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FIFTH ANNUAL TECHNICAL REPORT

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT, 211(d) GRANT

AID/csd-1921

to

UNIVERSITY OF MISSOURI, COLUMBIA

for period

June 1, 1972 to May 31, 1973

~~314-449-8222~~
~~882-2221~~

J. M. Poehlman, Project Director

Columbia, Missouri 314-882-~~2121~~ 3317

June 25, 1973

FIFTH ANNUAL TECHNICAL REPORT
U.S.A.I.D. 211(d) GRANT
UNIVERSITY OF MISSOURI, COLUMBIA
JULY 1, 1972 TO MAY 31, 1973

AID/csd-1921 June 15, 1973

TITLE OF GRANT: A grant to Develop Within the University of Missouri, Columbia, Specialized Competency in the Breeding of Agronomic Crops in India

GRANTEE: University of Missouri, Columbia

DIRECTOR: John M. Poehlman, Professor of Agronomy

A. STATISTICAL SUMMARY:

Original period of grant: June 1, 1968 to May 31, 1973* Amount: $200,000

Expenditures: For report year: $47,061 Accumulated: $175,231

Anticipated for 1973-1974: $13,000

*(This grant has been extended to May 31, 1975)

B. NARRATIVE SUMMARY:

The objective of this 211(d) grant was to develop expertise in the University of Missouri, Columbia, to conduct plant breeding research with international applications. Implementation was to be through an International Professor and graduate students who would develop theses studies on plant breeding problems relevant to developing countries. The initial focus was on India, but with the phasing down of the AID programs in India, the scope has been extended to include other developing countries. Teaching and research has been concentrated on the mungbean species (*Vigna radiata*), a widely grown but little researched pulse crop in Southeast Asia and other tropical countries, using it as the vehicle for involving students in research which would develop their capabilities to cope with a wide range of breeding problems.

In the mungbean research we have delineated the genetic variability of the species and studied the genetic parameters for high yield. By developing an International Mungbean Nursery, which in 1973 will be grown at more than 20 locations in 14 countries on four continents, we are reaching into both temperate and tropical environments and evaluating the climatic limitations to the adaptation of the species. Photoperiod responses of different strains at different latitudes are being verified by controlled environmental studies. Sources of disease resistance and other important characteristics are being identified. International cooperation and exchange of breeding materials has been fostered among mungbean research workers in many countries. These activities, made possible by this grant, have developed into a powerful teaching tool and provides evidence that developing expertise in the breeding of agronomic crops as envisioned in the grant objective is being accomplished.

FIFTH ANNUAL TECHNICAL REPORT OF USAID 211(d) GRANT
USAID/csd-1921
UNIVERSITY OF MISSOURI, COLUMBIA
JUNE 1, 1972 TO MAY 31, 1973

This grant is one of six separate disciplinary 211(d) grants made to the six U.S. Universities involved in Agricultural development in India. The six Universities and the field of concentration of the different grants are as follows:

University of Illinois: Identification, Causes, and Control of Agronomic Crop Diseases

University of Missouri: Breeding of Agronomic Crops

Kansas State University: Improved Grain Utilization

Ohio State University: Soil-Plant-Water Relationships

Pennsylvania State University: Crop Production and Management

University of Tennessee: Economic Issues of Agricultural Development

These six Universities individually and through the Council of United States Universities for Rural Development in India have had a growing interest in assisting the developing nations to improve their agricultural productivity and thereby contribute to the solution of the world food problem. They were bound together by the fact that each was engaged in agricultural university development in India. However, they were not able to exploit their potential due to the limitation on state resources being utilized for developing the expertise necessary to engage in agricultural research on an international basis. This need was recognized not only by the Universities, but also by the Agency for International Development and the U.S. Congress. Section 211(d) of the 1966 Foreign Assistance Act provided for the Agency for International Development to partially meet this problem by giving support to U.S. research and educational institutions for the purpose of strengthening their capacity to develop and carry out programs to improve the economic and social well being of less developed countries.

This series of 211(d) grants to the six Universities are unique in that (a) each was aimed at developing expertise in a separate discipline, (b) all grants were focused on India where each of the Universities were involved in agricultural development, and (c) all projects have recognized the desirability of joint planning to provide for greater cross linkages. During the current year the involvement of the U.S. University in Agricultural University development in India was phased out and it became desirable to redirect the geographic focus of the program in progress. Accordingly, activities of this project have evolved from a broad focus on plant breeding in India to a more specific focus on genetic improvement of one of the important pulse crops, the mungbean (*Vigna radiata* (L.) Wilczek). This redirection of effort has extended our involvement over a much wider geographic base than India alone.

