIUC, with the University of Puerto Rico, Mayaguez Campus, to serve in an intensive leadership role in mobilizing U.S. resources as the hub of an international network of organizations and individuals linked in ways to provide means for stimulating cooperative efforts, insure effective utilization of program outputs and contribute to sustaining future soybean development programs for the tropics and subtropics.

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* During the first 3-4 months after development of the controlled vocabularies a full time programmer and key puncher will be needed.

The principal domestic, international organization and LDC linkages remain as described in last year's annual report. Development of additional linkage mechamisms and network building has continued at a high level of activity. The INTSOY Director and INTSOY Regional Representative for Asia (grant program directors) have been involved in a series of discussions with the Secretariat, Chairman and members of the Technical Advisory Committee of the Consultative Group for International Agricultural Research (CGIAR) as that organization considers the priority position of soybeans as a commodity for which research should be supported through CGIAR and the appropriate relationships between and among INTSOY and CGIAR recognized institutions. During the report period two ad hoc consultations were held in FAO Headquarters, Rome, and the Chairman of TAC, Dr. Ralph W. Cummings, personally visited UIUC for discussions with the INTSOY Director and staff.

Linkage development activities were given additional impetus from an INTSOY-sponsored International Soybean Network Conference held at UIUC May 25-26, 1977. Representatives from 16 institutions and organizations reviewed the history, rationale, objectives and programmatic guidelines of the INTSOY program. At the completion of the Conference a number of institutions expressed strong support for the overall program concept and an interest to participate further in the development of an "International Soybean Network, INTSOY". Plans have been made for INTSOY technical staff and administrators to visit several universities to discuss areas of potential collaborative efforts. Following this round of visits it is anticipated that a second networking conference will be held at which time specific assignments for further planning and recommendations for the formation of an overall management entity might be made. Discussions were held with U.S. Department of Agriculture representatives encouraging collaborative efforts.

The INTSOY Director has been active in linkage/program development activity of other institutional entities, as those groups have potential for interaction with INTSOY or as their planning process contains features that may be adapted to the INTSOY planning efforts. Close cooperation with the Mid-America International Agricultural Consortium (MIAC) and the Center for International Crop Protection (CICP) has been most useful in linking aspects of INTSOY activities to newly emerging programs.

In addition the INTSOY Director and the Chairman of INTSOY Executive Committee participated in the two major Title XII conferences held during this report period in Blacksburg, Virginia and Minneapolis, Minnesota. The Assistant Director also participated in the Central Region International Agricultural Training Conference held in Columbus, Ohio, in May, 1977. This conference, sponsored by the U. S. Agency for International Development, the U. S. Department of Agriculture, the International Science and Education Council and the Resident Instruction Committee on Organization and Policy of NASULGC, focused on the integration of development education into overall program planning. A paper illustrating the INTSOY approach, including reference to training opportunities inherent in this grant, was presented.

INTSOY Representative for Asia. Dr. Carl N. Hittle has served as INTSOY Representative for Asia, on a 20 percent basis since July, 1976. Dr. Hittle is on extended assignment with the Sri Lanka Soybean Development Program, a major outreach program primarily funded by UNDP/FAO with additional support from UNICEF and CARE. In addition to strengthening the capabilities of Sri Lanka, this has provided experience in coordination of multi-organizational support for a broad-scale program of soybean production, marketing, processing, and use.

Dr. Hittle has played a lead role in developing and sustaining linkages with governments and institutions interested in and committed to soybean development, as well as expanding the international soybean network in Asia. He represented INTSOY at the Second FAO/SIDA Seminar on Field Food Crops in Africa and the Near East held at Lahore, Pakistan, September 18-October 5, 1977 where he presented a paper entitled, "Development of Soybean Varieties and Associated Agro-Techniques for Different Agro-Ecological Conditions of Africa and the Near East."

He was active in linkage development with the International Crops Research Institute for Semi-Arid Tropics, India, and the Philippine Council for Agricultural and Resources Research in November 1976 and November 1977, where he was involved in discussions of operational agreements under a joint PCARR/INTSOY Memorandum of Understanding. Dr. Hittle participated in the December 1976 meetings called by the International Board for Plant Genetics Research in the Philippines where he reviewed INTSOY interests in plant exploration and germ plasm bank maintenance.

He also made selected visits to International Soybean Variety Experiment cooperators and test sites in several countries in Asia and Oceania in connection with travel to conferences and consultations. These visits to cooperating research scientists provided useful information to the breeding program centered at UPR/MC and strengthened the established linkages between INTSOY and remote test sites.

The assignment of a regional representative has been a significant advance in program operation and is improving INTSOY response capability in a number of important areas.

Regional Conferences and Training Courses. Three major conferences have been held for soybean scientists of Latin America, Africa, and Asia and Oceania and were reported in last year's annual report. The proceedings of these conferences (INTSOY Series 2, 6 and 10) are continually requested as resource material.

A workshop on soybean rust was sponsored by INTSOY, The Asian Vegetable Research and Development Center (AVRDC) and the Philippines Council for Agriculture and Resources Research (PCARR) in Manila February 28-March 4, 1977. The genesis of this conference was a symposium on soybean rust held at the Regional Conference in Chiang Mai, February, 1976. The report of this workshop (INTSOY Series 12) serves as a statement of the seriousness of the problem of soybean rust and contains an outline of research needs for combating this serious disease problem.

Two non-degree training courses were established in 1975 under the USDA/AID training program format. Each course has been offered three times. The courses are: 1) Soybean Processing for Food Uses--a five week course attracting 39 trainees from 22 countries; and 2) Technical and Economic Aspects of Soybean Production--an 18 week course with 46 participants from 28 countries.

