AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

# BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch #31

**1. SUBJECT CLASSIFICATION**

A. PRIMARY: Serials — Y-AH20-0000-G635

B. SECONDARY: Agriculture--Plant diseases--India

**2. TITLE AND SUBTITLE**

Study and control of diseases of agronomic crops in developing nations; annual report,1972/1973

**3. AUTHOR(S)**

(101) Ill. Univ. Dept.of Plant Pathology

| 4. DOCUMENT DATE | 5. NUMBER OF PAGES | 6. ARC NUMBER |
|---|---|---|
| 1973 | 29p. | ARC 632.I29 |

**7. REFERENCE ORGANIZATION NAME AND ADDRESS**

Ill.

**8. SUPPLEMENTARY NOTES** *(Sponsoring Organization, Publishers, Availability)*

(Activity summary)

**9. ABSTRACT**

**10. CONTROL NUMBER**

PN-AAB-859

**11. PRICE OF DOCUMENT**

**12. DESCRIPTORS**

Grain legumes
India
Plant pathology

**13. PROJECT NUMBER**

**14. CONTRACT NUMBER**

CSD-1922 211(d)

**15. TYPE OF DOCUMENT**

AID 590-1 (4-74)

7

CSD-1922 211(d)
632.I29
PN-AAB-859

#1922

# ANNUAL REPORT ON THE 211(d) PROJECT

# FOR THE UNIVERSITY OF ILLINOIS

# (FISCAL 1973)

Title: A Grant to Develop Within the University of Illinois Specialized Competency in the Study and Control of Diseases of Agronomic Crops in Developing Nations.

Grantee: University of Illinois, Urbana, Illinois 61801

Director: Prof. James B. Sinclair, Department of Plant Pathology

## A. Statistical Summary:

| | |
|---|---|
| Period of the Grant: | May 1968 through December 1973 |
| Amount of the Grant: | $200,000 |
| Expenditures for 1972-73: | $ 25,564 |
| Accumulated Expenditures: | $185,279 |
| Anticipated Next 6 Months : | $ 14,721 |

## B. Narrative Summary:

This is the fifth and last annual Technical Report concerning the development with the University of Illinois specialized competency in the identification, cause and control of diseases of agronomic plants in India and other countries and the establishment of international plant pathology as a legitimate and continuing function of the University of Illinois and the College of Agriculture. This 211(d) Program is linked with the University of Illinois College of Agriculture's International Program for the development of soybean as an oil and food crop in developing nations, as well as in the U.S. The 211(d) Program has increased the competency of the 211(d) Professor in international agriculture, particularly in plant pathology. The graduate teaching and training program has increased the pool of manpower with international experience and understanding of the problems of developing nations. The research and teaching programs developed under this grant, have a strong international dimension which have had an influence on many people within and outside of the University community. The research has centered on diseases of soybean and cowpea. The termination date of the grant was extended to December 1973, when a final report will be submitted.

## C. Detailed Report

I. General Background and Purpose of the Grant: This is one of six separate grant proposals submitted to the Agency for International Development by the Council of United States Universities for the Rural Development in India (CUSURDI) for funding to begin in 1968. The University of Illinois proposal was built around the need to employ a full-time, tenured faculty member who would conduct research, supervise graduate students and carry out other activities, all for the purpose of increasing the competency of the University in international plant pathology with emphasis on Indian agronomic crops, particularly soybeans.

A Coordinated Soybean Research Project (CSRP) was started in 1967 between the University of Illinois College of Agriculture and the two university (JNAU and PTAU in India, with whom the college was cooperating in an university-development program. Little information was available on soybean diseases and their effects on production in developing countries. There was a need for an experienced plant pathologist to develop a program in this area. The 211(d) Program provided some of the funds needed to begin this program.

II. Objectives of the Grant:

1. List of Grant Objectives:

   A. To increase the capabilities of the University of Illinois to the area of international agriculture, particularly in the area of plant protection and plant pathology, and to generate increased public awareness of the significance of the international dimension of university education and research.

   B. To increase the pool of manpower with understanding of problems of developing nations.

   C. To assist in the development of faculties and competencies in international agriculture, particularly palnt pathology, at the University of Illinois and act as a catalyst in the expansion of interest and training for careers in international agriculture.

   D. To educate college students for careers in foreign agriculture.

   E. To more effectively use university personnel with foreign experience in the development and training of domestic and foreign students for professional positions in international agriculture.

   F. To develop a corps of experts in the various phases of agricultural development which may contribute to the evaluation and solution of problems in which there is national interest.

2. Review of the Objectives:

   All the objectives of the grant have been met. The Program has increased the competency of the 211(d) Professor in international agriculture, particularly in plant pathology and soybean diseases. Through the contacts with the 211(d) Professor and the graduate students involved in the Program, many faculty at the University of Illinois and other domestic and overseas institutions; students; nonacademic and nonuniversity personnel; both within and outside

of the State of Illinois have become aware of the significance of the University of Illinois in international agriculture. This has been accomplished through formal classroom presentations and informal discussions both on and off the campus. Announcements concerning these activities are published in the local press, in professional newsletters and in overseas publications.

The research and teaching programs developed under this grant, have a strong international dimension which has had an influence on many people. The teaching of advanced courses and graduate student training programs directly or indirectly under the direction of the 211(d) Professor is not only educating college students in international agriculture, but is acting as a catalyst in the expansion of interest and training students in this area. Faculty members in plant pathology, horticulture, and economic entomology with international experience have been directly involved in formal course presentations, seminars, and discussions in the department of plant pathology.

If an area has received more emphasis than another, it has been in graduate student training and research. The graduate training program is increasing the pool of manpower with international experience and understanding of the problems of developing nations. There were seven students involved in this program this year. The program was so arranged that U.S. graduate students work with graduate students from India in the same laboratory and on complementary research problems. The U.S. students continue their association with some of these Indian students while studying and working in India. This has provided a basis for an institution to institution working relationship.

Soybean is an important crop in the U.S. and in India. Programs for the development of soybean as a commercial crop have been started in other countries including Thailand, Brazil and some African countries. The experience gained by the 211(d) Professor and the graduate students (both domestic and foreign) both here and abroad aid in the understanding and solving of soybean production problems due to diseases both in the U.S. and developing countries. Control measures beneficial to all countries concerned can be developed only after the various disease problems are known and understood.

III. Accomplishments: The 211(d) Program at the University of Illinois has continued to make progress during the fifth year, although it has been a year of phasing down and completing projects initiated and supported under the grant. The last two students supported by the project completed their studies in field research in either India or Nigeria and returned to finish their thesis studies. The 211(d) Professor was transferred to state funds in October, so that the position would be a continuing one at the University. The Professor made a trip to India at the invitation of the Indian government and one to Nigeria and Brazil.

The remarkable progress during the grant period justifies the efforts and support given by the University of Illinois, the College of Agriuclture, AID, and CUSURDI to the entire program. The 211(d) Program has been an outstanding success. The broad objectives of the grant are continually being met as the program comes to an end. It should be emphasized that the success for the past five years was possible because of the efforts of many people and of: (1) substantial financial and logistical support from the University of Illinois, the College of Agriculture, and the Department of Plant Pathology; and (2) the total cooperation on the part of University of Illinois personnel at all levels, as well as at several institutions and other agencies in India, Nigeria, and other countries.

A. Development of Teaching Competence. The formal course dealing with international food crops, diseases and insects was given during the Spring semester (see previous technical reports). The teaching responsibilities were shared with Dr. A. M. Rhoades, Professor of Horticulture, replacing Dr. A. E. Thompson. The international experience of the 211(d) Professor, provided by the grant, his collection of international scientific literature, as well as color slides of crop production and diseases from foreign countries were used to illustrate various diseases of tropic crops and their control. This course was begun because of the presence of the 211(d) Professor and his interest in teaching such a course. There were eight international students and three U.S. students in the course this semester representing four disciplines: agronomy, horticulture, agriculture economics, and plant pathology. The departments provided secretarial assistance, office supplies, and duplicating facilities for the production of teaching aids.

A large number of seminars and special talks were given at all of the overseas institutions visited, as well as in the U.S. At each presentation, the AID-sponsorship was acknowledged and the international dimension of the program was stressed. In addition to two seminars presented at each institution visited during the international trips, the following special presentations were made:

Two special seminars were prepared and presented at the invitation of National Soybean Commission, Porto Alegre, Brazil in October 1972. An invitational paper was given in January 1973 at the Symposium on Mycoplasma Disease, Chandigarh, India at the invitation of the Indian National Science Academy. A special seminar was presented to the Agronomy Department in March 1973 on seedborne pathogens in U.S. and India soybeans.

B. Development of Research Competence. A very active research and graduate training program has developed involving American and Indian students since the completion of the research laboratory in May 1969 (see Technical Report #1). There were seven graduate students (five Ph.D. and two M.Sc. candidates) participating in the program this past fiscal year, five American and two Indian. The program has involved JNAU, (Jabalpur), PUAT (Pantnagar) and IITA (Ibadan) their personnel and facilities, as well as those of the University of Illinois.