II. Objectives of Grant

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 this grant are:

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 which would lead 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.

Review of objectives

The activation of the grant objectives has been built around a 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.

At the University of Missouri, where our charge was to develop expertise in plant breeding with international dimensions, we felt that the objectives could best be reached by involvement of the International Professor and the graduate students in a cooperative plant breeding project with an Indian Agricultural Research Institution. Initially, then, we developed plans to assist the Orissa (India) University of Agriculture and Technology in starting wheat and pulse breeding programs. As the project matured we have concentrated on a single pulse crop, mungbeans (*Vigna radiata* (L.) Wilczek). Later this has been extended to cooperating with mungbean breeders in other countries in order to broaden the informational base regarding this particular species. Through this approach we have rather emphatically accomplished the overall objective and have emphasized in varying degrees each of the specific objectives. The latter are integral facets of the general overall objective, hence, they are not amenable to being sorted out and worked on or even reported on separately to the exclusion of the others. Perhaps the greatest deterrent to reaching all of the specific objectives fully was the amount of the funds available. These were really too meager to achieve the sweeping objectives originally envisioned. Nevertheless, we are proud of the accomplishments which we could achieve by good husbandry of the funds available and by directing them toward reaching specific and important goals. These accomplishments will be detailed in Section III.

III Major Accomplishments (1972-73)

At the University of Missouri we are accomplishing the overall objective of this grant, "to increase. . .competency. . .to generate knowledge and render assistance in the international area of plant breeding" by active participation and involvement in plant breeding research on an international scale using the mungbean as the vehicle for this research. In the process we are generating new knowledge regarding the genetic potential and adaptation of this species, adding a broader perspective to our plant breeding staff and students and to cooperative mungbean breeders around the world, teaching graduate students to participate in internationally cooperative plant breeding activities, and increasing the competency of the University of Missouri, Columbia, agronomists to participate in these activities.

The grant program was initiated by the grant professor offering assistance to the Orissa University of Agriculture and Technology, Bhubaneswar, India, (where UMC had an AID Agricultural University Development contract) in development of wheat and pulse breeding projects. Later, the decision was made to concentrate on one pulse crop, mungbeans, which was the principal pulse crop in Orissa. From the extensive wheat improvement programs at CIMMYT (Mexico) and in India breeding materials were quickly assembled to initiate the wheat breeding research at Bhubaneswar. With mungbeans there was a paucity of basic information regarding the species, and a failure to assemble on a large scale genetically diverse materials to develop a broad based mungbean breeding program. In the process of searching for more diverse germplasms, and establishing parameters for identifying traits useful in evaluating performance, we have

fostered cooperation with a large number of mungbean breeders throughout the world. This activity has been a powerful teaching tool for the staff and students involved. It has broadened their knowledge of the genetic limits in a species, the ecological factors affecting adaptation, the climatic differences of different geographical areas as they affect species adaptation. Just as important we have demonstrated how progress can be made through international cooperation in agricultural research. In other words, it has been the key "to increase. . .competency, to. . .generate knowledge, and to render assistance in the international area of plant breeding."

In this report the accomplishments will be detailed by presenting (a) the activities of grant supported personnel in 1972-73, (b) the development of teaching competency, and (c) the development of research competency.

Activities of Grant Supported Personnel in 1972-73

In previous technical reports, Dr. J. M. Poehlman, Professor of Agronomy (Crop Breeding and Genetics), has been identified as the International Professor on this project. Professor Poehlman has continued to be identified with the 211(d) project in 1972 with one-half of his salary paid from the grant and the remainder from University of Missouri salary funds. During the year he taught two courses, Agronomy 325, "Field Crop Breeding", an undergraduate course in plant breeding, and Agronomy 425, "Development of Plant Breeding Concepts", a graduate level course. In addition he served as adviser to six graduate students, four of whom were supported by the 211(d) project. During this year the mungbean evaluation program was continued at Columbia, the First International Mungbean Nursery was grown, and a "Bibliography of Mungbean Research" published. Mungbean research workers were visited in Korea, Iran, India, Philippines, and Thailand. Three of the International Mungbean Nurseries (in Thailand, Philippines, and Korea) were visited. Arrangements were made during the visit to Thailand for a graduate student to conduct thesis research at the Northeast Agricultural Center during 1972-73.