These courses have been well received and have been useful in forming linkages with soybean workers in LDC country programs. The courses are offered annually and are supplementary to degree work available at the University of Illinois and the University of Puerto Rico, and many other universities with soybean expertise.

Grant support of these two useful linkage building activities, conferences and courses, was limited to salary of grant personnel who participated by reporting on grant activities or as instructors or resource persons.

There is little INTSOY activity that does not result in building or strengthening linkages in the soybean network.

The INTSOY Newsletter. A one sheet quarterly-issued publication, the INTSOY Newsletter was first published on experimental basis in August, 1974 with support from UIUC and an AID funded soybean research contract. The first mailing went to approximately 500 individuals and institutions.

Experience has shown this to be an effective device for providing information to soybean workers of the tropics and subtropics and their institutions. It has also assisted in communication and building linkages with U.S. institutions and international organizations interested in providing technical assistance in soybean production and use. Requests by individuals or institutions to be added to the free subscription list have increased the size of the list to just over 1,700, with more than half the issues going to overseas addresses. While grant funds have not been used in the publication of the INTSOY Newsletter, program activities have been well publicized.

E. Impact of Grant Supported Activity on Achieving Grant Purposes

The 211(d) grant has had a positive effect on the process of developing UIUC (and under a companion grant UPR/MC) response capability in soybean production and use. There is little doubt, however, that the effect would have been substantially greater had the level of funding assumed in the grant redesign been realized. Programmatic gaps would have been bridged and greater flexibility of operations would have been possible.

In retrospect the overall effect of the grant on the total INTSOY program has been positive. The process of redesigning the grant helped sharpen the focus of the program and has been extremely useful in subsequent intermediate and long range planning activities. Because of the complementarity of grant objectives and objectives of other AID supported program activities (e.g. a research contract, basic ordering agreements for technical services and training, general technical services contracts for regional conferences, and purchase orders for technical services) and international organization supported projects, the introduction of grant supported activities has had a desirable ripple effect.

F. Other Resources for Grant Related Activities

INTSOY follows a programmatic approach to international soybean development. As such, all elements of the program are supportive of a common goal, that of cooperating with international and national organizations to expand the use of soybeans for human food.

Grant related activities have been supportive from a number of sources; state, federal, private and international. UIUC provides administrative costs, access to laboratories, equipment, computers, research facilities and libraries. Offices and classroom space, and consulting service of faculty and fields are related to grant activities.

The Agency for International Development, through a number of instruments, assists in grant related activities associated with the five outputs discussed in Section D. Complementary activities of research contract AID/TA/C-1294 contribute to all five outputs. Task orders performed under basic ordering agreement AID/TA-BOA-1109 strengthened Objectives II, III, and V particularly. General technical services grants for conferences and support of on-campus short courses contribute to Objectives I and IV and complement Objectives III and V.

Private contributions, chiefly a one-time grant from the Rockefeller Foundation, provided needed equipment in support of Objective II, provided some graduate stipends complementary to Objective I, and partially supported some information system development in Objective IV. It further provided impetus to new work in seed storage and seed quality maintenance at UIUC and UPR/MC that was incorporated at a minimum level in research contract AID/TA/C-1294.

Participation by international organizations in outreach activities is encouraged by INTSOY. The United Nations Development Program and the Food and Agriculture Organization of the United Nations are supporting INTSOY assistance to the Government of Sri Lanka in a comprehensive program of soybean development from production through utilization in the diets of the rural poor. This effort is further supported by two additional organizations of the United Nations program. CARE and UNICEF are combining to support a pilot food processing plant and a related consumer education extension activity. Information from this project will be especially useful in the development of soybean genetic technology (Objective II). Training features special opportunities for Sri Lanka nationals at the G. B. Pant University of Agriculture and Technology, India, and assists in the development of UIUC competence to plan and conduct regional training in cooperation with collaborative institutions (Objective I). Service in Sri Lanka by INTSOY core staff and associated personnel materially increases UIUC competence to advise and consult on national development programs (Objective III). Linkages with organizations within the United Nations family and with other donor agencies and governments are being fostered (Objective V). Information on a wide spectrum of germ plasm improvement and disease and insect susceptibility or resistance augments the data stored in information systems and will be available to interested scientists (Objective IV).

G. Utilization of Institutional Response Capabilities in Development Programs

Programmatic assistance was provided to a number of requesting organizations and is summarized in Table III. Technical and advisory assistance was provided by core and associated staff under an array of task orders and other arrangements. On and off campus training programs were offered to soybean workers of tropical and subtropical LDCs who are doing or are responsible for research and extension work in soybean development in their countries. Graduate students supported by the grant who have completed degree objectives, and non-grant supported but grant associated students, are working in LDCs or with international groups. More will follow as degree objectives are met and additional employment opportunities in LDCs and international organizations arise.

It is appropriate to express a word of appreciation to the vast numbers of scientists and support workers at the UIUC, UPR/MC and associated institutions upon whom the program has drawn for assistance in grant related activities. Most of these persons were not supported with grant or other AID funds intended to be used for development of LDCs of the tropics and subtropics and their willingness to contribute speaks highly of their committment to international agriculture and to the validity of the concepts underlying the total INTSOY program.

H. AID Fourth Year Review

As part of its overall grant management process AID schedules periodic reviews of 211(d) grants, one after the first 18 months and the second during the fourth year. The companion 211(d) grants TA-G-73-49 and TA-G-73-50, of the University of Illinois at Urbana-Champaign and the University of Puerto Rico, respectively, were reviewed in early 1977.

The UIUC review was conducted February 2-4, 1977, in a cordial and collegial atmosphere. The review team was well briefed on the objectives of the grant and was reasonably well briefed on the total INTSOY program. The team was augmented by the AID project monitor who served in an unofficial role as recorder.