The research program involves laboratory, greenhouse, growth chamber and field work (facilities and maintainence provided by the University). All members of the group have worked together and assisted one another in their respective research efforts. The success of this relationship can be partially judged by the fact that over 20 research contributions and publications have come from the program in fiscal 1973. The areas of research include: soybean and cowpea diseases, nematode diseases and the movement of systemic fungicides in soybeans, cowpeas and other plants. Articles were published in Indian, German, as well as U.S. journals. A list of the major publications is attached.

Soybean is being introduced as a possible oil and food crop in India through PUAT and JNAU. Soybean has become one of the leading sources of plant protein in the past few years. U.S. consumers now have hamburger meat mixed with soybean meal available in the market. Soybean is becoming a truly international food crop. The research on soybean done at either of these three institutions is of mutual benefit not only to the respective countires, but to other countries as well.

Cowpea is a major food crop and source of plant protein in Tropical Africa and other countires. The studies completed at IITA and the University of Illinois provides similar benefits as those studies on soybeans.

All the students have completed their research studies on soybean cowpea and other crops: P. D. Kharbanda, B. L. Kirkpatrick, W. A. Meyer, J. F. Nicholson, R. W. Schneider, R. L. Slusher and P. N. Thapliyal. A listing of the titles of their respective theses is attached.

This has been a truly international research program. These men carried on research projects involving disease organisms found to be of economic importance in both countries. They have made comparisons in the behavior of these organisms, which would not have been possible under any other conditions. It is not advisable to import strains of plant pathogens from other countries for study in the U.S. because the imported strain may be more virulent than the indigenous ones. Therefore, these men have had the opportunity to note similarities and differences between these organisms, often using the same crop varieties and noting their response in both countries. This is of great interest to the Indian, African and U.S. scientists. There is an advantage for conducting extensive field studies in India and Africa as compared to the U.S., because of the low cost of hand labor. All research results are made available to plant pathologists in the three countires, in addition to journal publication.

R. A. Sikora's program of research while in India (PUAT) was concerned with control of nematodes and nematode diseases by biological means. W. A. Meyer's (JNKVV) work was concerned with studying a soil-borne soybean pathogen that causes the disease, charcoal rot of soybean. It is known to occur in soybean fields in Illinois and other states. B. L. Kirkpatrick (PUAT) studied chemical control of soybean seedlings through seed treatment. J. F. Nicholson (JNKVV) studied seed-borne pathogens in soybean. R. W. Schneider (IITA, Nigeria) studied foliage blight organisms on cowpea. The results of their work will be of mutual interest and benefit to all countires concerned.

Besides the graduate students listed above, the 211(d) Professor has acted as research adviser to a number of other graduate students, both U.S. and foreign, in plant pathology and other departments on the University of Illinois campus, as well as in India.

The seminars and invitational papers given at various institutions already

cited often concern the research results from his laboratory. These talks provide up-to-date information to the overseas researchers and give the 211(d) Professor new insights and approaches to his own as well as the graduate students' research. The mutual benefits derived from this direct contact with plant scientists in the various countries visited cannot be overemphasized.

C. The Graduate Student Program. This year there were six graduate students in the program, which has been so arranged that the U.S. students work with graduate students from India in the same laboratory and on related research problems. The U.S. students continue their association with the same Indian students when they go to India to continue their studies. This provides an obvious strong association and basis for cooperation between the Indians and the U.S. students while the latter are studying and working in India. It has provided a blueprint for future institution to institution cooperation.

Extremely favorable comments have been made concerning the activities of the graduate students while studying overseas. It seems that their efforts have been most effective and they have set high standards for other graduate students to follow. Several personal letters are on file to support these statements. All comments from the administration and faculties of the Indian universities involved have been very complementary. This portion of the program has been an outstanding success.

Funding in support of graduate students has come from many sources. A brief statement is given below for each student involved in the program this past year concerning his activities and source of funding.

O. D. Dhingra -- An M.Sc. graduate from JNKVV in plant pathology, he joined the department in September 1971 to do graduate work toward the Ph.D. He worked with Mr. Meyer at JNKVV for over six months before coming to the University of Illinois and worked with Mr. Nicholson in this laboratory for about five months before the latter's departure to JNKVV for a year of study. He is supported by other than 211(d) funds.

B. L. Kirkpatrick -- The only M.Sc. candidate in the 211(d) Program; he studied at PUAT in August 1971 through January 1972. He received his degree in January 1973. He was sponsored by 211(d) and other funds during his course of study.

W. A. Meyer -- He worked at JNKVV for one year beginning in January 1971. He was supported by departmental, fellowship, and 211(d) funds while studying at the University, before and after his study period in India, and by a special USAID/Delhi Local Currency Contract while in India. He worked with P. N. Thapliyal and P. D. Kharbanda before leaving for India, and with O. D. Dhingra both at JNKVV and the University of Illinois. He completed all the requirements of the Ph.D. in August 1972.

J. F. Nicholson -- He began his studies and research program at JNAU in February 1972 and completed them in September 1972. His entire program in India was supported by 211(d) funds. He worked with the two Indian students in the program (Dhingra and Thapliyal) before his departure. Portions of his studies at Urbana were supported by other than 211(d) funds. He received his Ph.D. in June 1973.

R. W. Schneider -- Mr. Schneider completed his studies at IITA, which began in March 1972 and ended in December 1972. He received his Ph.D. in June 1973. His program at the University and at IITA was supported in part by 211(d) funds.

R. W. Slusher -- His knowledge and overseas experience in Taiwan for three years added to the international quality of the program. He was supported in part by 211(d) funds. He completed all the requirements for the M.Sc. in January 1973.

Two students, one from Pakistan (Ph.D. candidate) and a second from Thailand (M.Sc. candidate) joined the laboratory during this past fiscal year. Drs. Nicholson and Schneider and Messrs. Slusher and Dhingra worked with these men. These men were not supported by 211(d) funds.

D. Development of Competence for Consultation and Service. The 211(d) Program has provided the unique opportunity for the University of Illinois to have a Professor in plant pathology with a strong interest in international agriculture to devote full time to the development of a program of teaching, research and graduate training with international involvements. The Program initially began with India and now involves other countries.

In order to be knowledgable in the many aspects of international agriculture (including plant pathology), and to carry out the format of the Program, it is necessary for the Professor to make at least one overseas trip each year. At least one trip a year has been made to India. These trips not only allow the Professor to set up the essential esprit de corps so that the logistics of the Program can be carried out, but it provides him with the opportunity to maintain professional contacts, and become up to date on current research, trends and new agricultural problems. He can increase the foreign literature collection and slides on crops and diseases.

As a result of the trip to Brazil this Fall, two men are coming for three months to the Professor's laboratory to study soybean diseases this summer (1973) and another student may come to take Ph.D. work in his laboratory within the year. As a result of his trips to Thailand, four students have come to the University to study soybean culture. Many of the countries visited are willing to take America students for study in programs such as the one just ending.

Professor Sinclair made two trips this fiscal year. One to Nigeria, and Brazil, the other to India, Thailand, Indonesia and Korea.

The trip to Nigeria served to review the progress of R. W. Schneider who was doing his Ph.D. research under the sponsorship of the 211(d) Program. He did his work at IITA under the guidance of Dr. R. J. Williams, IITA Plant Pathologist. IITA will be a "backup" institution in the future for all development of soybean in Tropical Africa. Brazil has initiated a soybean development program. It is one of five commodity projects sponsored by PL 480 funds and a World Bank Loan. As a result of the trip to Nigeria, a post doctorate candidate will come to study in the department for 3 months beginning in January 1974.

The trip to India through Rome to visit with plant pathologists at FAO was prompted by an invitation by the Indian National Science Academy to give an invitational paper during a symposium on mycoplasma diseases held in conjunction with the National Science Congress. The Government of India did not approve the visit using 211(d) funds at first, but final approval came on November 6. Approval for the trip was given by AID/Washington and the University.

Thailand was visited on two earlier occasions. It was decided that to renew and strengthen the contacts with plant pathologists and other agriculturists involved in the Thai soybean program would be advantageous to the University. The only plant pathologist in the national soybean program is a former student

and personal friend of the 211(d) Professor.

The University cooperates with the institutional development program in Indonesia through MUCIA. It was decided that the 211(d) Professor should visit Institut Pertainian Bogor and Universitas Gadjah Mada to make initial contacts with the plant pathologists at the two universities.

With the anticipation of the University being named an international soybean research source, it was decided that a visit to Korea was in order. Korea is the geographical area where the soybean was indigenous. Initial contacts were made with plant pathologists in anticipation of more formalized cooperative efforts in the future.