Dr. John M. Yohe, who conducted research in India during 1971-72, completed his dissertation and received the Ph.D. degree. He presented a paper before the American Society of Agronomy at Miami in November, 1972 and recently has accepted a position with the University of Wisconsin team in Recife, Brazil, where he will conduct research on soybeans and other grain legumes.

Mr. Earl Watt, who received an M.S. degree in May, 1972, is spending nine months at the Northeast Agricultural Center, Khon Kaen, Thailand, working on his Ph.D. dissertation study. In addition he is growing the Second International Mungbean Nursery and evaluating a large number of strains of mungbeans from our collection. Mr. Watt's M.S. thesis was a study of height inheritance in semidwarf wheats.

Mr. Richard Swindell received an M.S. degree in May, 1973. His thesis study was concerned with heterosis and combining ability in mungbeans. Mr. Swindell will spend one month at the Asian Vegetable Research and Development Center in the summer of 1973 working with Dr. MacKenzie on their mungbean breeding program. He will continue his studies toward a Ph.D. degree in 1973-74.

Mr. Mohab M. H. Bashandi received an M.S. degree in May, 1973. For his thesis research, he studied the photoperiod reaction of mungbean strains under controlled environments in the growth chamber.

Mr. Mohamed Elmigra (a Libyan student supported by Friends of the Middle East) received his M.S. degree in August, 1973 with a thesis study on the relationship between coleoptile length and culm length in semi-dwarf wheats. This problem is relevant to his native Libya where wheats must be seeded deeply to reach moisture and under these seeding conditions the dwarf wheat seedlings may have difficulty in emerging from the soil due to their short coleoptiles. Mr. Elmigra is continuing graduate study toward a Ph.D. degree at the University of Arizona.

Teaching Accomplishments

In this period of time, with the increasing U.S. global involvements, both politically and economically, and with the important contribution of agricultural exports in stabilizing U.S. economy, it is no longer sufficient to teach only Missouri agriculture or even U.S. agriculture to our students. Rather, it is important that students have some knowledge of agricultural problems in all of the world including the tropics. An important aspect of the 211(d) program at the University of Missouri has been its contribution to the development of a broader teaching base, particularly in tropical agriculture which will become more important in overall world food production in the years ahead.

During 1972-73 there was taught for the first time at the University of Missouri, Columbia, a course in Tropical Agronomy. In this course the relationship of tropical climate agronomy was compared with temperate climate agronomy. Some of the lectures on the plant breeding section of the course were taught by Dr. Yohe, who as a 211(d) graduate student had developed competency for this from conducting thesis research in India. Competency for the major staff input into the course was developed by periods of service on the UMC-AID University Development and APP contracts in Orissa and Bihar State in India. The Department of Agronomy, also for the first time, co-sponsered a tour of undergraduate students to several Central American countries to study agronomic practices and livestock production in those countries.

Research Accomplishments

At the beginning of the grant period, the view was taken that research competency would be developed only by active participation of the Professor and his students in some international agricultural research activities.

Because the original grant was focused on India, the Orissa University of Agriculture and Technology, Bhubaneswar, India, was selected as the cooperating institution. OUAT was selected because UMC had an AID University Development contract with that University. Informal cooperation was established between Dr. Poehlman (UMC) and Dr. Sinha (OUAT) in wheat and pulse improvement. From the cooperative research thesis problems would be evolved that would be relevant to India. The mungbean was selected as the pulse crop on which to work. Later the mungbean research was expanded to other countries in Southeast Asia and subsequently to South America and Africa.

1. Research on wheat

The assistance given by the International Professor to OUAT in developing a wheat breeding program has been detailed in the Third and Fourth Annual Technical Reports of this project. Breeding materials from CIMMYT and India were quickly assembled, major breeding objectives identified, and crosses made among Indian, Mexican and U.S. varieties. It was quickly observed that Helminthosporium leaf spot was a major disease of wheat in Orissa and that the Mexican varieties were susceptible to this disease. Greatest tolerance was observed in U.S. spring varieties and in segregates from crosses with U.S. winter varieties. This research is being continued by Dr. Sinha in India. Dwarf winter-type segregates from crosses between U.S. soft red winter varieties from Missouri and Mexican spring wheat hold promise for Missouri and are being continued in the nursery at Columbia by Dr. Dale T. Sechler. Since the utilization of the dwarf wheats in Missouri may necessitate changes in cultural practices for growing wheat, two thesis studies on this problem have been conducted by M.S. students under Dr. Sechler's guidance. This is an example of how research initiated in India has broadened our research program and may ultimately make important contributions to Missouri as well as Indian agriculture. In 1972-73 additional crosses were made both at Columbia and in Orissa between U.S. winter and Mexican-Indian spring varieties. These are being evaluated for potential of the spring segregants in Orissa and the winter segregants in Missouri.