The review team received a report of progress of the INTSOY program focusing on the grant and how it contributed in important ways to the overall program objectives. This means of reporting, while understandable and logical to INTSOY staff, produced some confusion in the review team when they attempted to assess progress toward specific grant objectives.

At the completion of the review the team prepared a Project Appraisal Report (PAR). This report contained five specific recommendations (pages 5-8 of the PAR) supplemented by a list of actions detailed on the PAR cover sheet. The recommendations and INTSOY response are reviewed below.

Recommendation 1: "That where inputs are attributal to various sources of funding the inputs should be disaggregated so that the relevant contribution of each can be measured." It was planned that the efforts under the 211(d) grant would complement work conducted under other support to attain a program of research results and institutional response capability; therefore discrete disaggregation of inputs and associated outputs is different. INTSOY, in subsequent reports, has attempted to limit discussions of progress to the specific project under report. In cases where complementary activities are reported they are clearly noted as being outside the scope of funding, but complementary to, the objective of the grant or contract under report. The problem leading to this recommendation would largely be solved by following Recommendation 4.

Recommendation 2: "That there be greater continuity in project managership." INTSOY concurs and is pleased to acknowledge the positive contributions to this grant and complementary research contract made by the seventh and current project monitor, Dr. John Yohe.

Recommendation 3: "That a revised log frame be prepared in collaboration with the two universities, which reflects the current plans of action for the remainder of the grant period. This is needed both to permit enhanced monitoring for the remainder of the grant period and for evaluation of accomplishments upon its termination." A revised logframe for the total grant is attached as Appendix A. It is necessarily reduced in scope from that prepared at the time of the grant project redesign activity because the funding levels anticipated did not materialize.

Recommendation 4: "That in the future AID review the entire program at one time, along with clarification by the University of contribution of each project, rather than reviewing the projects separately." INTSOY strongly concurs with this recommendation. It has been INTSOY's position that total program reviews should be made, as opposed to discrete project reviews, to provide the Agency with a perspective of progress not possible on a project by project review basis. This review procedure would be consonant with the philosophy that the research contract and inter-institutional and companion 211(d) grants would contribute to a soybean research and educational program to serve the developing countries of tropical and subtropical areas.

Recommendation 5: "AID needs to officially advise Illinois that 211(d) funds can be used for travel of persons who can contribute to the Project and who do not necessarily receive any of their salary from 211(d) funds." This was a most heartening recommendation to project director, who had been seeking a means to involve outside and internationally recognized consultants in the program. Following this recommendation, and in concert with a suggestion from one of the review team that a senior soybean breeder be detailed to Puerto Rico to review the breeding program, efforts were made to obtain the services of Dr. Luis H. Camacho, the foremost tropical soybean breeder of Latin America. Dr. Camacho, a citizen of Colombia, was at the time stationed in Tehran, Iran, as director of a regional pulse project sponsored by FAO. The recommendation and assurances of the review team notwithstanding, it was only after protracted correspondence and discussions with the Agency that INTSOY was permitted to engage Dr. Camacho as a consultant to review the soybean breeding work at UIUC and UPR/MC, and then not on the 211(d) project but on the complementary research contract. Nevertheless, the consultancy was highly productive; a summary of Dr. Camacho's findings and recommendations are attached as Appendix B.

Recommendation 6: "In view especially of budgeting cycles of AID and other financing organizations the Team urges the two Universities and AID to explore at the earliest possible date the various types of possible post-grant relationships such as: (1) an organic network relationship to the CGIAR; (2) a consortium program suitable for Title XII collaborative research program grant; (3) a more specific research grant; and/or country program grants/contracts. The Team also believes that AID might consider the possibility of a 211(d) grant extension to the University of Puerto Rico in the utilization mode in order to help establish more firmly its competence in soybeans." INTSOY for its part has continued its planning process stressing examples 1 and 2 above, both of which are complementary. INTSOY is pleased that the Agency has continued to express its willingness to support a 211(d) grant extension to the University of Puerto Rico to continue and expand on the remarkable progress on soybean protection made during the first four years of the grant.

With one point of the Project Appraisal Report INTSOY takes strong exception. The team reported that "It does not appear that Illinois has assumed much of a role in attempting to strengthen the cooperation between the University of Puerto Rico program in soybeans, the various organizations and programs underway in the Commonwealth where complementarities could be developed. Specific reference is made to the ARS Institute of Tropical Agriculture, the Soils Benchmark Project, and the AID-supported bean/cowpea project." INTSOY has worked diligently to foster cooperation and communication at both administrative and scientific levels. Project leadership has encouraged the close cooperation of the two universities and the Mayaguez Institute of Tropical Agriculture (MITA) including encouraging the United States Department of Agriculture to assume responsibility for the tropical soybean germplasm. The INTSOY Director (project co-director) has continuously called to the attention of Agency and UPR/MC administration the need for closer collaboration among the various AID-supported projects in Puerto Rico. Included was the recommendation that one administrator at UPR/MC and one AID/Washington Monitor be responsible for all projects the goal being to gain the complementarities among the various projects.

There is active cooperation on specific projects and excellent communication between INTSOY staff and Puerto Rico staff working on the Soils Benchmark Project. INTSOY staff employed by both UPR/MC and UIUC share the same facilities and work on associated projects, most closely in the areas of breeding, production and protection. These are the areas of concentration of the companion 211(d) grants. University of Illinois personnel and staff of the UPR/MC Department of Agricultural Engineering cooperated in a project on storability of soybeans under small farm tropical conditions. Most of this work was done under the aegis of a Rockefeller Foundation Grant and an AID research contract, but grant personnel provided facilities and support. Examples of understanding and cooperation at the administrative level from the chancellors of each institution through the deans and liaison officers are numerous.