Further competence of the 211(d) is reflected in his involvement in five other international activities at the University of Illinois by being:

1. Named the Campus Coordinator for the Illinois Tehran Research Unit, with responsibilities beginning in August 1973. He has been on the Advisory Committee for several years. The University of Illinois and University of Tahran have maintained exemplary institutional to institutional relationships for a number of years.

2. Named to the Illinois Tehran Research Unit Committee on research and development.

3. Asked to collaborate with the INTSOY, the international soybean resource base (see details under Sections IV and VII).

4. Asked to serve on the University Graduate College committee concerned with the "Role of the International Student".

5. Asked to be in charge of all international programs in the Department of Plant Pathology, and particularly, coordinate on-campus activities for the 2nd International Congress of Plant Pathology (see Section VII).

Competence in international agriculture was further developed by:

1. Participating in a discussion session on the training and education of graduate students from the Third World Nations at the 2nd International Congress of Plant Pathology, September, 1973.

2. Participating in a colloquium at the Congress on crop loss assessment methods because of research published in this area.

3. Continuing to serve as the vice chairman of the International Cooperation Committee of the American Phytopathology Society.

4. Continuing to make a world collection of color slides on soybean diseases.

5. Continuing to act as a "Career Consultant" to the Peace Corps.

6. Arranging for the visit of Dr. R. J. Williams, Plant Pathologist, International Institute of Tropical Agriculture, Ibadan, Nigeria during the summer of 1972.

7. Acting as an advisor for two technical men from the Brasilian national soybean program for three months during the summer of 1973.

8. Arranging for and advising a postdoctorate candidate from the University of Ibadan, Ibadan, Nigeria in Spring of 1974.

9. Continuing many of the activities initiated in previous years, such as: (a) participating in the Southern Regional Research Project on soybean seed quality; (b) collaborating with Indian plant pathologists on planning research work, graduate student training, course offerings, etc., (c) cooperating with other departments in the College of Agriculture and in several programs; (d) continuing to serve on the Environmental Quality Council Task Group on Pesticides and Pest Control Systems.

10. Providing resumes of the program and activities of the 211(d) Professor and students in the program to the attention of professional newsletters and the local news media.

11. Maintaining contacts with professionals abroad.

E. Expenditures. Expenditures from the 211(d) grant funds for the University of Illinois are presented in the accompanying table (Table 1). The expenditures for airline tickets to and from India are only estimates until receipt of official advice of charges from the Grant Officer.

Committed grant funds for the salary of the 211(d) Professor were released by paying him from other sources of funds from within the College of Agriculture from September 1972 while retaining responsibility for carrying out the grant objectives.

Stipends for graduate students varied each year. Six students will have been supported at various times by grant funds. It is anticipated that Messrs. Ellis and Tenne will be involved in the INTSOY program and perhaps will do portions of their Ph.D. research overseas.

Travel expenses, other than the GTR's, were for domestic travel for the 211(d) Professor and some of the students, to support the visit of Dr. Moore as a consultant in seed pathology (see Technical Report # 1), and for international travel of R. W. Schneider. Drs. R. E. Ford and J. B. Sinclair traveled to Puerto Rico to consult on further cooperation between UPR and the University of Illinois in the INTSOY Program.

Funds have been committed for paying travel/per diem for distinguished progessors attending the 2nd International Plant Pathology Congress. These men will visit the University campus either before or after the Congress and present a seminar and consult with various staff members.

Supplies, equipment and publication costs are presented. There are a number of papers resulting from 211(d)-sponsored research. The costs for publishing these papers will be paid for in part from grant funds.

Table 1. Expenditures and estimates in U.S. dollars from the 211(d) grant funds for the University of Illinois for the 5 1/2-year period, May 1968 through December 1973.



| Budget Item | Fiscal Year 1968-69 | 1969-70 | 1970-71 | 1971-72 | 1972-73 | Totals thru June 1973 | Estimate Dec. 1973 | Totals | Firm Budget | Balances + or - |
|---|---|---|---|---|---|---|---|---|---|---|
| Salaries and Fringe Benefits | 17,627 | 22,533 | 23,867 | 25,288 | 4,397 | 93,712 | 0 | 93,712 | 130,000 | +36,288 |
| Stipends | | | | | | | | | | |
| Schneider | | 2,042 | | 3,365 | 4,305 | 9,712 | | | | |
| Kirkpatrick | | 146 | 3.542 | | | 3,688 | | | | |
| Slusher | | | 2,958 | 3,637 | 617 | 7,212 | | | | |
| Nicholson | | | | 4,313 | 3,187 | 7,500 | | | | |
| Ellis | | | | | 312 | 312 | 1,875 | | | |
| Tenne | | | | | | | 1,400 | | | |
| Subtotals | | 2,188 | 6,500 | 11,315 | 8,421 | 28,424 | 3,275 | 31,699 | 31,000 | - 699 |
| Travel | | | | | | | | | | |
| Airline tickets | 1,400[a] | 1,720[a] | 1,311[a] | 9,654[a] | 2,835[a] | 16,920[a] | b/ | | | |
| Other | 1,269 | 1,047 | 1,189 | 7,638 | 4,096 | 15,239 | b/ | | | |
| Subtotals | 2,669 | 2,767 | 2,500 | 17,292 | 6,931 | 32,159 | 7,500 | 39,659 | 13,000 | -26,659 |
| E & E | | | | | | | | | | |
| Equipment | 3,803 | 16,220 | | | 30 | 20,053 | 0 | 20,053 | | |
| Supplies | 3,336 | 961 | 179 | 670 | 5,200 | 10,346 | 1,946 | | | |
| Publication costs | | | | | 585 | 585 | 2,000 | | | |
| Subtotals | 7,139 | 17,181 | 179 | 670 | 5,815 | 30,984 | 3,946 | 34,930 | 26,000 | - 8,930 |
| GRAND TOTALS | 27,435 | 44,669 | 33,046 | 54,565 | 25,564 | 185,279 | 14,721 | 200,000 | 200,000 | 0 |

a/ This travel figure includes a total estimate of 14,900 for international air fares provided in Rupees to Prof. Sinclair; B. L. Kirkpatrick; and J. F. Nicholson and family. Upon receipt of an official advice of charges from the Grant Office, this amount will be included as an exact amount. Breakdown of estimated travel expenses in $US for fiscal 1973 follows:

| Name | No. of tickets | Airfares (including GTR's) | Other costs | Shipping costs | Domestic travel | Subtotal | Grand total |
|---|---|---|---|---|---|---|---|
| Sinclair | 3 | 3,598 | 1,643 | | 98 | 5,339 | |
| Nicholson | | | | 822 | | 822 | |
| Schneider | 2 | (1,026) | 823 | 460 | | 257 | |
| Ford | 1 | 263 | 250 | | | 513 | |
| Subtotals | 6 | 2,835 | 2,716 | 1,282 | 98 | 6,931 | 6,931 |

b/ Includes 5,000 reserved for travel/per diem for distinguished professor attending 2nd International Congress of Plant Pathology.

List of Publications for Fiscal 1973 Resulting From The

University of Illinois 211(d) Program

1. Dhingra, O. D., J. F. Nicholson, & J. B. Sinclair. 1973. Influence of temperature on recovery of Aspergillus flavus from soybean seed. Plant Dis. Reptr. 57:185-187.

Abstract: Aspergillus flavus was seedborne in 17 of 20 seed lots of 'Lee 68' soybean harvested in five states in 1970. Of the 20% recovered at 35C, 2.7% was internally seedborne and 17.3% was externally seedborne. Recovery of A. flavus varied from 0 to 45% among individual lots. The fungus was recovered from 17 lots at 30 and 35C, but recovery was negligible at 20 and 25C. Increased recovery of A. flavus was significantly correlated with decreased germination. Germination of 'Amsoy' soybean seed decreased when inoculated with an isolate of A. flavus from 'Lee 68' seed with temperature increase (20 to 35C). A. flavus may be important in evaluating soybean seed quality.

2. Dhingra, O. D., & J. B. Sinclair. 1973. Variation among isolates of Macrophomina phaseoli (Rhizoctonia bataticola) from different regions. Phytopath. Z. 76:200-204.

Abstract: Nine isolates of Macrophomina phaseoli (Rhizoctonia bataticola) from soybean were collected from three geographic areas in the U.S. Single hyphal tip cultures were studied for their variation in cultural characteristics and virulence in causing soybean seedling blight. All isolates varied in their growth rate and colony characteristics of PDA at 15, 20, 25, 30, and 35C. Maximum growth of seven isolates was at 35C and two at 30C. Growth rates and sclerotia varied on three media at 25C. The isolates varied from virulent, through moderately virulent, to weakly virulent. Pycnidia formation and rosetting on inoculated seedlings was recorded for the first time. There was a general correlation between in vitro growth on PDA and virulence of the isolates. The studies were carried out for three generations using single, hyphal-tip isolates. There was no variation within any isolate.