2. Research on mungbeans (*Vigna radiata* (L.) Wilczek)

As the grant program has developed, the major research thrust has been directed toward the research on mungbeans. At the beginning of this grant it was evident to me that the cereals had been given major attention in the international breeding programs and that the pulses had been neglected. This view was shared by Dr. Sinha at OUAT. In the summer of 1969 we grew several of the important pulse crops at Columbia in order to view their potential and adaptation in Missouri's climate. The mungbean proved to be the most productive (excluding soybeans if the latter is included as a pulse). The mungbean was the principle pulse grown in Orissa State, India, where it is a favored pulse for eating and does not require commercial processing. Furthermore, production practices there are known to the cultivator. Since our resources were small, it was believed that

the greatest impact could be made by concentrating on a single species. Prior research on the mungbean was meagre, hence any contribution to the knowledge about this species would be useful. All of these considerations led us to select the mungbean as the pulse species on which to concentrate our efforts.

In retrospect we believe this was an excellent choice. The mungbean is a more widely adapted crop and has greater native productivity than originally suspected. It is the most widely grown pulse in Eastern India, Cambodia, Thailand and the Philippines, and has proven highly productive in Colombia in South America and Ethiopia in Africa. Its movement in the world market is increasing, 17 million pounds were imported into the U.S. in 1972.

Our research began by obtaining 321 strains from the USDA and other sources and these were grown at Columbia in 1970, in Orissa by Mr. Yohe in 1972, and in Thailand by Mr. Watt in 1973. Our collection has subsequently grown to nearly 600 strains by introductions obtained from India, Thailand, Philippines, Canada, and other areas. As our research with the mungbean became known, requests for seed came from the Philippines, Thailand, South Vietnam, Australia, Ethiopia, Nigeria, Colombia, and other countries and we have distributed seed of the higher yielding lines to mungbean research workers in all of these countries. In each case we requested that information obtained from growing these strains be returned so that we could evaluate their performance over a wide range of environments. We have been immensely pleased by the care with which observations have been taken and the response we have received as measured by the data returned.

As data was returned to us from the above nurseries, several observations became clear. When grown at the lower latitudes the strains tended to be early, short, and relatively less productive in comparison to local varieties. This led to the conclusion, not unexpected, that the varieties being identified at Columbia, Missouri, for high performance were not necessarily the best adapted varieties in the low latitudes. Therefore, to learn more about adaptation we, in 1972, developed the First International Mungbean Nursery in which were included 28 strains with a range in flowering at Columbia, Missouri, of 37 days. This nursery was grown in 1972 at nine locations ranging from approximately 3 to 49 degrees north latitude. Data from this nursery is now being summarized and will provide information on the range of adaptation of specific strains in comparison with local check varieties. The Second International Mungbean Nursery has been developed along similar lines and distributed in 1973 to 24 test sites in 14 countries throughout North and South America, Asia, and Africa. Some of the local strains found to be superior in 1972 are included in the 1973 nursery. The increased number of locations in 1973 came almost exclusively as a result of mungbean research workers requesting seed so that they could participate in growing the nursery.

We have demonstrated that mungbean varieties differ in their photoperiod sensitivity by growing a series of strains in environmental controlled growth chambers with effective light periods of 12, 13, 14, 15, and 16 hours. With a 12-hour photoperiod all varieties flower in approximately the same number of days. Some varieties are relatively photoperiod

insensitive, with only a slight increase in number of days to flowering as the photoperiod is increased. With other varieties the flowering is greatly delayed as the photoperiod is increased to 13, 14, or 15 hours. Some varieties did not flower in a 180-day period with a 16-hour photoperiod. This information was obtained in the M.S. thesis study of Mr. Mohab Bashandi.