I. Year Five Plan of Work

The final year of the grant will focus on the outputs expected from the original grant namely, output 1: improved education and training; output 2: extended knowledge base; and output 3: expanded and strengthened linkages and networks, with such funds as may be residual devoted to outputs four and five. Since the inception of this grant the first priority has been given to generating populations leading to development of soybean varieties adapted to small farm, tropical and subtropical conditions. This priority will be sustained in year five. Graduate training opportunities will again be central to the plan of work, however, any new students added will be faced with the prospect of finding new sources of support after their first year. Linkage and networking activities will be continued with special emphasis in Asia by the INTSOY regional representative. Other linkage and networking activities will be furthered by core and associated staff in connection with normal and special assignment.

Other program objectives e.g., on and off campus short courses, information dissemination and improved advisory capability will be addressed with partial support from the grant but primarily through nongrant arrangements as has been the case during the four years of the grant.

J. Involvement of Minority Personnel and Women

The grant provided opportunities for employment of women under Objective IV, information management capability, working with the soybean germ plasm bank, (TAXIR) and the reference collections of soybean pests (SIRIC and IRCSA). Women are also utilized in a professional capacity in Objective V, linkages and networks, in the production and distribution of the INTSOY Newsletter.

The University of Illinois has, on each of its three campuses, an affirmative action program to assure opportunities of employment for minority personnel in compliance with Title IX. Each program is supervised by a campus level officer under coordination of a general officer of the University. The program is on file with a number of departments of the United States Government.

Table I-A--211(d) Expenditure Report--Actual and Projected Summary Under Institutional Grant AID/CM/ta-g-43-49

Reporting Period 01 October 1976 to 30 September 1977

	Expenditures to date		Projected expenditures	
	Reporting period	Cumulative total	Year 5	Total
Personnel (including stipends)	$ 76,147	$235,751	$ 83,530	$319,281
Fringe	8,293	21,713	13,180	34,893
Travel	25,243	43,835	16,850	60,685
Research support	21,004	69,350	16,000	85,350
Total	$130,687	$370,649	$129,560	$500,209

Table I-B--211(d) Expenditures for Reporting Year
Under Institutional Grant AID/CM/ta-g-73-49

Reporting Period 01 October 1976 to 30 September 1977

I.	Salaries			$ 76,147
	A. Academic			
	W. N. Thompson	.25		
	C. N. Hittle	.20		
	E. H. Paschal II	1.00		
	D. K. Whigham	.25 to April 11, 1977		
	W. H. Judy	.25 beginning June 1, 1977		
	R. E. Dunker	1.00 October 21, 1977 to September 20, 1977		
	J. Kogan	.50		
	B. Stipends			
	Roger Elmore	.50 beginning August 21, 1977		
	Stephen R. Foor	.50 to February 20, 1977		
	Barry Glaz	.50		
	Roger McBroom	.18 beginning August 21, 1977		
	James Orf	.50		
	David Sammons	.50 to August 20, 1977 .20 beginning August 21, 1977 and UIUC fellowship		
II.	Fringe			8,293
III.	Travel			25,243
IV.	Research support			21,004
	A. Hourly help		3,222	
	B. Materials and supplies		17,782	
Total				$130,687

Table II--Requests for Assistance Received During Reporting Period 01 October 1976 to 30 September 1977

Description of request for assistance	Whom did you assist?	Who requested assistance?	Who funded assistance?	Size of effort		Results of assistance
				Dollars	Man days*	
1. Technical assistance--Program planning to improve management resources for effective performance in a soybean development program	Ministry of Agriculture Govt. of Peru	Govt. of Peru through USAID	AID	$99,440	22 m.m.	1. Short-term assignments by agronomists, economist, extension specialist. 2. Assisted in development of comprehensive soybean development program. 3. Provided U.S. and third-country training for six participants. 4. Week-long seminar for extension workers in Peru for January 1977. 5. Project completed.
2. Technical assistance--Manpower development	Oilseed Research and Development Company Govt. of Iran	Govt. of Iran	Govt. of Iran	$8,290	14 m.m.	1. Provided observation and field training for 16-man team.
3. Technical assistance--Development and planning of technical aspects for a Project Paper (PP) on National Institute of Agricultural Research (INERA) Support	Govt. of Zaire	USAID Mission to Zaire	AID	$24,053	3 m.m.	1. Project paper prepared and submitted 2. Project completed

* m.d. = man days
m.m. = man months

Table II - continued

Description of request for assistance	Whom did you assist?	Who requested assistance?	Who funded assistance?	Size of effort		Results of assistance
				Dollars	Man days*	
4. Technical assistance--Advise on development of a soybean industry, including emphasis on production by small farmers of direct use of soybeans for human food	Govt. of Ghana	USAID Mission to Ghana	AID	$29,295	4 m.m.	1. Four man team assessed production utilization prospects. 2. Submitted report and recommendations to GOG and USAID. 3. Project completed.
5. Technical assistance--support of faculty of Agronomy, University of Panama in Development of Applied Research Programs in Soybean Production and Protection.	Govt. of Panama	USAID Mission to Panama	AID	$11,800	2 m.m.	1. Four Spanish speaking scientist from UIUC and UPR/MC recruited assisted in requested areas of specialization. 2. Reports submitted to mission and GOP. 3. Project to be completed by end of December, 1977.
6. Technical assistance--consultant on soybean production to Govt. of Iraq	Govt. of Iraq	FAO	FAO	$12,670	2 m.m.	1. Two person team recruited for scheduled October/November mission. 2. Project, including consultants' report and recommendations to be completed by December, 1977.

