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UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

DEPARTMENT OF AGRONOMY

ANNUAL TECHNICAL REPORT OF 211(d) PROJECT

1970 - 1971

THIRD ANNUAL TECHNICAL REPORT
U.S.A.I.D. 211(d) GRANT
UNIVERSITY OF MISSOURI COLUMBIA
(July 1, 1970 through June 30, 1971)

TITLE OF GRANT: A grant to develop within the University of Missouri, Columbia, specialized competency in the breeding of agronomic crops in India.

I. SUMMARY:

Progress continues to be made in the Department of Agronomy in developing an international dimension in teaching and research, in increasing competency for consultation and service, and in involvement of University resources in these activities. The 211(d) program is acting as a catalyst to bring about these changes.

New courses, "International Agronomy" for undergraduates in Agronomy, and "Philosophy of Extension," a seminar for foreign graduate students in Agronomy, have been developed. The former is designed to introduce undergraduates to the agronomic and interrelated factors associated with world food production and the transition from traditional to modern agriculture. The seminar on extension is designed to give a better understanding of extension and its relationship to the development of relevant teaching and research programs.

The USAID 211(d) grant has enabled the University of Missouri, Columbia to assist in initiating wheat and pulse breeding projects at the Orissa University of Agriculture and Technology in India. Resistance to *Helminthosporium* blight disease and early maturity have been clearly defined as the major objectives for developing wheats adapted to Orissa. A wheat disease screening nursery containing 1700 strains was assembled and grown at OUAT in 1970-71, providing a source of parent materials from the best wheat breeding nurseries in India and from CIMMYT.

A mungbean nursery containing 321 cultivars assembled from the USDA world collection, India, and other sources was grown at Columbia in 1970 by Mr. Yohe, graduate student on the 211(d) program. Parent materials to initiate a breeding program for improved yield, plant type, early maturity, disease resistance, seed quality, and nutritive value have been identified. The mung bean is the principal pulse crop in Orissa state in India where UMC has an AUD contract.

Plans for an international Mungbean Improvement Project have been developed. Germ plasm collections will be evaluated, an international screening nursery will be developed, and bulk hybrid pools distributed

to breeders in India and other countries of South and Southeast Asia where the mung bean is an important pulse crop. This program may be initiated within the 211(d) project but will require additional funding to fulfill its major objectives.

The increasing interest and awareness of the importance of teaching and research activities in the international sphere and the acceptance of them by the University of Missouri, Columbia, as legitimate activities is evident by UMC providing one-half the salary of the International Professor in 1970-71; limited funding of an AES research project on breeding India crops; land, labor and technician assistance for field research; greenhouse and laboratory facilities; computer and chemical laboratory services; and library facilities.

II. GRANT OBJECTIVES:

The overall objective of this grant is to increase the general competency of the University of Missouri, Columbia, to generate knowledge and render assistance in the international area of plant breeding, and to establish this area of specialization as a legitimate and continuing function of the University.

The specific objectives of the grant are to:

1. To increase the capability of the University of Missouri to render assistance to India (and other developing nations) in the general area of plant breeding.
2. To increase the pool of scientific manpower trained in plant breeding interested in and capable of assisting India (and other developing nations).
3. To create a professional awareness of the international dimensions of plant breeding.
4. To stimulate interest of plant breeders in international service careers as employees of private or public entities.
5. To encourage college students to seek training leading to careers in international plant breeding under private or public auspices.
6. To provide an opportunity for graduate students to obtain research experience on problems of particular relevance to the developing countries (to the maximum extent feasible, by assisting with research activities carried out wholly or partially in India.)
7. To increase interest in and knowledge about the agricultural problems of India by drawing upon all relevant special competencies of staff members of the Department of Agronomy and other departments of the University.

The activation of the grant objectives is built around the employment of a full-time faculty member who will teach, conduct research both in the U.S. and overseas, supervise graduate students, and carry out other activities pursuant to the grant objectives. The activities are designed to create a professional awareness of the service opportunities in the international area of plant breeding, to train graduate students for careers devoted to assisting developing nations in the discipline of plant breeding, and to provide research experiences overseas (in India) which will assist in the personal development of the professor and the graduate students and thereby increase their competency to understand the agricultural production problems of developing nations and to contribute toward the solutions of those problems.