A heterosis study was conducted as an M.S. thesis problem by Mr. Richard Swindell. Significant heterosis of F_1's over parents was observed for seed yield, leaf size, height, branch length, pods per plant, and seeds per pod. Heterosis was not observed for days to flower and seed weight. The F_1 of the cross, M101 x M90, significantly exceeded the yield of the higher parent, M101, which was also the highest yielding parent in the experiment.

Five strains of mungbeans selected for diversity of plant type were crossed in all combinations by Dr. John M. Yohe for his Ph.D. dissertation study. As in Mr. Swindell's study, M101 was the highest yielding parent and had the highest yielding general combining ability. M101, however, has an undesirable prostrate plant type. Parent M277 which had an upright plant type had the highest general combining ability for height, and parents M277 and M304 each had negative general combining ability for branch length. From these combining ability studies one would predict that a broad range of segregants with erect plants and short branches might be obtained from the crosses M277 x M299 and M277 x M304. This in fact did occur and lines with these characteristics were selected and will be evaluated further.

For his Ph.D. dissertation study Mr. Earl E. Watt crossed local strains from Orissa, India, which have resistance to bean yellow mosaic virus (BYMV) and small seed size with strains from our collection superior in yield and seed size. The objective was to combine resistance to BYMV and large seed size into a productive line. Since the BYMV is not present in Missouri Mr. Watt planned to grow the segregating generations in India where BYMV is a widespread and serious disease. With the phasing out of the AID programs in India this was not possible, so he is growing them in Thailand instead. We are not sure at this time whether BYMV will be present in Thailand with sufficient intensity to enable him to identify accurately the resistant segregants.

Another significant contribution has been the identification by Mr. Swindell and Mr. Watt of a natural tetraploid strain which has shown near immunity to mildew, a foliar disease, in Missouri and Orissa, and resistance to BYMV in Orissa.

IV Impact of Grant Supported Activities in Developing Institutional Capabilities

The impact of the grant supported activities in developing the capabilities of the Department of Agronomy of the University of Missouri, Columbia, to conduct plant breeding research on an international scale has been far reaching. Some of the benefits may be earily documented;

others, while no less real, are less visible. At the outset it must be recognized that, considering the size of the grant, no major change in the contour of the institution would be made, and that a major impact may be expected only in the target area, which in this case is the area of plant breeding.

Our initial thrust, viz. to utilize the 211(d) grant to become involved in an international plant breeding activity, has developed into a powerful teaching tool. In our case the mungbean, a widely grown[1] but little researched pulse crop, has become the vehicle through which we can teach not only the subject matter of plant breeding but also the principles of international cooperation. It has enabled us to transcend the traditional state and regional boundaries, which distinguishes much agricultural research, and to reach into all continents and into both temperate and tropical environments. The development of the International Mungbean Nursery has permitted us to evaluate the genetic potential of specific strains on a global basis and to identify parameters for defining the characteristics that contribute to adaptation. This is made possible by the wholehearted cooperation of mungbean research workers in many countries who are willing to contribute their efforts in return for the benefits that will accrue to their breeding programs.

How does this contribute to UMC capabilities? Such contributions are difficult to measure objectively. Capability is demonstrated by 'doing', and by 'doing' capability is enhanced. I would submit the fact that we are now 'doing' the activities described in this report is the most important testimonial that we could make to the impact of the 211(d) grant on UMC's institutional capabilities in international plant breeding.

V Utilization of Institutional Resources in Development

Following is a partial list of the contributions that UMC has made to developmental activities in the subject matter area of the grant.

1. Distribution of seed lots of mungbeans other than International Mungbean Nursery. (Detailed list is attached to this report)

2. Organization of International Mungbean Nursery and distribution of seed lots. (List of cooperators in 1972 is attached to this report)

3. Published a Bibliography of Mungbean Research.

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[1]The mungbean is the leading pulse species in certain states of India, Burma, Cambodia, South Vietnam, Thailand, and the Philippines, and is also grown in Korea, Pakistan, Iran, Taiwan, Peru, and other countries in South America and Africa.