3. Meyer, W. A., & J. B. Sinclair. 1972. Root reduction and stem lesion development on soybeans by Phytophthora megasperma var. sojae. Phytopathology 62:1414-1416.

Abstract: Phytophthora megasperma var. sojae (Pms) reduced the root system of soybean (Glycine max) in the presence and absence of stem lesions. Pms-infested soil in the greenhouse and field had no stem lesions, but plant heights and yields were significantly less than those of similarly treated Pms-resistant cultivars. In the greenhouse, Pms reduced dry weights of roots, but not plant heights of 10-day-old resistant plants. Lesions developed on stems of Pms-susceptible plants in the greenhouse when inoculum was placed adjacent to plants at 1 or 4 cm below the soil line, but not at 9 cm. Root and shoot dry weights increased with depth of inoculum placement.

4. Meyer, W. A., J. B. Sinclair, & M. N. Khare. 1973. Biology of Macrophomina in soil studied with selective media. Phytopathology 63:613-620.

Abstract: Two selective media using rice agar as the basal medium, were developed for the isolation and enumeration of Macrophomina phaseoli from soil and soybean plant debris. The first, designated as CC, was developed in India and contained chloroneb, methoxyethylmercury chloride (Ceresan Wet), streptomycin sulfate, and potassium penicillin. The second, designated as CMR, was developed

at the University of Illinois and contained the same ingredients, except that mercuric chloride was substituted for methoxyethylmercury chloride and rose bengal was added. Recovery of M. phaseoli from artificially infested soil was close to 100% with either medium. Assays with CC showed M. phaseoli persists in soil under diverse environmental conditions and that populations of the fungus in soil, increased with increased years of continuous soybean cropping. Populations of M. phaseoli in soil from Illinois soybean and corn fields, determined with CMR, were higher than those determined using the sclerotial-flotation method. In the absence of a suitable host, M. phaseoli populations increased and mycelial inoculum persisted in soil up to 7 days. The test fungus was capable of invading dead stem tissues in soil containing antagonistic micro-organisms. The evidence does not support the strict classification of M. phaseoli as a root-inhabiting fungus.

5. Muller, G. J., M. B. Linn, & J. B. Sinclair. 1972. Translocation, disease remission and persistance of thiabendazole and 5-ethoxy-3-(trichloromethyl)-1,2,4-thiadazole in tomato seedlings. Plant Dis. Reptr. 56:1054-1057.

Abstract: The systemic fungicide thiabendazole (2-(4-thiazolyl)-benzimidazole and 5-ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole (ETMT) were taken up by roots of tomato seedlings and moved unaltered into stems and leaves. Seedlings grown in soil treated with thiabendazole at 25 or 50μg/g restricted development of wilt symptoms in seedlings following stem-inoculation with conidial suspensions of Fusarium oxysporum f. sp. lycopersici and Verticillium albo-atrum. Thiabendazole persisted in tomato leaves for 7 days and in stems for 5 days after root uptake. ETMT was not detected in any tissues after 1 day. Thiabendazole in soil for 16-20 weeks and ETMT for 5 weeks.

6. Nicholson, J. F., O. D. Dhingra, & J. B. Sinclair. 1972. Soil temperatures and inoculation techniques affect emergence and reisolation of Sclerotinia sclerotiorum from soybean. Mycopath. Myc. Appl. 45:1-4.

Abstract: Emergence of 'Amsoy' soybean (Glycine max) seed inoculated with Sclerotinia sclerotiorum was significantly reduced below noninoculated seed at soil temperatures of 25, 30, and 35C, but not at 20C. S. sclerotiorum was readily reisolated from wound-inoculated stems of seedlings and nearly mature plants above the point of inoculation below to the crown area, but not from roots. The fungus was recovered from stems but not roots of seedlings grown in sterile soil for 15 days before infestation of the soil surface with a suspension of mycelium and sclerotia and assayed at 15 days after soil infestation. When compared to healthy, seed infected with S. sclerotiorum were characterized by appearing flattened.

7. Nicholson, J. F., O. D. Dhingra, & J. B. Sinclair. 1972. Internal seed-borne nature of Sclerotinia sclerotiorum and Phomopsis sp. and their effects on soybean seed quality. Phytopathology 62:1261-1263.

Abstract: Sclerotinia sclerotiorum and Phomopsis sp. (Diaporthe phaseolorum var sojae) are internally seed-borne in soybean (Glycine max) and may inhibit seed germination in vitro and field emergence. S. sclerotiorum was internally seed-borne in: 30 of 39 lots of 'Lee 68' seed harvested from six states in 1969 and 1970; either lots of 1971 'Cutler' seed from Kentucky; and one lot of 'Beeson' and 17 lots of 'Amsoy' 1971 seed from Illinois. When recovery was more than 25%, in vitro germiantion and field emergence were reduced. Recovery of S. sclerotiorum from 'Lee 68' seed was reduced when stored at room temperature (22 ± 3C) after 6 and 24 months, when compared to samples of the same seed lots stored for 18 months at 3 ± 1C. Recovery from 'Cutler' seed increased 26% between normal and

late harvest periods 30 days apart, but harvest method (machine and hand) appeared to have no effect on percent occurrence of the fungus. S. sclerotiorum was first isolated from seed and pods of field-grown plants at 16 weeks after planting.

Phomopsis sp. was internally borne in the following seed lots: 12 or 20 'Lee 68' lots harvested in 1970 from five states; eight lots of 'Cutler' seed from Kentucky; one lot of 1971 'Beeson' seed; and 17 lots of 1971 'Amsoy' seed from Illinois. Phomopsis sp. was recivered from less than 25% from any single lot assayed, except for two lots. A reduction in vitro germination or field emergence was not detected.

8. Nicholson, J. F., J. B. Sinclair, & P. N. Thapliyal. 1973. The effect of rate of planting on incidence of brown stem rot in soybean. Plant Dis. Reptr. 57:269-271.

Abstract: The incidence of brown stem rot of soybeans (Glycine max) increased as the space between plants within the row was increased during three successive growing seasons in field plots with a previous cropping history of 2 years or less in soybeans. The percent of plants showing brown stem rot at 6- and 12-inch spacing was significantly higher than that at 1-, 2-, and 4-inches. Plots with a cropping sequence of 5 or more years of continuous soybeans showed no significant differences between planting date and incidence of brown stem rot. Spacing and crop history could be important factors in evaluating varieties or breeding lines for resistance to C. gregatum or in conducting brown stem rot disease surveys.

9. Nicholson, J. F., J. B. Sinclair, J. C. White, & B. L. Kirkpatrick. 1972. Upward and lateral translocation of benomyl in strawberry. Phytopathology 62:1183-1185.

Abstract: Root uptake and translocation of benomyl and its breakdown product, methyl-2-benzimidazolecarbamate (MBC), was studied in cultivated strawberry (Fragariae xananassa 'Tioga') in single plants and in two stolon-connected plants. Treatment of roots of single plants with 1,000 mg/liter benomyl for 24, 48, or 72 hr resulted in upward translocation of benomyl or MBC to the growing point and throughout all tissues except those of newly emerged leaflets. Treatment of the roots of either a daughter or mother plant connected by a single stolon with 1,000 or 2,000 mg/liter benomyl for 96 hr resulted in translocation of benomyl or MBC through the stolon to nontreated tissues of the other plant. Translocation from the daughter plant through the stolon to mother plant tissues was considered "lateral" translocation of the fungitoxic compounds.

10. Sikora, R. A. 1973. Plant parasitic nematodes associated sugarbeet and soybean in India. Indian J. Nematology:in press (Abstract not available).

11. Sikora, R. A., P. K. Koshy, & R. B. Malek. 1972. Evaluation of wheat selections for resistance to the cereal cyst nematode. Indian J. Nematology:in press (Abstract not available).

12. Sikora, R. A., K. Sitaramaiah, & R. S. Singh. 1973. Reaction of tomato cultivars to Meloidogyne javanica in India. Plant Dis. Reptr. 57:141-143.

Abstract: Tomato cultivars bearing the Mi gene for resistance to root-knot nematodes (Meloidogyne spp.) were field-tested in India for their reaction to Meloidogyne javanica. Cultivars Healani, Kalohi, Anahu, Hawaii 7526, Atkinson, Nematex, Y-207, and Y-240 lacked visible root galling. Two cultivars, VFN-8 and VFN-368, were heavily galled. The results suggest that one or more genes other

than the Mi may directly or indirectly affect root-knot nematode resistance in tomato.

13. Sitaramaiah, K., R. S. Singh, K. P. Singh, & R. A. Sikora. 1971. Plant parasitic nematodes of India. Uttar Pradesh Agr. Exp. Sta. Bull. No. 3 70 pp.

Abstract: A check list of plant parasitic and soil nematodes reported from India up to March 1970 and a host-nematode index.