This grant is one of six separate disciplinary grants being coordinated through the Council of United State Universities for Rural Development in India. The UMC grant is focused on the development of educational competence and research expertise in plant breeding as related to agricultural development in India.

The period covered by this report is from July 1, 1970 through June 30, 1971.

III. MAJOR ACCOMPLISHMENTS:

In the previous technical reports Dr. J. M. Poehlman, Professor of Agronomy (Plant Breeding), was identified as the International Professor on this project from the University of Missouri, Columbia. Professor Poehlman continues to be identified with the 211(d) project and has directed the activities throughout the year. During the year he traveled to India in the interests of the program. Assistance was given to the Orissa University of Agriculture and Technology, Bhubanesuar, India, in developing a wheat breeding program and cooperation has been given to OUAT and to the Orissa State (India) Pulses Research Station in developing a mungbean breeding program.

Mr. John M. Yohe has completed course work and comprehensive examinations for the Ph.D. degree. He will be traveling to India during 1971-72 to conduct thesis research. During the summer of 1970 he evaluated 321 strains of mungbean at Columbia, identifying parent materials for breeding for increased yield, early maturity, plant type, seed quality, and disease resistance. He will grow parent F_1 and F_2 progenies from a diallele cross in India in 1971-72 as a part of his thesis research.

Mr. Earl Watt is studying toward the M.S. degree and is conducting research on winter wheat x mexican spring wheat crosses for his M.S. thesis. During the 1970 summer he assisted in the evaluation of the 6th International Spring wheat nursery, the International Spring Wheat Screening nursery, and the International Biological Program (IBP) Spring Wheat

adaptation nursery. It is planned that Mr. Watt will go to India in 1972-73 for research.

It is expected that one or two additional graduate students will be added to the program at the beginning of the 1971-72 fiscal year.

Excellent progress has been made during the year in all phases of the 211(d) program - teaching, research, competence for consultation and service, and involvement of other University resources. This has been possible because of the cooperation, financial assistance and support received from the University of Missouri, Columbia, which supplement the expenditures from 211(d) grant funds.

A. Development of Teaching Competence:

The USAID grant from 211(d) funds has enhanced the teaching competence of the UMC Department of Agronomy in the area of International Agronomy because it has permitted the employment of an International Professor and graduate assistants who are focusing on a worldwide perspective in plant breeding. The grant assists in development of this perspective by providing opportunity for travel, study, and participation in plant breeding research in India and other countries.

Students in plant breeding at the University of Missouri, Columbia, benefit also through the broader perspective which the International Professor brings to the courses he teaches. During 1970-71 the International Professor taught two courses in plant breeding at the University of Missouri, Columbia, a graduate course the first semester and an introductory course the second semester. The graduate course contains plant breeding majors from the Department of Agronomy and from related areas such as Entomology or Plant Pathology. Enrollment in the undergraduate course includes agronomy majors and graduate students transferred from other institutions. In both of these courses the principles of breeding and the contributions from breeding of wheat, rice, and other crops to the agricultural development and food production of India and other developing countries are illustrated by examples from the professor's experiences and with slides taken in India and other countries.

Research being conducted with the Mexican spring wheats and with the pulse crops, as a result of the cooperative program in India, has provided new and timely areas of research and has added an international dimension in our graduate student teaching program.

The international perspective is not limited to courses taught by the International Professor. An awareness of the relevance of internationally oriented subject matter is being fostered throughout the Agronomy Department staff. Present courses are being broadened by introduction of an international dimension. A new course, INTERNATIONAL AGRONOMY, has been developed by Dr. Dale T. Sechler (Crop Science) and

Dr. Wm. Upchurch (Soil Science). The purpose of this course is to introduce the undergraduate student at an early stage of his studies to an understanding of the agronomic problems of the developing regions and to create an awareness of their implication for maximum production of food and fiber. A new course also is in preparation on Philosophy of Extension. This course is being developed primarily for the foreign students in Agronomy by Professors Falloon, Murphy, Schler and Upchurch, all of whom have worked in India on the USAID-UNC Contract programs. It will be designed to teach the foreign student an awareness of the linkages between a successful agricultural extension program and the relevance of the research and teaching programs in an agricultural university.