4. Visitors in 1972 to see mungbean plots or discuss mungbean research:

Mr. Harry H. Stine, Stine Seed Farms, Adel, Iowa
Mr. Wm. Huntsman, Banquet Foods, Moberly, Missouri
Mr. Steve Mason, Mennonite Control Committee, Port-au-Prince, Haiti
Mr. J. Richard Lockman, Technical Services Ass'n., Lahore, West Pakistan
Mr. Mohammad Noory, Ministry of Agriculture, Afghanistan

5. Foreign students who have completed degrees in plant breeding at UMC during the past year:

Mohamed R. Elmigra (Libya), M.S. (J. M. Poehlman, adviser)
Bong-Ho Choi (Korea), Ph.D. (Marcus Zuber, adviser)
Alvareo Bueno (Brazil), M.S. (Dale T. Sechler, adviser)
Soontorn Duangploy (Thailand), M.S. (Dale T. Sechler, adviser)
Patrick N. Egharevba (Nigeria), Ph.D. (Duane Horricks, adviser)

6. Consulting:

Dr. Dale T. Sechler served as consultant in Agronomy on an UMC-AID Sector Study in Tanzania.

7. Dr. John M. Yohe, former 211(d) student on this project has accepted a position as legume breeder on the AID-University of Wisconsin project in Recife, Brazil.

8. Mr. Earl E. Watt, 211(d) student in Thailand, in cooperation with Dr. Arwooth Nalampang, Grain Legume Section, Ministry of Agriculture, Thailand, has collected over 100 local Thai strains of mungbeans. All of the strains will be accessioned into the U.S.D.A. Plant Introduction Collection.

VI Other Resources for Grant-Related Activities

The following are examples of use of non-grant funds to support the activities reviewed in this report. All of the funds were supplied by the University of Missouri.

a. One-half of salary of the International Professor.

b. An experiment station project on breeding agronomic crops with international dimensions.

c. Computer facilities for processing data.

d. Office space, office supplies, photo copy work and secretarial help for International Professor and graduate students.

e. Library facilities for International Professor and Graduate students.

f. Field plots, plant and harvesting equipment, crop drying facilities, irrigation equipment, etc.

VII Next Years Plan of Work and Anticipated Expenditures

Currently, Mr. Earl Watt is working on his Ph.D. thesis research in Thailand. He will return to the U.S. at the end of August and will continue his graduate studies with an anticipated date of completion of August, 1974.

Mr. Richard Swindell, a Ph.D. candidate, will spend the month of August at the Asian Vegetable Research and Development Center, Taiwan, working with Dr. David MacKenzie on his mungbean breeding research. Enroute he will visit International Mungbean Nurseries in Korea, Thailand, and the Philippines.

Mr. Wacharia, a student from Thailand, sponsored by the University of Kentucky-USAID team at the NEAC, Khon Kaen, Thailand, will start on an M.S. thesis study on mungbeans at UMC.

Mr. V. D. Aggarwal, from India, will be starting a Ph.D. program with thesis research on mungbeans.

The International Mungbean Nursery, started in 1972, will be continued with costs supported by a new USAID contract. We will continue the evaluation of new strains being received from the USDA Plant Introduction Station, Experiment, Georgia, from India, and from the collection made by Mr. Watt in Thailand. Also, we expect to obtain many new strains from AVRDC as a result of Mr. Swindell's visit there this summer with Dr. MacKenzie.

The anticipated budget for 1973-74 and 1974-75 is given in Table III.

VIII Report of Expenditures

Expenditures for the current review period (June 1, 1972 to May 31, 1973) and the cumulative totals are reported in Table II. The salary item includes one-half the salary of the International Professor and miscellaneous labor utilized during the year in the mungbean research. Graduate student stipends were paid to Mr. John M. Yohe, Mr. Earl E. Watt, and Mr. Richard Swindell. Travel costs included part of the cost of Mr. Yohe returning from India, travel expense and per diem for Mr. Watt in Thailand, and international travel by the International Professor to arrange for Mr. Watt to work in Thailand. Also, some of the international tickets purchased earlier from rupee funds were charged back to the grant during the current year. Equipment costs included two-thirds of the cost of a pick-up truck used to provide transportation to the Bradford farm where graduate students conduct much of their thesis research.