14. Sinclair, J. B., L. E. Gray, W. A. Meyer, R. W. Schneider, and P. N. Thapliyal. 1972. Epidemiology, spread and control of Phytophthora megasperma var. sojae and Cephalosporium gregatum in soybean. Proc. Indian Natl. Sci. Acad. 37:(B5):280-284.

Abstract: Phytophthora root and stem rot, caused by P. megasperma var. sojae a soil-borne fungus first reported in Ohio in 1951, causes a lesion on the outside of the root and lower stem, progresses upward inducing internal browning, followed by wilting, which may lead to eventual death of the host. Lupinus spp. are susceptible. Susceptible soybeans are vulnerable at any age. There are at least two races of the pathogen. Resistant varieties serve as control with resistance related to quantity rather than quality of phytoalexin produced. Greenhouse and field studies showed that P. megasperma var. sojae influences plant growth by lateral root pruning. In a specially designed system, it was shown for the first time that soybean roots produce phytoalexin. Brown stem rot, caused by C. gregatum has been detected in increasing numbers of U.S. soybean fields since 1944. The soil-borne fungus invades the vascular system, then the pith and eventually causes a brown discoloration throughout the stem. Mung bean (Phaseolus aureus) and red clover (Trifolium pratense) are susceptible. Disease development is favored by an air temperature of 15C and is inhibited at 21C or above. Optimum temperature for in vitro growth is 22-24C, and for spore production 15-20C. There are no commercial resistant varieties and a 5-year corn-soybean crop rotation proves to be an effective control measure.

We proposed a three-class system for field surveys to determine prevalence of brown stem rot. Greenhouse experiments suggest that certain systemic fungicides show promise for control.

## Thesis Titles and Abstracts of Students Participating

## in the University of Illinois 211(d) Program

1. Kharbanda, P. D. 1971. Systemicity of $^{14}$C-labeled chloroneb in soybean tissues. Ph.D. Thesis, Univ. Illinois, Urbana. 23 p.

Abstract; $^{14}$C-chloroneb was absorbed by soybean roots within 12 hrs after application and was translocated into hypocotyl tissues. No fungitoxic compound could be detected in soybean plants whose roots were treated with chloroneb. It is postulated that chloroneb breaks down into nonfungitoxic components in soybean tissue during uptake and translocation. Such a nonfungitoxic compound was identified. There was little redistribution of $^{14}$C-chloroneb or its metabolite in a soybean plant once the supply of fungicide was removed. When $^{14}$C-chloroneb was applied to one of the leaflets on a soybean plant, radioactivity was detected in the petiole of the treated leaf and in the stem both below and above the point of attachment of the treated leaf, but not in the roots. A similar distribution pattern was observed in autoradiographs of treated plants. The phenomenon of downward movement of chloroneb or its metabolite is not fully understood. None of the four fungicides, benomyl, carboxin, chloroneb, or thiabendazole could be recovered from pods or seed from pods harvested from treated plants. Thiabendazole, but not benomyl and carboxin, was taken up by lateral roots and translocated to the lateral roots on the opposite side. Chloroneb may not be a good systemic fungicide for use on soybean because of its limited translocation and instability within the plant.

2. Kirkpatrick, B. L. 1973. Studies on Macrophomina phaseoli and control by systemic fungicides. M.Sc. Thesis, Univ. Illinois, Urbana, 43 p.

Abstract: The development of charcoal rot on soybean seedlings caused by *Macrophomina phaseoli* is described. There was a significant increase in growth inhibition in vitro of *M. phaseoli* on potato-dextrose agar (PDA) containing either 5, 10, or 50μg/ml of the systemic fungicides BD 18653 and thiophanate-methyl. BD 18654 broke down into another compound in fresh aqueous solution, the former but not the latter being heat stable. *M. phaseoli* and *Penicillium atrovenetum* were sensitive to both compounds in vitro. Thiophanate-methyl was stable for 1 week in an aqueous solution, but broke down into methyl 2-benzimidazole carbamate (MBC) after autoclaving. *M. phaseoli* was sensitive to both of these compounds, but *P. atrovenetum* was sensitive only to MBC. All four compounds were absorbed by germinating soybean seed within 4 hr. Charcoal rot was not controlled if seeds were treated with BD 18654 and thiophanate-methyl at 5 and 10 g/kg. BD 18654 and MBC were absorbed through the roots of 1- and 2-week-old seedlings and translocated upward. Both compounds protected seedlings for 3 but not 7 days after treatment when roots were exposed for 24 hrs. Seedlings whose roots were drenched with the two fungicides developed no symptoms 7 days after inoculation. Control in plants treated with thiophanate-methyl was due to MBC.

3. Meyer, W. A. 1972. The use of selective media for studying the biology of Macrophomina phaseoli in soil. Ph.D. Thesis, Univ. Illinois, Urbana. 34 p.

Abstract: Two selective media using rice agar as the basal medium were developed for the isolation and enumeration of *Macrophomina phaseoli* from soil and soybean plant debris. The first, designated as CC, was developed in India and contained chloroneb, methoxyethylmercury (Ceresan Wet), streptomycin sulfate and protassium penicillin. The second, designated as CMR, was developed at the University of Illinois and contained the same ingredients, except that mercuric

chloride was substituted for the methoxyethylmercury and rose bangal was added. Recovery of M. phaseoli from artificially infested soil was approximately 100% with either medium. Assays with CC showed M. phaseoli persists in soil under diverse environmental conditions and that the populations of the fungus in soil increased with continuous soybean cropping. Populations of M. phaseoli in soil from Illinois soybean and corn fields, determined with CMR, were higher than those determined using the sclerotial-flotation method. An increase in soybean seedling disease corresponded to an increase in the populations of M. phaseoli assayed on CMR. In the absence of a suitable host M. phaseoli populations increased and mycelial inoculum persisted in soil up to 7 days. The test fungus invaded dead stem tissues in soil containing anatagonistic microorganisms. The evidence does not support the strict classification of M. phaseoli as a root-inhabiting fungus.

4. Nicholson, J. F. 1973. The effect of internally seed-borne microorganisms on soybean seed quality. Ph.D. Thesis, Univ. Illinois, Urbana. 41 p.

Abstract: Two phytopathogens, internally-borne in soybean seed from the U.S. and India, were shown for the first time to significantly reduce germination and field emergence of soybean seed and thus affect seed quality. Pseudomonas glycinea was isolated from each of 17 lots of 'Lee 68' soybean seed from the U.S. and 27 lots of 'Bragg' from India. Two isolates were recovered from infected seed, and were distinguished in vitro in that one had a smooth surface and margin; and the other, a rough surface and margin. The rough-margined isolates and a similar isolate of P. glycinea from B. W. Kennedy significantly reduced germination of inoculated seeds below that of noninoculated controls. Colletotrichum truncatum reduced the pre-emergence of seedlings from inoculated seeds in India by 25% and post-emergence by 80%. Cotyledon-inoculation studies with this fungus showed that the time of infection as well as the point of infection was important in determining the extent of seed and seedling kill. The effect of seven dates of planting during the monsoon season of India on the occurrence of internally seed-borne fungi in five soybean varieties was studied. The presence of fungi decreased sharply for soybean planting dates of July 15 and later during the 1971 growing season. Germination and emergence significantly increased with later planting dates, but the 100-seed weight decreased for all varieites. Storage conditions for these seed lots were shown to influence germination in laboratory tests. Germination was significantly higher for seed from the first three planting dates that were stored at room temperature (15-45C) than for samples of the same seed lots stored in a refrigerator (1-5C) from March until bioassay. Isolation studies showed that a greater percentage of internally-borne fungi survived in the refrigerated seed than in seed kept at room temperature. Three fungi occurring most frequently in seed from early planting dates were: C. truncatum, Macrophomina phaseoli and Sclerotinia sclerotiorum.

5. Schneider, R. W. 1971. Etiology of Cephalosporium gregatum in soybean. M.Sc. Thesis, Univ. Illinois, Urbana. 25 p.

Abstract: Cephalosporium gregatum penetrated the roots and moved to the top nodes of naturally inoculated soybean plants in the early pod-filling stage within 2 days. The fungus required only 1 day to move through artificially inoculated stems of plants of the same age. These findings support the contention that conidial movement within the transpiration stream is the principal method of fungal spread within the plant. Plants inoculated at 6, 8, 10 or 12 weeks in the greenhouse showed 65, 61, 35 and 46% stem browning, respectively. In field plants inoculated at the same ages, percentage stem browning was 41, 40, 35, and 5%, respectively. Symptom development was most extensive in plants exposed to cool temperatures (18-24C) for 10 out of 12 weeks infection time. Percentage of stems

browned in plants infected for 12 weeks and exposed to 0, 4, 6, 8, 10, or 12 weeks cool temperatures were 36, 42, 46, 62, 65, and 54%, respectively. These data and those of earlier findings support a revised concept of the etiology of C. gregatum in soybean. It is proposed that the fungus enters the roots of young soybean plants during the early, cool part of the growing season. It then spreads extensively within the plant until the middle of the season (July). At this time warm temperatures and amture plant resistance mechanisms inpede further spread of the pathogen. Typical symptoms seen develop (early August). At the end of the growing season (mid-September) the fungus is again induced to spread within the plant by cooler temperatures favorable for conidial production and reduced resistance due to plant senescence.