The competency of the Department of Agronomy in the international area has been enhanced by the return of four staff members (in addition to the International Professor) from assignments on the AUD or APP contracts in Orissa or Bihar states of India. One additional staff member, Dr. Roger Hansen went to Orissa for a two-year tour beginning October, 1970. The experience and knowledge of these people has been utilized to broaden our understanding in the international area. One staff member, Dr. Gordon Kimber, is completing a six-month tour at the Indian Agricultural Research Institute, New Delhi, under the auspices of the Atomic Energy Commission of FAO. Dr. George Smith has advised with Yugoslov administrators and doctors on "Balkan Nephropathy" and the possible relationship of this disease to soil and water management.

The Department of Agronomy sponsors a number of post-doctoral appointments and graduate assistantships for foreign nationals in order to broaden our cultural environment and as a service to international agricultural development. During 1970-71 there were four Post-Doctorals, one visiting professor and one visiting lecturer in the Department, all of whom were foreign nationals.

During 1970-71 there were 62 graduate students in the Department of Agronomy. Of these, 26 were Foreign Nationals. Seven were supported by AID funds, one by a Rockefeller fellowship, one by a Libyan government fellowship, one by a Nigerian government fellowship, and the remainder by departmental or personal funds.

The 211(d) Professor served as adviser to two foreign students during the 1970-71 year as follows:

Mr. Mohammed Elmigri, (M.S.), Libya, Supported by Friends of Libya.

Mr. Praphas Weerapat, (Ph.D.), Thailand, Supported by the Rockefeller Foundation.

Two seminars were presented to the Agronomy Department staff by Dr. D. S. Athwal, Assistant Director of the International Rice Research

Institute, Los Banos, Philippines. Dr. Athwal's visit was sponsored by the 211(d) program.

Professor Clifford R. Meeker, Chief of Party and Extension Adviser of the USAID-UMC Agricultural Production Promotion Project, Patna, Bihar, India, presented a joint Agronomy-Agricultural Economics Seminar in which he discussed the work of one of the UMC contract programs in India.

B. Development of Research Competence:

The competence of the Department of Agronomy to participate in International Agricultural research activities continues to grow. This competence has been enhanced by the 211(d) grant since it provides an opportunity for the International Professor and his students to actively participate in and contribute to the development of wheat and pulse breeding projects in India.

The arrangement for cooperative research and training of graduate students at the Orissa University of Agriculture and Technology, Bhubaneswar, Orissa State, India, was reported in the First and Second Annual Technical Reports. OUAT was selected because the University of Missouri, Columbia, has an AID contract to assist with development of this Indian university. Informal cooperation has been established with Dr. Sinha, Chairman, Department of Agricultural Botany, OUAT, whereby Dr. Poehlman will assist with development of wheat and pulse breeding projects. From these programs thesis research problems will be identified and Dr. Sinha will serve as the students overseas research adviser.

(1) Research on Wheat:

The wheat breeding program was initiated at OUAT in 1968-69 with 15 crosses between adapted Indian spring varieties and 1-gene, 2-gene, and 3-gene Mexican dwarf spring varieties. Thirty-six additional crosses were made in India and 56 crosses at Columbia, Missouri, in 1969-70. The crosses made at Columbia include both spring x spring and spring x winter parents. Early generation bulks of these crosses are now being increased at OUAT.

In 1968-69 and again in 1969-70, Helminthosporium blight was observed to be the major disease in wheat at Bhubaneswar. This is in contrast to North India where rust is the major disease. The Mexican spring wheats are susceptible to the Helminthosporium organism. Resistance to this disease is clearly a major breeding objective in Orissa if wheat is to be grown in the Coastal Plains area of that state. The need for early maturity is also evident in order to escape heat and rust.

In 1970-71 a disease screening nursery, assembled with assistance of Rockefeller wheat consultants in India, was grown at Bhubaneswar. This nursery contained 1700 entries from wheat breeding nurseries and CIMMYT. All strains in this nursery were evaluated for reaction to the Helminthosporium blight and for plant type.