Table I

Distribution of 211(d) Grant Funds and Contributions from Other Sources of Funding*

Institution: University of Missouri, Columbia
Grant: AID/csd-1921 Amount of Grant: $200,000
Period of Grant: June 1, 1968 to May 31, 1973
Review Period: June 1, 1972 to May 31, 1973

Grant Related Activity	211(d) Expenditures				Non 211(d) Funding
	Period Under Review	Cumulative Total	Projected		
			1973-74	1974-75	
Teaching	9,000	55,000	500	500	10,000
Research	19,289	71,890	3,800	2,869	10,000
Graduate Student Training	18,772	48,341	8,700	8,400	5,000
Totals	47,061	175,231	13,000	11,769	25,000

*Estimated

Table II

Expenditure Report

Institution: University of Missouri, Columbia
Grant: AID/csd-1921 Amount of Grant: $200,000
Period of Grant: June 1, 1968 to May 31, 1973
Review Period: June 1, 1972 to May 31, 1973

Budget Line Item	Original Budget	Expenditures to Date					Cumulative Total
		1968-69[a]	1969-70[a]	1970-71[a]	1971-72[b]	1972-73[c]	
Salaries	114,000	24,209[d]	25,445	16,593	15,603	19,822	101,672
Stipends	52,000		4,229	7,300	7,223	11,950	30,702
Travel	21,000	986	1,217	1,367	8,860	10,209	22,639
Equipment, Supplies, and Miscellaneous	13,000	9	236	11,825	3,068	5,080	20,218
Totals	200,000	25,204	31,127	37,085	34,754	47,061	175,231
Unexpended Balance							24,769

[a]Expenditures for 12-month period July 1 through June 30.
[b]Expenditures for 11-month period July 1 through May 31.
[c]Expenditures for 12-month period June 1 through May 31.
[d]Includes stipends paid in 1968-69.

Table III

Projected Expenditures for the Extended Grant Period

Institution: University of Missouri, Columbia
Grant: AID/csd-1921 Amount of Grant: $200,000
Period of Original Grant: June 1, 1968 to May 31, 1973
Period of Grant Extention: June 1, 1973 to May 31, 1975
Amount Expended During Original Grant Period: $175,231
Balance Remaining to be Expended During Extended Grant Period: $24,769

Budget Line Item	Projected Expenditures for Period		
	1973-74[a]	1974-75[a]	Totals
Salaries	500	500	1,000
Stipends	8,700	8,400	17,100
Travel	2,200	1,000	3,200
Equipment, Supplies, and Miscellaneous	1,600	1,869	3,469
Totals	13,000	11,769	24,769

[a]Expenditures for 12-mongh period June 1 through May 31.

APPENDIX I

LIST OF PUBLICATIONS

Institution: University of Missouri, Columbia
Grant: AID/csd-1921
Grant Period: June 1, 1972 to May 31, 1973

Bashandi, Mohab M. H. Studies on photoperiodic responses of mungbean, *Vigna radiata* (L.) Wilczek. M.S. Thesis, University of Missouri, Columbia. 1973.

Narain, A., S. K. Sinha, B. K. Mahapatra, Dale T. Sechler, and J. M. Poehlman. Incidence of Helminthosporium blight on wheat in Orissa State, India. Plant Disease Reporter 57:278-280. 1973.

Poehlman, J. M. and Freda Fu-Mei Yu-Jean. Bibliography of mungbean research. University of Missouri Special Report 184. 15 p. 1972.

Swindell, Richard E. Heterosis and combining ability in mungbean, *Vigna radiata* (L.) Wilczek. M.S. Thesis, University of Missouri, Columbia. 1973.

Swindell, Richard E., Earl E. Watt, and Garath M. Evans. A natural tetraploid of suspected amphidiploid origin. Journal of Heredity (In Press) 1973.

Watson, David. 211(d) program strengthens research capabilities. Newsletter, UMC Center for International Programs and Studies. Vol. 2 (No. 2):1, 4. 1973.

Watt, Earl E., Richard E. Swindell, John M. Yohe, Mohab M. H. Bashandi, Dale T. Sechler, and J. M. Poehlman. Evaluation of mungbean (*Vigna radiata* (L.) Wilczek) strains at Columbia, Missouri, in 1972. University of Missouri, Columbia, Department of Agronomy, Miscellaneous publication no. 73-6. 1973.

Yohe, John Milton. Plant type, yield, and components of yield in mungbeans, *Vigna radiata* (L.) Wilczek. Ph.D. dissertation, University of Missouri, Columbia. 1973.

Yohe, J. M., Richard E. Swindell, and J. M. Poehlman. Parameters for varietal evaluation and adaptation in mungbean, *Vigna radiata* (L.) Wilczek. Agronomy Abstracts. p. 192. 1972.