Table II - continued

Description of request for assistance	Whom did you assist?	Who requested assistance?	Who funded assistance?	Size of effort Dollars	Man days*	Results of assistance
7. Technical assistance--consultancy on soybean research and production in Venezuela.	Fundacion Servicio Para El Agricultor Venezueala.	Fundacion Servicio Para El Agricultor	Fundacion Servicio Para El Agricultor	$2,800	.5 m.m.	1. Terms of reference agreed 2. Recruited Spanish speak-ing soybean breeder 3. Project to be undertaken early 1978.
8. Technical assistance--advise Govt. of Peru on multi-year maize/soy production and utiliza-tion scheme.	Govt. of Peru	USAID Mission to Peru	AID	$652,187	124 m.m.	1. Four person soybean team recruited 2. Language training ar-ranged. 3. Contract in final stages of negotiation. 4. Anticipate first team members in place by January 1978.
9. Technical assistance--Manpower development	Ministry of Agriculture Govt. of Ivory Coast	Govt. of Ivory Coast	Govt. of Ivory Coast and UIUC	$42,000 (approx.)	150 m.m.	1. Intensive English training provided for two groups in spring and fall semesters. 2. Placement in degree programs for students who completed English preparation.

Table II - continued

Description of request for assistance	Whom did you assist?	Who requested assistance?	Who funded assistance?	Size of effort: Dollars	Size of effort: Man days*	Results of assistance
10. General education development--Inter-institutional collaboration in education, research and related activities	Univ. of Puerto Rico, Mayaguez Campus	AID and UPR/MC	AID, Rockefeller Foundation, UIUC and UPR/MC		Continuing	1. General support services provided. 2. Expansion of collaborative research in plant protection and post harvest operations. 3. Additions to INTSOY staff on part of both institutions. 4. Interchange of policy staff, scientific workers and students.
11. International Research Center--Collaboration on research, service and related activities	International Institute for Tropical Agriculture, Nigeria	IITA	ITTA and AID	Undetermined	Continuing	1. Cooperation in ISVEX for African countries. 2. Continuation of search for funds to permit assignment of INTSOY outreach team to IITA.
12. International Research Center--Collaboration on research, service and related activities	Asian Vegetable Research and Development Center, Taiwan	AVRDC	AVRDC and AID	Undetermined	Continuing	1. Co-sponsorship of Third Regional Soybean Conference in Thailand, February 1976. 2. Formation of Soybean Rust Working Group and plans for Asian Rust Conference in February 1977 in Philippines. 3. Exchange of scientists.

Table II - continued

Description of request for assistance	Whom did you assist?	Who requested assistance?	Who funded assistance?	Size of effort Dollars	Size of effort Man days*	Results of assistance
13. National Development Programs--Collaboration on research service and related activities	Philippine Council of Agriculture and Resources Research, Philippines	PCARR	PCARR and AID	Undetermined	Continuing	1. General program of collabortion established. 2. INTSOY Asia Representative visited in November 1976. 3. Assistance in arranging February 1977 Asian Conference on Soybean Rust.
14. National Development Programs--Advice and assistance on multidisciplinary soybean development program	Crop Improvement Research Center, Office of Rural Development, Govt. of Korea	CIRC	CIRC/AID	Undetermined	Continuing	1. Provided postdoctoral training for CIRC researcher. 2. Exchange of vistis by INTSOY and CIRC staff. 3. Consultation under letter agreement #4 on pest management.
15. International Organization--Assistance to country program in area of soybean development	Central Agricultural Research Institute, Ministry of Agriculture, Govt. of Sri Lanka	Ministry of Agriculture, Govt. of Sri Lanka	UNDP/FAO	$680,000	142 m.m.	1. National staff recruited and assigned. 2. Program policy committee operational. 3. Recommendations for research on production and utilization implemented. 4. Regional training program conducted in India. 5. Participation by CARI in two USDA short courses: 120-7 "Soybean Processing for Food Uses" and 120-6 "Technical and Economic Aspects of Soybean Production." 6. Plans for pilot processing facility developed. Funds from CARE and UNICEF to be provided in late 1976. 7. Advice on soybeans, marketing, post harvest operations, plant protection by INTSOY short-term staff. 8. Assignment of food processing specialist.

APPENDIX A

UIUC-INTSOY Soybean Response Capability Logical Framework

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: UIUC-INTSOY Soybean Response Capability

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: Increased production of soybeans by small farmers of the LDCs and increased utilization of soybeans for food use, particularly by the urban and rural poor.	Measures of Goal Achievement:		Assumptions for achieving goal targets:
Project Purpose: To develop, mobilize, and maintain a U.S. institutional response capability in soybean production and use utilizing the competence, leadership and facilities of the University of Illinois at Urbana-Champaign and the University of Puerto Rico Mayaguez Campus, and focusing on the solution of LDC problems with emphasis on technology applicable to the small farmer and improving nutrition of the rural and urban poor.	Conditions that will indicate purpose has been achieved: End of project status. a. Recognized as center of tropical soybean excellence. b. Integration of programs and activities into the mainstream of the UIUC. c. Continuing demand for expertise and services from LDCs and growing response to requests. d. Adequate financing available for sustaining the program.	a. Recognition by tropical and subtropical LDCs, and international soybean network. b. Peer evaluation by other U.S. universities, federal agricultural agencies, and national and international agencies. c. Use of expertise and services by LDCs, and AID, and other national and international organizations. d. Annual and other reports. e. Other program support sources.	Assumptions for achieving purpose: a. Outputs will result in increasing institutional capacity. b. Increasing demand for the growing institutional response capability. c. Complementary inputs from other related programs and that use of outputs will generate increasing support for sustaining programs.
Outputs: 1. Education and training program 2. Knowledge base and research capability 3. Advisory and consultation capability 4. Soybean linkages and networks	Magnitude of Outputs: 1. See page 75. 2. See page 75a. 3. See page 75b. 4. See pages 75c to 75e.	1. See page 75. 2. See page 75a. 3. See page 75b. 4. See page 75c to 75e.	Assumptions for achieving outputs: a. LDC student interest and U.S. university capacity. b. Nongrant support for trainees. c. AID support for research. d. Support of work at national and international centers. e. Network cooperation in talent registry. f. Complementary inputs to grant. g. AID support for UIUC and UPR-MC in network leadership role.
Inputs: Students support to faculty Soybean technology development Germplasm, literature, reference collections Soybean network and linkages	Implementation Target (Type and Quantity) INPUTS 1. Salary & Stipends $342,850 2. Fringe 36,080 3. Travel 64,750 4. Research Support 56,320 Total Grant Inputs $500,000	Records of UIUC and donor agencies Reports, reviews, evaluations	Assumptions for providing inputs: a. 211(d) support October 1975 to September 1978. b. Complementary UPR-MC 211(d) soybean support. c. Inputs from additional sources.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: UIUC-INTSOY Soybean Response Capability