In three seasons we have identified the major breeding objectives, assembled the best breeding materials from India and CIMMYT, and advanced a large number of bulk populations to the F₃ and F₄ generations. Although much of this progress has resulted from the input of the 211(d) Professor, with this start OUAT will now be able to carry the wheat breeding forward with a minimum of assistance.

The Missouri wheat breeding program will also benefit from this cooperative effort. The observations and experiences gained in India broaden our knowledge and concepts about and improve the objectives of the Missouri program. Segregating populations of the spring x winter crosses are being grown at Columbia and winter-type selections will be utilized in the Missouri wheat breeding program.

The Helminthosporium disease complex at Bhubaneswar is of interest to us in Missouri. Helminthosporium blight is damaging to wheat and barley throughout much of the area where these crops are grown in the United States. Epiphytotics are usually light and no serious effort has been made to breed for resistance in this country. Sources of high resistance are not known. The severe epiphytotic at Bhubaneswar provides an excellent opportunity to screen for resistance in the field. We are exploring the possibility of screening the USDA world collection of wheat for resistance to this disease.

(2) Research on Pulses:

In the 1969-70 report it was reported that we would conduct research, in cooperation with OUAT, on mungbean or green gram (Phaseolus aureus Roxb.), a pulse crop. This species was chosen because it is the principal pulse grown in Orissa, yet no breeding work was in progress in Orissa on this pulse. Mungbeans may also be grown at Columbia. This makes it a good species for thesis research since research may be done both in Missouri and in India.

During the summer of 1970, 321 cultivars of mungbean were grown at Columbia. They came from the Oklahoma Agricultural Experiment Station, California, the USDA, and India. Seed was harvested from over 300 of these lines. The maximum yield obtained

was 2,708 kilograms/hectare with 98 lines exceeding 1,000 kilograms/hectare. Data were obtained on yield, days to flowering, days to maturity, plant height, plant width, pod number, seed number, seed color, and resistance to an unknown virus and to mildew. Seed is also being analyzed for protein, lysine, and methionine by the Agricultural Experiment Station Laboratories. Parent materials have been identified for breeding for improved plant type, early maturity, disease resistance and seed quality. Data on this experiment is being processed and will be published in the near future. Mr. Yohe is developing a diallele cross and will grow the segregating progeny in India for his thesis research.

Possibilities are being explored for developing and evaluating (in cooperation with the USDA) an enlarged germ plasm pool, developing an International Screening nursery, and for developing and distributing bulk hybrid pools to countries in Southeast Asia where the mungbean is an important pulse crop.

Our research has stimulated interest with a commercial company in Central Missouri that is utilizing imported mungbeans for bean sprouts in their processed foods. The possibility of producing mungbeans locally is being explored.

C. Development of Competence for Consultation and Services:

The 211(d) grant is making it possible for the International Professor and for other members of the staff to actively participate in a wide range of activities with International dimensions. Major activities participated in throughout the year by the International Professor which reflect development of competence for consultation and service are listed below:

(1) International Travel:

The International Professor made a return visit to India during February and March, 1971. During this visit he assisted Dr. Sinha in evaluation of the wheats at OUAT, Bhubaneswar. Also, he assisted Dr. Anderson and Dr. Prescott, Rockefeller Consultants in evaluating the 1700 strains in the Wheat Disease Screening Nursery. Superior lines were selected for harvest and will be included in the 1971-72 Nursery. Observations were also made of the mungbean varieties growing at Bhubaneswar and at Nayagarh, Orissa. Seed of ten cultivars, representing a range of plant types grown at Columbia, in 1970, were planted both at Bhubaneswar and Nayagarh. One strain, M221 from the USDA collection, which is being utilized by Mr. Yohe in his crossing

program due to its erect plant type and mildew resistance, was observed to be resistant to mildew at Nayagarh and also free of yellow mosaic virus. Strains of mungbeans grown at Nayagarh will be sent to Columbia for chemical analyses.

Wheat research nurseries were visited at IARI, New Delhi, and at PAU, Ludhiana. Conferences were held with both wheat and pulse breeders at IARI and Ludhiana.