6. Schneider, R. W. 1973. Epidemiology, yield-loss prediction and control of Cercospora leafspot of cowpea (Vigna unguiculata). Ph.D. Thesis, Univ. Illinois, Urbana. 58 p.

Abstract: The epidemiology, yield-loss prediction and control of Cercospora leaf spot of cowpea (Vigna unguiculata (L.) Walp.), caused by Cercospora canescens Ell. and Martin and C. cruenta Sacc., were studied near Ibadan, Nigeria. Nine Cercospora spp. produced conidia in vitro within 3 days under near ultraviolet light, including C. canescens, C. cruenta, C. musae, C. abelmoschii, C. henningsii, C. caribeae, C. arachidicola, C. longissima, and C. caracallae. C. kikuchii and C. zinneae did not produce conidia with this technique. The aerobiological patterns of C. canescens and C. cruenta differed with the former not producing conidia at night nor during a rain, while the latter always produced conidia at these times. Leaf spots appeared only on leaves subtending reproductive structures. There was a highly significant correlation between immature pod weights and corresponding leaf spot development. Germination of C. canescens conidia was inhibited on young cowpea leaves. However, there were no significant differences in percent germination, number of germ tubes/conidium, or germ tube length of C. canescens conidia in sterile, deionized water and sterile, water washings from young leaves. A disease severity index was developed, tested and used in a yield-loss prediction model. The model was based on specific disease intensities at known times during the growing season. Equations were derived for calculating expected yield-losses for disease situations involving natural and chemically regulated epiphytotics. C. canescens and C. cruenta reduced cowpea yields by 18 and 42%, respectively. Yield losses were prevented in a determinate variety with one benomyl spray at 5 weeks after planting. However, in an indeterminate variety, benomyl sprays reduced total grain yield by 20%.

7. Slusher, R. L. 1972. Development of Phytophthora megasperma var. sojae in soybean roots. M.Sc. Thesis, Univ. Illinois, Urbana. 32 p.

Abstract: A new stain was developed which stains Phytophthora megasperma var. sojae (Pms) oospores in soybean root tissue to varying densities of color. It does not stain surrounding root tissues. This may be of value in determining physiological differences in oospore formation. Stages in the life cycle of Pms in soybean root tissue were examined by light microscopy. Inter- and intracellular hyphal growth was shown, with haustorium-like bodies invaginating or penetrating the cell. Roots of susceptible 'Amsoy' (AS) and field tolerant 'Wayne' (WS) contained more oospores when the plants were grown in a sand medium as opposed to sterile or nonsterile soil. WS plants had almost the same percentage of oospore-infected roots as AS plants. Few roots of resistant 'Amsoy 71' (AR) plants contained oospores regardless of media. Root discoloration in AS roots was less marked than in AR roots and was absent in WS roots. In situ oospores and oogonia from these experiments were generally smaller than those reported for other isolates grown in vitro. The WS plants had a greater root

dry weight than AS plants, but there was little difference in top dry weights. Oospores were found in roots that had overwintered in Pms-infested soil. Roots of field tolerant or resistant plants, as well as plants susceptible to Pms, may provide overwintering inoculum.

8. Thapliyal, P. N. 1970. Systemicity and fungicidal activity of three systemic fungicides in soybean. Ph.D. Thesis, Univ. Illinois, Urbana. 51 p.

Abstract: Three fungicides were tested for their systemicity in soybean seedlings and plants, as well as their in vitro activity against Rhizoctonia solani and Penicillium atrovenetum and in vitro and in vivo activity against Cephalosporium gregatum. Benomyl was found to be fungistatic to R. solani in vitro and to C. gregatum in vitro and in vivo. Chloroneb and oxycarboxin were fungistatic only to R. solani in vitro. The three compounds were absorbed by germinating soybean seed within 12 hr. Benomyl and chloroneb tended to be localized in cotyledons, chloroneb moved in hypocotyl and cotyledons, while benomyl moved into epicotyl tissues. Carboxin was not localized in cotyledons and distributed uniformly throughout the seedling with higher concentrations in epicotyl tissues. Thin-layer chromatographic studies showed that benomyl did not break down in vivo, while chloroneb broke down in cotyledons into at least one other metabolic compound. All results were confirmed with $^{14}C$-labeled chloroneb and carboxin.

IV. Impact of Grant Supported Activities in Developing Institutional Capabilities: The University of Illinois 211(d) Program has been involved in maay of the other programs of the University concerned with the development of Indian agriculture, as well as that of other countries (see Section V of this report). Among these programs are: The Coordinated Soybean Research Project (CSRP); the various institutional development programs at JNKVV and PUAT; graduate student participant training programs of India and other countries; and the informal institution to institution programs.

1. Coordinated Soybean Research Project. Most of the students involved in the 211(d) Program did research and studied soybean and soybean diseases at the two contract universities, JNKVV and PUAT, and worked with the Indian and American technicians in the program. The 211(d) Professor has given many formal and informal seminars, met with various research groups to exchange technical information, and discussed soybean diseases and their control during each visit to India. These discussions were held at many Indian universities and institutions other than the two contract universities.

2. Institutional Building Programs. Students involved in the University of Illinois 211(d) Program have taught formal courses (R. A. Sikora), assisted in the instructional laboratories (W. A. Meyer and J. F. Nicholson), have given seminars on their research to audiences in both the U.S. and India. There has not been a 2-year "adviser or technician" in plant pathology at either contract university and only two, 3-month "short-termers". Essentially the 211(d) Program in plant pathology was used to provide this expertise at the contract universities.

3. Contract Universities' Participants. Of 23 University of Illinois graduate students from India in plant pathology in the past 10 years, six have been USAID participants primarily from our two contract universities. The 211(d) Program was the only program that would have U.S. students, who were to study and work in India, work closely with these participants and other students from India. It has provided a basis for the development of an institution to institution relationship in plant pathology.

4. Institution to Institution Programs. The 211(d) Program has given the University of Illinois an opportunity to begin developing an institution to institution program in plant pathology in India as well as Sierra Leone, Iran, and Nigeria, that has set a format for the development of similar programs in other academic areas and countries. Graduate student exchange has set the stage for possible faculty exchange. However, in order to be successful, it is absolutely necessary that there be a 211(d) Program or some similar supported program in the U.S. to provide the funds for such an exchange.

5. International Soybean Research Base. In 1969 a Program for International Research, Improvement, and Development of soybeans (PIRIDS) was activated and received support from AID since July 1971. It incorporates the CRP activities in India and has field trials in progress or planned in a number of other tropical and subtropical locations. The program is going to be expended to include all departments of the College of Agriculture. The University will be named the International Soybean Resource Base (INTSOY) and funded from several international agencies. The 211(d) Program has provided a strong resource base in plant pathology to compliment INTSOY.

V. Utilization of Institutional Resources in Development: The following is a summary of the international programs of the College of Agriculture, University of Illinois. Similar material was summarized for the "Directory of University Competencies and Resources in Specific Areas Supported by 211(d) Grants". The material below comes from a brochure entitled: "International Programs and Studies 1972-74" at the University of Illinois Urbana-Champaign, published in May 1972.

"The instructional programs of the College of Agriculture have an international dimension that is rapidly broadening. The College fully recognizes the world food-population problem as one of the major issues facing mankind and hopes to assume a major role within the University community in studying its solution. The College of Agriculture is expending its international agriculture program in order to educate American students for development activities abroad as well as to train foreign students who come to the College for study.

The College has had cooperative working agreements in India since 1952 and in Sierra Leone since 1963. At the present time there is a close relationship between the College and the Indian states of Madhya Pradesh and Uttar Pradesh and with Njala University College (NUC) in Sierra Leone, through contacts with the United States Agency for International Development (AID). In India, College of Agriculture staff members are assigned to Jawaharlal Nehru Agricultural University (JNAU) at Jabalpur and Govind Ballabh Pant University of Agriculture and Technology (PUAT) (formerly Uttar Pradesh Agricultural University) at Pant Nagar and, as at Njala University College, they assist in the development of integrated programs for teaching, research, and extension. As a part of the Midwest Universities Consortium for International Activities, Inc. (MUCIA) AID contract activity in Indonesia, the College expects to participate in institution-building programs at two Indonesian universities. A study team from the College of Agriculture and the College of Education recently was requested by the Government of Nepal to conduct a survey of higher agricultural education in that country.