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Purpose: To develop, mobilize, and maintain a U.S. institutional response capability in soybean production and use utilizing the competence, leadership and facilities of the University of Illinois at Urbana-Champaign and the University of Puerto Rico Mayaguez Campus, and focusing on the solution of LDC problems with emphasis on technology applicable to the small farmer and improving nutrition of the rural and urban poor.	Conditions that will indicate purpose has been achieved: End of project status. a. University of Illinois at Urbana-Champaign recognized as a center of excellence, and in a leadership role with other U.S. institutions, in a network providing information, expertise, and research and development capability relating to soybean production in tropical and subtropical areas and soy food use among the poor of the LDCs. b. Integration of programs and activities into the mainstream of the UIUC. c. Continuing demand for expertise and services from LDCs and growing response and involvement in LDC soybean production and use problems. d. Adequate financing available for sustaining the program.	a. Recognition by tropical and subtropical LDCs, regional and international research and development centers, and donor agencies. b. Peer evaluation by other U.S. universities, federal agricultural agencies, and national and international resource management agencies. c. Use of expertise and services by LDCs, AID, and other national and international organizations. d. Annual and other reports. e. UIUC records showing other sources of program support.	Assumptions for achieving purpose: a. That the outputs outlined will result in increasing institutional capacity. b. That there will be an increasing demand for the growing institutional capacity. c. That there will be complementary inputs from other related programs and that use of outputs will generate increasing support for sustaining programs. d. That the specific assumptions under "Outputs" and "Inputs" are valid.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: UIUC-INTSOY Soybean Response Capability

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: Output I. Improved education and training capabilities in soybean production, protection, and utilization.	Magnitude of Outputs: Graduate students at M.S. and Ph.D. levels in soybean production and use (four per year supported by grant); others supported by national and international organizations. Increased numbers of faculty with tropical soybean expertise. Modifications of curricula and courses reflecting tropical and subtropical emphasis on soybeans. Seminars, workshops, conferences, regionally or nationally (1977 to 1978). Individual special training.	Number of graduate students with emphasis on tropical-subtropical soybeans (a) U.S., (b) from other countries. Number of faculty involved with graduate students and otherwise on tropical soybean production and use. Sources of graduate student support. Number of faculty servicing requests for assistance from tropical-subtropical LDCs. Curricula and course modifications. Employment of completed graduate students. Requests for seminars, workshops, and conferences and requests fulfilled; evaluation of individual activities. Number of individuals in special training.	Assumptions for achieving outputs: 1. That increasing numbers of students from the U.S., Puerto Rico, and the LDCs of the tropics and subtropics will be interested in and supported for graduate study at UIUC in the various aspects of soybean production, marketing and use and that UIUC and other network universities will have the capacity for these students. 2. That LDC country personnel participation in short courses, seminars, workshops, conferences, and special training programs will be supported by a combination of USDA-AID training programs, USAIDs, foundations, and national and international agencies.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

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NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: Output II. An extended knowledge base and research capability which emphasizes soybean production on small farms of the tropics and subtropics, with special emphasis on improved genetic technology, and direct use of soybeans for human food by the rural and urban poor.	Magnitude of Outputs: Hybrid populations of soybeans with tropical-subtropical adaptation to small farms and with improved yield capabilities and nutritional qualities. Output in soybean production and use technology resulting from complementary UPR-MC 211(d) grant and UIUC-INTSOY AID research contract program. Capacity to respond to LDC country requests through BOA Task Orders, GTS, or other arrangements, including capacity to provide rapid response to outbreaks of soybean production hazards.	Hybrid populations developed for use in breeding programs. Improved characterisitcs of breeding materials for tropical small farm use. Use of developed materials and information in national, regional, and cooperative programs at international centers. Requests for assistance from tropical LDCs and man months and other input measures indicating response to requests.	Assumptions for achieving outputs: 1. That AID will support UIUC research on soybean production, marketing, and use for tropical and subtropical areas under separate contractual or other appropriate means. 2. That resources will become available for developing cooperating soybean breeding programs located at national and international centers strategically located in the tropics and subtropics.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

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NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: Output III. Expanded advisory and consultation capability in soybean production, protection, marketing, and utilization to meet the needs of LDCs of the tropics and subtropics.	Magnitude of Outputs: Information supplied to individuals and organizations in the soybean network. Integrated and coordinated grant program under leadership of grant co-directors. Language training provided to selected UIUC-INTSOY core staff.	Use in providing personnel to meet needs of LDCs. Numbers of staff with improved language capability. Numbers of staff involved in non-English-speaking LDCs assisting with soybean programs. Overall review of grant program (see summary).	Assumptions for achieving outputs: 1. Complementary inputs making developing, mobilizing, and maintaining U.S. soybean institutional response capability a viable part of the international soybean network to serve the tropical and subtropical LDCs.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