The International Professor gave a seminar at OUAT, Bhubaneswar; participated in a review of the Department of Agricultural Botany, OUAT; participated in a symposium on "National Agricultural Research Systems" organized by ICAR and the Agricultural Development Council; participated in a symposium on "The Green Revolution - The Next Phase" organized by ICAR and featuring a lecture by Dr. Norman Borlaug; and attended a "District Conference of Wheat Workers" at Ludhiana. The latter trip was made with Dr. Glen Anderson, wheat consultant with the Rockefeller Foundation.

Enroute to India the International Professor visited Kew Gardens, London, regarding the proposed change in genus designation for the mungbean, and the Regional Pulse Research Project, Teheran and Karaj, Iran. Returning he conferred with the plant breeders in the Crop Experiment Station, Rural Development Division, Ministry of Agriculture, Suwon, Korea. This visit was made at the request of Mr. Allan Sudholt, Rural Development Officer, USAID, Korea.

In Delhi and enroute discussions were held regarding mungbean research with AID officials from Pakistan, Indonesia, and Korea; and with the Director, Indonesia Agricultural Research Organization, Bogor, Indonesia; Director of Research, University of the Philippines, Los Banos; and Director, Rice Department, Bangkok, Thailand.

Seeds of mungbeans were collected in the market at Bhubaneswar, Calcutta, Delhi, Bangkok, Hong Kong, and Seoul. Arrangements were made for exchanging germ plasm collections with research workers in Iran, the Philippines, and Korea.

(2) Lectures and Seminars:

In addition to the Seminar given at OUAT, Bhubaneswar, the International Professor gave the following lectures during the 1970-71 year:

"Plant Breeding and the Green Revolution," at the seminar on "Utilization of Soil-Water-Plant Resources in World Food Production," Ohio State University, July 8, 1970.

"World Food Production - with Focus on India," American Society of Agronomy, Visiting Scientist Lecture Series. Midland Lutheran College, Fremont, Nebraska, Nov. 11, 1970.
Central College, Pella, Iowa, Nov. 16, 1970.
Wichita State University, Wichita, Kansas, Nov. 20, 1970.
Arkansas College, Batesville, Arkansas, January 14-15, 1971.

Mr. John Yohe, Graduate student on the 211(d) program presented a talk on "Breeding Mungbeans, a High-Protein Food Crop in India" to the Missouri Academy of Science, Springfield, Missouri, April 23, 1971.

(3) Consulting:

The International Professor was invited to meet and advise with the plant breeding staff of the Crop Experiment Station, Suwon, Korea, on the breeding of wheat and barley. This visit was made on the return trip from India.

Acknowledgement must be given to many other staff members for their contributions to the increased competence of the Agronomy Department in the area of International Agriculture. The Chairman, Dr. Roger L. Mitchell has supported the 211(d) program vigorously. Staff members returned from tours in India are contributing to this effort. Professors Sechler and Upchurch are organizing a course in International Agronomy. Professors Falloon and Murphy are developing the seminar for foreign students, "Philosophy of Extension." Dr. Kimber is consulting on nuclear techniques in plant breeding and genetics with IARI under FAO auspices. Dr. George E. Smith served on a team of American scientists in Yugoslavia studying "Balkan Nephropathy" under the auspices of the Public Health Service, HEW. Several Agronomy members are serving on the College of Agriculture task force on International Agriculture. Dean Elmer Kiehl, College of Agriculture has also given full support to the 211(d) program.

D. Involvement of Other University Resources:

The purpose of the 211(d) grant was to make it possible to initiate teaching and research in plant breeding with international dimensions. A program of this nature is often difficult to initiate and implement in a state financed institution, but once established and the value recognized it may then become an ongoing program within the institution and serve as a catalyst to stimulate local support. It was this philosophy which generated the present 211(d) program. Considering the small size of the grant and the limitations on its utilization, revolutionary changes may not be expected immediately. However, there are several important actions which demonstrate that the University of Missouri, Columbia, does consider teaching and research in international agriculture a legitimate function.