In India, in addition to the two university-building projects, the College has agricultural exonomics staff working with several Indian universities under Ford Foundation auspices for research and development of agricultural economics programs. A Coordinated Soybean Research Project (CRP) has been conducted at JNAU, PUAT, and the Urbana-Champaign campus since 1967. This project is aimed at developing India's capabilities to produce, process, and utilize soybeans. Research programs and personnel at the two Indian institutions and at Urbana are closely integrated under the leadership of project coordinators at Urbana-Champaign and in India. This program has stimulated rapid expansion of soybean acreage in India and a keen interest in the possibilities of developing a soybean processing industry there.

In 1969 a Program for International Research, Improvement, and Development of soybeans (PIRIDS) was activated. This program will give world-wide attention to problems of soybean research and development. It incorporates the CRP activities in India and has field trials in progress or planned in a number of other tropical and subtropical locations. Since July 1971 this program has been receiving financial support through a contract with AID.

Also in 1969 a study of Agricultural Development Strategies was organized and funded. This study will concentrate on research to determine the best strategies for agricultural development, using an interdisciplinary and comparative approach to actual developmental problems.

International instructional and research programs are closely related to these overseas service projects in which the College participates. Supervision of graduate thesis research is possible in India (agronomy, agricultural economics, animal science, dairy science, and agricultural engineering), Sierra Leone (agronomy, animal science, and agricultural exonomics) and Indonesia (several departments at varying times)".

Department of Agricultural Economics

Several faculty members of PUAT are being trained at the Urbana-Champaign campus, and Illinois staff members act as short-term teaching and research consultants with counterparts at PUAT.

Under the terms of a United States Agency for International Development (AID) contract, the Department is participating in soybean marketing research in association with Jawaharlal Nehru Agricultural University at Jabalpur, India.

Also under an AID contract, the Department has participated in the development of Njala University College in Sierra Leone. Two faculty members serving at Njala helped to develop the curriculum as well as conduct teaching, extension, and research activities.

Active international research and teaching programs on the Urbana-Chanpaign campus complement the overseas activities of the Department. The research, funded largely through the Office of International Agriucltural Programs, concentrates primarily on economic problems of agriculture in Sierra Leone and India. International teaching activities of the Department include a course on agricultural development; one on international comparative agriculture; one each on African, Indian, and Latin-American economic developments; and two courses dealing with social change in developing areas.

Department of Agricultural Engineering

The Department of Agricultural Engineering has been involved in furnishing advisers and consultants to Indian universities for the past eighteen years as part of contracts of both the College of Agriculture and College of Engineering. It has been instrumental in setting up two of the first three agricultural engineering departments in India and in organizing colleges of agriucltural engineering in two new Indian agricultural universities. The Department also furnished consultants to give guidance in research, teaching, and extension at those new universities.

At present the Department is developing a cadre of engineering consultants willing to undertake short-term overseas assignments. Under this arrangement an adviser went on a 1971 assignment in administration and curriculum planning at Jawaharlal Nehru Agricultural University, Jabalpur, India. A second adviser in farm electrification and processing is working with an Indian graduate student whose research is being done at JNAU for a University of Illinois Ph.D. degree. This Indian graduate student completed all other degree requirements at the University of Illinois prior to returning to his home university.

Since the authorization of a graduate program in agriculture engineering in 1949, the Department has awarded nineteen master's degrees to students from seven countries and four Ph.D. degrees to Indian students. Presently, the Department has graduate degree candidates from six foreign countries.

## Department of Agronomy

For many years the Department of Agronomy has been directly involved in the agriculture of foreign countries. The Department's program in international agronomy has developed to include (1) research, teaching, and extension activities of staff and graduate students in foreign countries, (2) training of American students for careers in foreign countries, and (3) training of foreign graduate students.

The Crop Evolution Laboratory of the Department of Agronomy is concerned with the study of the origins and evolution of cultivated plants and weeds; it is the only one of its kind in the United States. Extensive collections of major crops from all over the world and their companion weeds and wild ancestors are being assembled for detailed biosystematic studies. Cultivated plants are recent in origin and provide excellent opportunities to study evolution in progress. Techniques are being developed that will allow plant breeders to utilize fully all variability that could contribute to the improvement of major crops. The collections also serve to familiarize foreign students, as well as American students interested in foreign assignment, with the crops with which they eventually will be working. The Laboratory further provides opportunities for ethnologists and archaeologists to become familiar with the history and evolution of the crops that made civilization possible.

A significant role is played by the Department of Agronomy in the international soybean research program, PIRIDS. Cooperative variety trials were conducted in Colombia, Ecuador, Brazil, Sierra Leone, Pakistan, India, Thailand, and Indonesia. Seed and plans were supplied by the University of Illinois for these trials and the data were summarized and distributed to those cooperating and to others. Quality characteristics were determined on these samples in the Department of Agronomy.

The Department of Agronomy also conducts a cooperative soil research project in cooperation with Njala University College. The objective of this work is to obtain information on the properties and treatment needs of major soils in Sierra Leone in order to provide a sound basis for improving soil management and increasing crop production.

## Departments of Animal Science and Dairy Science

The Department of Animal Science and the Department of Dairy Science have a cooperative program in international animal agriculture.

A course in world animal agriculture has been developed to give students an understanding of the role of animals in the food supply, economy, and culture of peoples from other nations. Currently the Department of Animal Science has two graduate students studying for doctorate degrees in world animal agriculture. One is conducting thesis research in Indonesia on cattle production and its potential to alleviate protein deficiencies in human diets in East Java. The other is researching the problems of the small swine farmer in Colombia, South America.

## Department of Food Science

The Department of Food Science has a major role in cooperative international programs and multidisciplinary research under overseas contracts and the international soybean program, PIRIDS.

A process has been developed which prevents the formation of the "beany" flavor in prototype food products made from soybeans. Such foods are inexpensive, nutritious, and adaptable to the food habits of people in various parts of the world. Emphasis has been placed on developing canned whole soybean products, powdered mixtures of whole soybeans with either fruits or cereals, soybean drinks, and breakfast foods. An essential part of the project will be to determine by nutritional studies the effect of processing variables on the biological value of the protein in the developed foods.

At present this project has eleven workers assigned to it which makes it one of the top priority projects in the Department. The project leader has accepted a two-year assignment at Govind Ballabh Pant University of Agriculture and Technology in India where he will be engaged in scaling-up production techniques for products developed at Urbana-Champaign. Later he will be joined by a doctoral candidate associated with the project. One Indian student at Urbana-Champaign is studying the toxin factor of lathyrism, a crippling nutritional disease in some parts of India, which is caused by eating a specific type of legume.

A new study has been initiated to determine the role of certain natural compounds in soybeans to control oxidation reactions that cause nutritional problems.

Department of Horticulture

In 1970 the interdisciplinary, interinstitutional Tropical Root and Vegetable Crops Program was initiated. This research project involves five staff members from the Department of Horticulture and one member each from the Departments of Agronomy and of Plant Pathology. Cooperative research has been initiated with members of the Faculty of Agriculture of the University of the West Indies in both Trinidad and Jamaica, and with the Federal Experiment Station, Mayaguez, Puerto Rico. Initial emphasis is on tropical sweet potatoes and yams, and on weed control research on tropical root crops and vegetables. Initial efforts for staff exchange under this program were made during 1970 when the leader of the Tropical Root Crops Program of the University of the West Indies spent two months during the summer conducting research at Urbana-Champaign.

New disease-resistant apple germ plasm with the potential for direct use as new crops continues to be distributed to India through cooperation with the Government Hill Fruit Research Station, Chaubattia, Uttar Pradesh, India. Studies on the dwarfing capability of size-controlling fruit tree root-stocks and the identification of such germ plasm are directly applicable to Indian needs in tropical fruit production and to increasing per hectare production of apples on terraced slopes.

The Department, in cooperation with the Department of Plant Pathology, has developed a new course for graduate and advanced undergraduate studies entitled "International Food Crops".

Department of Plant Pathology

The Department of Plant Pathology, in cooperation with the United States Agency for International Development and various Indian plant pathologists, embarked on a five-year cooperative research and student training program July 1, 1968, under Section 211(d) of the Foreign Assistance Act of 1966. Six American students will have completed the requirements for the M.S. and Ph.D. degrees by June 30, 1973. The program has been broadened by placing a student at the

International Institute for Tropical Agriculture at Ibadan, Nigeria. An overall objective of the program is to enhance the competence of the Department international plant pathology. It is hoped funds will be allocated to continue this or a similar program beyond June 1973.

The Department will continue cooperative work with the Tropical Root and vegetable Crops Program and PIRIDS.

Division of Agricultural Entomology

The Division of Agriucltural Entomology, which is staffed by entomologists of the Illinois Natural History Survey, the College of Agriculture, and two members of the Department of Entomology of the School of Life Sciences, participates in programs at Jawaharlal Nehru Agricultural University (JNAU) and Govind Ballabh Pant University of Agriculture and Technology (PUAT) in India. Several staff members have been assigned as short-term research advisers to these universities or as consultants to the Coordinated Soybean Research Project in India. One staff member is currently on a two-year assignment to PUAT.