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NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: Output IV. Expanded and strengthened linkages and networks among organizations and individuals with interests in tropical and subtropical soybean production and use.	Magnitude of Outputs: Domestic linkages AID-DSB, Regional Bureaus, need and problem identification, linkages to country missions, national and international organizations, program planning, implementation and evaluation. UPR-MC--Joint program development and implementation. USDA-SEA--Northern and southern regional laboratories, Mayaguez Institute of Tropical Agriculture--program coordination, germplasm exchange, staff cooperation in country programs. Scientists at Beltsville and U.S. universities in research and outreach program. U.S. universities with interests in international soybean research Iowa State University, University of Missouri, University of Arkansas, Kansas State University, Purdue University, Ohio State University, University of Georgia, Mississippi State University. Other universities with special interests such as Clemson University (entomology), Oregon State (weeds), University of Hawaii (nitrogen fixation), Texas A&M (rice-soybean systems and food use). University Consortium with related interests such as tropical soils, CICP, MUCIA, MIAC, and CID. Private sector--Input suppliers (seeds, inoculants, fertilizers, herbicides, fungicides, equipment). Food and food processors. U.S. foundations--support for country and other programs.	UIUC-AID interactions in program development including DSB and Regional Bureau representatives Joint involvement in research and outreach with crop protection and Caribbean, Central and South American emphasis. Personnel involvement in germplasm exchange, research and outreach programs; joint projects; personnel participation in task orders. Participation in tropical soybean development work cooperative and joint projects; greater institutional response capability in specialized areas as indicated by response to country requests. Participation in network programs, personnel involvement, programs, investments in tropical countries. Financial and program support.	Assumptions for achieving outputs: That U.S., international, and LDC institutions will cooperate with UIUC in strengthening of linkages, exchanges, and visits by staff and students, information exchange, and other cooperative activities.

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NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Output:	Magnitude of Outputs:		Assumptions for achieving outputs:
Output IV. (continued)	International linkages		
	Consultative Group for International Agricultural Research--(CGIAR)--cooperative work with international research centers and regional and country programs.	Support for UIUC-UPR-MC-INTSOY programs directly or through international research centers.	That AID will encourage and support UIUC and UPR-MC as the leadership institutions in the international soybean network and will assist in developing and support cooperative research and outreach work on soybeans in cooperation with international research centers with soybean interests.
	International centers with soybean programs--IITA, AVRDC.	Memoranda of understanding and letters of agreement providing for specific projects; staff and graduate student involvement; cooperation on regional and international projects.	
	Cooperative research and outreach information exchange, faculty exchange, training programs, graduate research.		
	International centers--cropping system programs--CIAT, CIMMYT, IRRI, etc., information exchange, graduate research; special soybean projects.	Support for regional and country programs; involvement in planning, implementation, and evaluation.	
	Multilateral organizations--FAO UNDP, IBRD, Regional banks--resources for country programs, need and problem identification.	Integration of programs at regional and national levels.	
	Regional research and outreach organizations--SEARCA, IRAT, etc., cooperative research and outreach.		

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NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs:	Magnitude of Outputs:		Assumptions for achieving outputs:
Output IV. (continued)	LDC linkages		
	AID Missions--need and problem identification, program planning and evaluation, information exchange, trainee identification, etc.	Country requests through USAIDs for assistance; BOA Task Orders and other soybean country projects; personnel participation in Output I programs.	That AID will assist in development and maintenance of linkages with the LDCs of the tropics and subtropics, in identifying training needs of institutions and individuals and locations for cooperative activities, and in exchange of information in the soybean network.
	National institutions--ministries, research institutes, colleges through variety testing, cooperative research and outreach, BOA task orders, training courses, etc. (see Output II), country soybean development programs.		
	INTSOY Newsletter		
	Information exchange throughout international soybean network.	Changes in content; requests for addition to mailing list from LDCs; recipient evaluation; contributions from various network entities.	

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: UIUC-INTSOY Soybean Response Capability

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Inputs: Outline of activities to be financed: Graduate students supporting staff expertise development. Seminars, workshops, conferences Soybean genetic technology development Language training Tropical germplasm data bank Literature compilation, retrieval and delivery Soybean pest reference collections Network of U.S. institutions Linkages of international organizations LDC linkages Newsletter to serve international network	Implementation Target (Type and Quantity) See page 73 of logframe.		Assumptions for providing inputs: a. That this redesigned 211(d) grant will be supported by AID for three years from October 1, 1975, the effective date of the initiation of the redesigned grant program. b. That AID sill support an expanded complementary companion 211(d) grant to the University of Puerto Rico, Mayaguez Campus, with emphasis in developing, mobilizing and maintaining institutional response capability in soybeans with emphasis in crop protection disciplines.

Other sources of financial inputs to support and complement grant activities: AID soybean research contract; Puerto Rico 211(d) soybean contract; other UPR-MC AID program support; AID BOA Task Orders; UNDP/FAO/Sri Lanka INTSOY Contract.

Potential sources: added and extended support from other, GTS project, AID regional bureaus, U.S. and other foundations; country resources, CGIAR, Illinois and other state resources, Title XII.