Some of these are as follows:

- (a) The University has assumed one-half of the salary of the International Professor during the 1970-71 fiscal year.
- (b) The Agriculture Experiment Station is funding a project on "Breeding Agricultural Crops of India."
- (c) The Agricultural Experiment Station has developed and presented to USAID a proposal for "Developing an International Mungbean Project."
- (d) The Agricultural Experiment Station Chemical Laboratories assumed 40% of the costs of analyzing the 1970 mungbean samples for protein, lysine and Methionine.
- (e) Computer Service has been supplied for processing mungbean data without cost to the project.
- (f) Additional books on international agronomy and plant breeding are being added to the University Library.

The expenditures by UMC will exceed \$30,000 for the current fiscal year.

IV. EXPENDITURES:

The original budget, actual expenditures for 1968-69, 1969-70, and 1970-71 fiscal years, and projected expenditures through 1973 (assuming no increase in funding is given below.

	Original Budget	1968 -69	1969 -70	1970 -71	1971 ^a -72	1972 ^a -73	Totals
Salaries	114,000	24,209 ^b	25,445	16,313	20,000	24,000	109,967
Stipends	52,000		4,229	7,580	8,800	10,000	30,609
Travel	21,000	986	1,217	1,367	11,300	10,000	24,870
Equipment, supplies, Misc.	<u>13,000</u>	<u>9</u>	<u>237</u>	<u>11,968</u>	<u>5,000</u>	<u>4,075</u>	<u>21,289</u>
Subtotals		25,204	31,128	37,228	45,100	48,075	186,735
International tickets (est.)		<u>1,350</u>	<u>1,300</u>	<u>1,365</u>	<u>5,900</u>	<u>3,350</u>	<u>13,265</u>
Totals	200,000	26,554	32,428	38,593	51,000	51,425	200,000

^a Estimated

^b Includes stipends paid in 1968-69.

^c Equipment, Supplies and Miscellaneous:

- (1) Equipment purchased in 1970-71 with cost in excess of \$100:
3 Growth Chambers, Model CEL 25-7 HL, from Sherer-Gillett, Marshall, Michigan, at cost of \$8,850 and installation charges by UMC Physical Plant (\$1434).
- (2) Chemical analyses of mungbean samples (\$1320).

The extension of the budget through 1973 shows less expenditure for salaries and stipends and higher expenditures for travel and equipment than the original budget. This change reflects the assumption of one-half of the salary of the International Professor beginning with the 1970-71 fiscal year, restructuring in allocation of overseas travel costs of the graduate students, and the purchase of three growth chambers.

V. WORK PLAN

A. For 1971-72 and 1972-73 Assuming No Increase or Extension of Project:

Plans call for Mr. Yohe and family to go to India to conduct thesis research in 1971-72 and for Mr. Watt and family to go to India in 1972-73.

Two additional graduate students will be added for M.S. thesis work but they will not complete course work in time to go to India unless an extension of the grant is made.

The International Professor will travel to India in each of these years to supervise and evaluate the research of the graduate students and to give further assistance to OUAT in their wheat and pulse breeding research.

The mung bean research will be continued with further evaluation of the USDA collection during 1971. Mr. Yohe is developing a diallele cross of contrasting plant types to grow and evaluate under Indian conditions. Preliminary research will be started to evaluate the photoperiod response of the mungbean strains utilizing the growth chambers to provide controlled environmental conditions.

B. For 1971-72 through 1975-76 with an Extension of the Present Project:

A proposal for extension of the 211(d) grant through 1975-76 has been prepared. If approved we would plan to continue and extend the program successfully initiated with the current grant. This extension would permit us to pursue vigorously the mungbean research with the objective of breeding improved strains for India (and other developing nations of Southeast Asia).

Basic studies would be conducted on the mungbean as graduate thesis research. These would involve genetic, breeding, cytologic, physiologic, and pathologic problems needed to further the breeding program.

We would plan to send one graduate student to India in each year to conduct thesis research and further the mungbean breeding program in Orissa. Nutritional aspects of the mungbean will be studied insofar as resources permit.

Linkages will be established with other CUSURDI Institutions on production, fertility, pathological, nutritional and marketing problems of the pulses, the solution of which would lead to increased production and nutritional value.

The proposed budget for the five-year period, 1971-72 through 1975-76 requests a grant of \$325,000. Approximately \$90,000 will be remaining from the current 211(d) grant at the end of the 1970-71 fiscal year so this will require \$235,000 additional funds.