The Division, working with the Department of Entomology of the School of Life Sciences, makes provisions for doctoral thesis research in India for American and Indian graduate students. Under this provision, selected students can elect to do thesis research in India following satisfactory completion of all entomology requirements and the preliminary examination. Students from India are working on advanced degrees in entomology on the Urbana-Champaign campus.

The Division is an active participant in the PIRIDS international soybean research program. Under the auspices of this program, the Division has gathered together in one location all of the world literature dealing with arthropods of soybeans and arthropod vectors of diseases of soybeans and is computerizing this literature for rapid retrieval of information. A synoptic collection of arthropods associated with soybeans is also being developed and the collection and the biodata associated with it is computerized. More than twenty-five thousand specimens are in the collection representing approximately six hundred distinct species of pests, parasites, and predators associated with soybeans. The collection contains species from the United States and sixteen international locations. These two reference collections of scientific information are service-oriented. They support the research of students and staff and enable the Division to respond to requests for information.

Personnel and students associated with the Division are engaged in research on insect behavior, host selection, biology and control, and claffification of arthropods. High priority is being given to the publication of a series of bibliographies of the literature on key pest insects of soybeans and to the assessing of actual and potential insect problems on soybeans in temperate, subtropical, and tropical regions.

Office of Agricultural Communications

Since 1952 the Office of Agricultural Communications has been involved in overseas projects, training foreign communications participants, and giving communications support to various college international programs. At the present time the Office has eight staff members who have had overseas experience.

During 1971 the Office received a two-year MUCIA grant to hire one person as an International Rural Communication Specialist. This person has carried out a broad survey of the international rural communication development field. He

is currently drawing up long-range proposals which outline the role of communications in international social and exonomic development, the role of communication in supporting other international programs, training communication and noncommunication participants, and training Americans for international work. Close liaison is maintained with colleges and departments on campus, with other universities, the United States Agency for International Development, the United States Department of Agriculture, the Department of Health, Education and Welfare, the East-West Center, and other organizations which are involved in international communication activities.

The Office has recently established an International Development Communication Committee made up of all staff who have overseas experience. In the 1972 spring semester the Office began offering an undergraduate course in communication in agricultural development.

Listed below are undergraduate and graduate courses offered by the departments within the College. In addition to these courses, opportunity for on-campus independent graduate research of an international nature is offered by the Departments of Agricultural Exonomics, Agricultural Engineering, Agronomy, Animal Science, and Dairy Science, the Office of Agricultural Communications, and Plant Pathology.

| Course | | Title, Prerequisite | Instructor | Credit |
|---|---|---|---|---|
| Ag Ec | 301 | Economics of Agriculture Development. Prerequisite: Econ 103 or 108 | Due, Herdt, Thompson | 3 hrs, or 3/4 or 1 unit |
| Ag Ec | 318 | Land Economics, Prerequiste: Graduates, consent of instructor; Undergraduates, Econ 103 or 103 | Dovring | 3 hrs, or 3/4 or 1 unit |
| Ag Ec | 352 | Economic Development in Latin (Same as Econ 352). Prerequisite: Econ 103 or 108, or consent of instructor. | Beckett | 3 hrs, or 1/2 or 1 unit |
| Ag Ec | 353 | Economic Development in India and Southeast Asia (Same as Econ 353). Prerequisite: Econ 103 or 108, or consent of instructor. | Herdt | 3 hrs, or 1/2 or 1 unit |
| Ag Ec | 354 | Economic Development of Tropical Africa (Same as Econ 354). Prerequisite: Econ 103 or 108, or consent of instructor. | Due | 3 hrs, or 1/2 or 1 unit |
| Ag Ec | 401 | International Comparative Agri. | Dovring | 1 unit |
| Agron | 350 | Crops and Man | Harlan | 3 hrs, or 3/4 unit |
| Agron | 429 | The Evolution of Agri. Economies. Prerequisite: Consent of Instructor. | Alexander Staff | 1 unit |
| Agron | 462 | Origin of Variation in Plants. Prerequisite: Consent of instuctor. | de Wet | 1 unit |
| An S | 350 | World Animal Agriculture (Same as D S 350). Prerequisite: Consent of instructor. | | 3 hrs, or 3/4 unit |
| D S | 350 | World Animal Agriculture (Same as S 350). Prerequisite: Consent of instructor. | | 3 hrs. or 3/4 unit |
| Hort | 307 | International Food Crops (Same as Pl Path 307). Prerequisite: Junior standing or consent of instructor. | Sinclair Rhodes | 3 hrs, or 3/4 unit |

| | | | | |
|---|---|---|---|---|
| Pl Path | 307 | International Food Crops (Same as Hort 307). Prerequisite: Junior standing or consent of instructor. | Sinclair, Rhodes | 3 hrs, or 3/4 unit |
| R Soc | 277 | Rural Social Change (Same as Soc 277). Prerequisite: Soc 100 or R Soc 117. | van Es | 3 hrs. |
| R Soc | 343 | Social Change in Developing Areas (Same as Soc 343). Prerequisite: Soc 100 or equivalent | van Es, Karsh | 3 hrs, or 1/2 or 1 unit |
| R Soc | 378 | Socio-Cultural Factors in Africian Economic Development (Same as Anth 378). Prerequisite: A course on Africia or international economic development. | Uchendu | 3 hrs, or 1 unit |

VI. Other Resources for Grant-Related Activities: The funds provided by the original 211(d) grant were not adequate to carry out the plans and scope of the program. Many units of the University of Illinois provided either indirect or direct support this past year.

1. Administration services and advice were provided by the: (1) Office of International Programs and Studies; (b) Office of Overseas Projects; (c) Office of International Agricultural Programs; and (d) Department of Plant Pathology.

2. All services for the operation of the teaching classrooms and laboratories; the research laboratories, greenhouses, and growth chambers; professor's office and graduate student office space and furniture; and other expenses provided by the University of Illinois. There were no indirect costs taken from the grant at any time by the University.

3. More specific support came from:

(a) The Department of Plant Pathology by providing:

(1) $2,200 for a 1/3-time secretary.
(2) $1,000 for office supplies and services.
(3) $ 500 for teaching aids and supplies.

Total $3,700

(b) The College of Agriculture by providing:

(1) $8,390 through regional research funds.
(2) $ 250 for renting approximately 1/2 acre of land for for experimental field plots.
(3) $20,000 in salary from September 1972 through June 1973.

Total $28,640

(c) The Office of International Agricultural Programs by providing:

(1) $6,000 for equipment, supplies, repairs and expense.

Total $6,000

(d) The University of Illinois by providing:

$934 for graduate student stipends.

Thus, at least $39,000 or over $39,274 was provided from funds other than 211(d) for direct support of the 211(d) Program in the fiscal year 1972-73.

In Fiscal 1972, the amount was $17,580; in Fiscal 1971, $24,780; in Fiscal 1970, $15,000; and for Fiscal 1969, $25,850. This is a total of over $125,484 for the five years of the grant period. This does not include the USAID/Delhi Rupee support funds and those provided by IITA.

VII. Work Plan for Remainder of 1973: In a letter dated February 6, 1973 to the Contracting Officer, an extension of the termination date to December 31, 1973 was requested. No additional funds were requested. Committed grant funds for the salary of the 211(d) Professor were released by paying him from other sources within the College of Agriculture from September 1972. This generous action gives the necessary flexibility to the grant to carry out the activities proposed. The extension was approved in mid-March.

The present educational programs will continue, but the grant-supported research, graduate student training and other activities will be phased out during the next 6 or 7 months.

Stipends for two graduate students will be supported by the project for the remainder of the grant period.

The University of Illinois is expected to be named an international soybean resource base (INTSOY) in the near future. The program will require close cooperation between scientists at the University of Puerto Rico and the University of Illinois. Both universities have proposals under Agency review to receive 211(d) grants in support of some of these activities. In order to establish the personal contacts between the plant pathologists at the University of Puerto Rico, Dr. James B. Sinclair, the 211(d) Professor and Dr. Richard E. Ford, Professor and Head of the Department of Plant Pathology plan to visit with professional colleagues at the University of Puerto Rico during the first week of June. Expenses for these two men will be paid for from grant funds.

The Second International Congress of Plant Pathology will be held at the University of Minnesota, Minneapolis, September 5-12, 1973. Plant pathologists from all over the world, including India and other countries with which contacts have been made under the grant, will be attending and participating in this meeting. The University of Illinois Department of Plant Pathology will take advantage of this situation by having selected scholars visit the campus, either before or after the meetings, to give formal seminars and lectures. This is a rare opportunity to meet with, confer, and have formal presentations from these distinguished scientists. Approximately $5,000 has been allocated for honoraria to cover the expenses of these scientists.