APPENDIX B

SUMMARY OF FINDINGS AND RECOMMENDATIONS OF
DR. LUIS CAMACHO
INTSOY CONSULTANT
JULY-AUGUST, 1977

FINDINGS AND RECOMMENDATIONS:

1. Research results on virus diseases of soybean have provided useful information on (a) sources of genetic resistance to SMV, (b) aphid populations associated with spread of SMV, (c) transmission of Cowpea Mosaic Virus to soybeans by insect vectors. Breeding work has been started to transfer the resistance to SMV found in variety Buffalo to other varieties of soybean.

2. Seedborne microorganisms have been found to substantially reduce germination and emergance of soybeans. The fungus Phomopsis spp. appears the most important pathogen contributing to seed deterioration. Delaying harvest after maturity results in decreased seed germination and this appears to be correlated with increase in percentage of seed pathogens in susceptible varieties. Screening of germplasm has resulted in the identification of two tolerant varieties, PI 279.088 and PI 205.912, which are presently being crossed with other varieties to transfer the resistant characteristic.

   Since timely harvest produces seeds with low percentage of seedborne pathogens and therefore with high germination potential, the result could find immediate application in developing countries of tropical regions where seed deterioration is a serious problem. Profuse circulation of these findings among soybean researchers of the LDC will be highly beneficial.

3. Other seed quality deterioration studies refer to the effect of different types of storage under simulated tropical conditions. Preliminary results indicate seeds with hard seed coat deteriorate less than seeds with normal seed coat.

4. Soybean varieties and lines from tropical countries will be assembled and planted at two locations in Puerto Rico for description of plant trials; selected materials will go into the SPOT scheme and finally to ISVEX trial.

   It seems desirable that the characterization and initial screening of these materials be conducted at two different latitudes, rather than at two locations of the same latitude. Arrangements could be made to plant half of the seeds at IITA where the environment is more suitable for the expression of foliar diseases and pod shattering.

5. Proposals are being made to commit INTSOY resources for research on soil fertility and crop and soil management. A total of 17 research problems with broad application in tropical and semi-tropical areas is being proposed to be addressed by INTSOY scientists.

   In addition to the 17, it would be desirable to consider problems on farming systems that include crop rotations, double cropping and mixed cropping. The latter system is very common in small farms of tropical latitudes.

6. The home and village level preparation of soy products was explained and samples of different foods were offered for tasting. The preparation of soy milk is based on the principle of enzyme inactivation and tenderization of beans followed by grinding, filtering, and cooking of the filtrate. Breakfast foods and fried patties are prepared by grinding raw beans followed by cooking, adding of flavoring ingredients, and cooking of the mixture. The process requires 25 minutes for breakfast foods and 35 minutes for fried patties (10 minutes for frying).

The process for preparing these soybean foods is easy to adopt since it does not require complicated equipment; extension programs of developing countries will find it easy to demonstrate in villages and rural communities.

7. The main purpose of the trip to Puerto Rico was to observe field plots and discuss with Dr. E. H. Paschal II the breeding work being conducted with tropical soybeans. Discussions were also held with Dr. M. Ellis on his work on seed pathology and seed quality studies, with Dr. S. Smith on rhizobium inoculation in soybeans, and with Dr. R. Smith, of the University of Puerto Rico, on rhizobium culture and inoculant carriers; a new carrier from the coconut fruit has been developed by Dr. R. Smith.

8. The INTSOY breeding work in Puerto Rico is devoted to developing improved varieties suitable for production under tropical and subtropical conditions. The need for developing these varieties arises from the fact that commercial U.S. varieties are adapted to temperate zones and do not reach satisfactory growth under short photoperiods of the tropical environments.

9. The breeding work presently carried out includes variety evaluation, selection in segregating populations, hybridization, and screening for disease and insect resistance. The programme is well organized and a close cooperation exists with other scientists in the areas of plant pathology, plant entomology and weed control.

10. The bulk of the breeding work is conducted at Isabela Substation. There is a nursery of about 300 varieties to study resistance to the insect pests pega pega (*Hedylepta indicata*) and velvetbean caterpillar (*Anticarsia gematilis*); some varieties showed less damage than others. In another nursery, the transmission of Cowpea Mosaic Virus to soybean varieties, by insect vectors mainly *Cerotoma* spp is being studied. A large number of F_2 populations from crosses between promising tropical varieties were in this field. Three preliminary yield trials and the SPOT trial were also planted at Isabela this year; some of the lines in the yield trials have yielded up to 2.7 tons per hectare in previous seasons. The Hardee Late Selection line looked promising. Selection criteria in early generations include plant vigor, plant height, maturity, pod height above ground, lodging and shattering; all these traits appear to have moderate to high heritability, therefore their mean expression can be maintained through all generations before commencing yield tests.

11. At Lajas Substation the three preliminary yield trials were also planted; plant height and plant vigor looked better here than at Isabela, probably due to better soil conditions.

12. A field of about 12 acres is planted at Fortuna Substation with variety Improved Pelican. Plant stand and plant growth at the initial flowering stage looked satisfactory.

13. Some suggestions for the breeding program:

    a. Consider the possibility of measuring harvest index in preliminary yield trials.

    b. Consider the possibility of developing branching genotypes for tropical environments; the compensating effect of these genotypes under poor stand conditions may have some value in small farms of the tropics and subtropics.

c. Consider the possibility of developing determinant and indeterminant isolines and test their suitability under tropical and subtropical conditions. Determinant types could be useful under short growing seasons where irrigation is available or rainfall can be predicated accurately. Indeterminant types may be suitable for rained areas with erratic rainfall.

d. Consider the possibility of developing varieties suitable for intercropping or mixed cropping with other food crops of the tropics like sorghum, maize or cassava.

e. Consider the possibility of supplying heterozygous plant populations to some selected national programs of tropical and subtropical countries for selection under local conditions.

PERSONS CONTACTED:

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