ALSO ANNUAL REPORT STATES: "PUBLISED A BIBLIOGRAPHY OF MUNGBEAN RESEARCH" DURING 1

APPENDIX II

MUNGBEAN ACCESSIONS DISTRIBUTED[a]

Date	No. Strains	To Whom Sent
6/ 9/71	50	Crops Experiment Station, Suwon, Korea
9/16/71	50	College of Agriculture, U. of Philippines, Los Banos, Philippines
9/16/71	50	International Rice Research Institute, Los Banos, Philippines
9/16/71	50	C.I.A.T., Cali, Colombia
9/16/71	50	IITA, Ibadan, Nigeria
10/15/71	321	Pulse Research Station, Nayagarh, Orissa, India
10/15/71	50	Ministry of Agriculture, Bangkok, Thailand
10/22/71	228	Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma
1/24/72	198	USAID/Vietnam (through Dr. H. L. Hyland, USDA, Beltsville, Maryland)
3/ 9/72	50	Pilot Farm Project, Kalasin, Thailand
3/ 9/72	218	Ohio Agricultural Research and Development Center, Wooster, Ohio
5/ 9/72	24	Research Station, Morden, Manitoba, Canada
7/26/72	60	USAID/Philippines (Dr. Allan D. Hankins)
7/26/72	60	USAID/Honduras (Dr. Harold D. Koone)
12/ 5/72	226	Northeast Agricultural Center, Tha Phra, Khon Kaen, Thailand (Mr. Earl Watt)
1/15/73	272	Plant Introduction Office, Darwin, Australia
5/ 2/73	100	Crop Science Department, U. of Saskatchewan, Saskatoon, Canada
5/ 2/73	25	Pulse Research Station, Nayagarh, Orissa, India

[a]Does not include First and Second International Mungbean Nurseries.

APPENDIX III

DISTRIBUTION OF INTERNATIONAL MUNGBEAN NURSERIES

First IMN, 1972 (28 strains)

Research Station, Morden, Manitoba, Canada (B. B. Chubey)
Centro Nal. de Investigaciones Agro., Palmira, Colombia (Edgar G. Acuna)
Horticultural Research Station, Melkassa, Ethiopia (Lars Ohlander)
Research Station, Melka Werer, Ethiopia (Lars Ohlander)
Agri. Expt. Station, Debre Zeit, Ethiopia (Donald Schmidt)
IRRI, Los Banos, Philippines (Richard Harwood)
Crops Experiment Station, Suwon, Korea (Mr. Park)
Pilot Research Farm, Kalasin, Thailand (Manope Pavakul)
University of Missouri, Columbia, Missouri U.S.A. (Earl E. Watt)

Second IMN, 1973 (28 strains)

Research Station, Morden, Manitoba, Canada (B. B. Chubey)
Crop Science Dept., Univ. of Saskatechwan, Saskatoon, Canada (A. E. Slinkard)
Centro Nal. de Investigaciones Agro., Palmira, Colombia (Edgar G. Acuna)
Horticultural Research Station, Nazareth, Ethiopia (Lars Ohlander)*
Mennonite Central Committee, Port-au-Prince, Haiti (Steve Mason)
USAID/Honduras (Harold D. Koone)
Pulses Research Station, Nayagarh, Orissa, India (R. C. Misra)
Punjab Agricultural University, Ludhiana, Punjab, India (K. B. Singh)
University of Tehran, Faculty of Agriculture, Karaj, Iran (M. C. Amirshahi)
Crops Experiment Station, Suwon, Korea (Keun Yong Park)
Technical Services Assn., Lahore, West Pakistan (J. Richard Lockman)
IRRI, Los Banos, Philippines (Richard R. Harwood)
AVRDC, Shanhua, Tainan, Taiwan (David MacKenzie)
Northeast Agricultural Center, Tha Phra, Khon Kaen, Thailand (Earl E. Watt)
Dept. of Agriculture, Suphan Buri, Thailand (Supachai Bangliang)
Northern Agri. Develop. Center, Chiengmai, Thailand (Manope Pavakul)
Oklahoma Agricultural Expt. Sta., Stillwater, Oklahoma, U.S.A. (J. S. Kirby)
Stine Seed Farms, Adel, Iowa, U.S.A. (Harry H. Stine)
University of Missouri, Columbia, Missouri, U.S.A. (J. M. Poehlman)
Alabama A. and M. University, Normal, Alabama, U.S.A. (V. T. Sapra)
USAID/Vietnam (A. Hartman)

*Seeds for four nurseries were sent to Ethiopia.