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Supplementary Information

Collaborative Research Support Proposal Grain Sorghum And Pearl Millet

Part II of the Final Report
Work Order No. 4, Contract AID/AFR-C-1139
United States Agency for
International Development
and
University of Missouri

March 1978

P A R T II

GRAIN SORGHUM/PEARL MILLET COLLABORATIVE RESEARCH SUPPORT PROGRAM

AID/AFR-C-1139 W/O #4

PREPARED BY

UNIVERSITY OF MISSOURI-COLUMBIA

COLUMBIA, MISSOURI 65201

FOR

JOINT RESEARCH COMMITTEE

BOARD FOR INTERNATIONAL FOOD AND AGRICULTURAL DEVELOPMENT

AGENCY FOR INTERNATIONAL DEVELOPMENT

DEPARTMENT OF STATE

WASHINGTON, D. C.

MARCH, 1978

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PART II

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FOLLOWED

IN THE PLANNING PROCESS

D. SUMMARY OF PROCEDURES FOLLOWED IN THE PLANNING PROCESS

The planning process was divided into two distinct phases.

Phase I covered (a) the identification of the principal constraints, (b) a summarization of the most urgent research needs, and (c) concluded with the preparation of the Interim Report and the Invitation to participate in the Collaborative Research Support Program on Grain Sorghum/Pearl Millet.

Phase II covered (a) the planning of the Sorghum/Millet Research Program, (b) an assessment of the research proposals, and (c) recommendations for implementation of the program.

THE METHODOLOGY UTILIZED IN PHASE I

The methodology of Phase I was presented in detail in the Interim Report and is summarized here.

Overall Summary.

The basic elements of the methodology to identify the principal constraints were established at a meeting of the Ad Hoc Planning Committee[1] constituted under the terms of the scope of work for developing a proposed CRSP on GS/PM.

The methodology involved three general steps:

(1) Survey questionnaires were administered to knowledgeable scientists to obtain quantified information on (a) constraints to GS/PM production and utilization in LDC's, and (b) the present level

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[1]Made up of knowledgeable scientists from the University of Missouri, Columbia, and U. S. institutions with know strong research programs in the subject matter, plus designated liaison personnel with BIFAD, JRC, and AID, and a representative of ICRISAT.

of scientific knowledge concerning such constraints.

(2) Site visits were made to selected U. S. and foreign institutions with a manifest interest in GS/PM research programs to gain qualitative insights not possible from quantified questionnaire responses.

(3) A day long workshop of an institution-wide, internal committee of scientists (composed of interviewer/site visitor scientists, and other knowledgeable UMC scientists collaborating in the planning effort) was held to interpret, integrate, and summarize the results of steps (1) and (2).

Selection of Scientists to be Contacted.

The sample of scientists to be contacted or interviewed were selected as follows:

1. Names were solicited from the directors of the experiment stations and the administrators of research in all eligible institutions of faculty who would represent the interest of that institution in a research program related to GS/PM production and utilization in the Less Developed Countries.

2. The ad hoc planning committee compiled a preliminary list of names of scientists which the committee members felt might be missed in step 1., above.

3. Respondents to the questionnaire were asked to name other scientists who had an interest in and knowledge about the subject matter.

4. During site visits scientists whose names appeared on the list and other knowledgeable persons were contacted.

Selection of Sites for Visit.

Selection of institutions for personal visits was made by an eight-member UMC internal planning group, based on (1) responses to

the letters sent to directors and administrators of research, (2) the level of expenditures for GS/PM agricultural research by responding institutions (from budget data from "Inventory of Agricultural Research," FY 1975, USDA, Volume II, Table II, B, pages 36-63), (3) location of persons judged to be sufficiently knowledgeable and experienced to merit personal interview, and (4) time constraints to which this planning process is subject.

The institutions visited for purposes of gathering constraint questionnaire information and of learning about research underway are listed in Section E of this Report.

During site visits to U. S. institutions, the questionnaires were explained and distributed to knowledgeable scientists. This procedure resulted in 90 responses.

Upon completion of the first group of visits, the internal planning group made further selections of U. S. institutions for site visits, and selected foreign institutions and agencies in LDC's to be visited. Interviews and site visits were completed by December 16, 1977.

Workshop Procedure.

As interviews and site visits were completed, the information on the constraints questionnaire was collated and summarized. Three additional kinds of information were available among the University of Missouri group, namely: (1) information gained from the site visits outside the constraints questionnaire; (2) several interviewers used the constraints questionnaire to summarize interviews, drawing quantitative conclusions based on their overall impressions and understanding resulting from the interviews and site visits; and

(3) members of the group studied written materials, both published and unpublished, relevant to the subject. In addition, one faculty member participated in a five day worldwide conference on millet held at ICRISAT and collected manuscripts from a similar conference on grain sorghum.

In total, twenty-one University of Missouri faculty members representing eight subject matter departments were involved in questionnaire interviews, site visits, literature reviews, CRIS reviews, and seminar discussions.

The day long workshop (December 20) was organized to bring together the understandings of these faculty members and to apply their combined judgment to the relevance and significance of the constraints identified and under consideration.

Summary of Workshop Evaluation by Interviewers and Internal Scientist Committee.

The constraints data were collected from three sources:

1. Literature of the field including CRIS project reports.

2. Constraint questionnaires filled out by scientists knowledgeable on grain sorghum/pearl millet.

3. Observations and information collected by teams of scientists in visits to U. S. and foreign research institutions.

The information collected was brought together in a workshop attended by 20 UMC scientists, including those who visited the U. S. and foreign institutions. The constraint form was used as the guide for the workshop deliberations. In order to make judgments relevant to the different areas of the world, the seven ICRISAT GS/PM regions

(West Africa, East Africa, South Africa, Asia, Middle East, South America, and India) plus the U. S. were used (Table D-1). Each major area was discussed from results of the constraints questionnaires and observations of site visit teams. From the discussions it was found necessary to make some modifications in the constraint categories.

Each constraint category was assigned a numerical rating for each major region in columns as follows:

Column A = Rating of the importance of the constraint category.

Column B = Rating of level of knowledge and programs underway.

The key to the rating system is:

A. The importance of the problem or constraint.

1. Problem or constraint of little importance
2. Problem or constraint of only periodic importance
3. Problem or constraint important in some local situations
4. Problem or constraint of wide-scale importance

B. Level of present knowledge and programs underway to gain necessary knowledge.

0. Problem or constraint solvable by transfer of technology, a crop production or development program required
1. Local information satisfactory, some other studies may be advantageous
2. Strong program underway that should generate necessary knowledge, may need some refinement
3. Only preliminary information available, major thrust is required
4. No local information available, a need to initiate new or relatively new research efforts

Agreement of the workshop participants was unanimous, or at least in substantial agreement for each of the ratings.

The results of the workshop ratings of the constraint categories for each of the ICRISAT regions (plus the U. S.) are given in Table D-2.

Evaluation of Methodology Utilized.

Experience in implementing the methodology described has resulted in some conclusions as to its strengths and weaknesses. Many of the weaknesses have been corrected in the ensuing planning period. It was the judgment of the planning institution that the results are an accurate representation of the problems and priorities to be addressed by a CRSP on GS/PM production and utilization in LDC's.

The substantial merit and strength of the methodology utilized is that it achieved as near complete coverage of the knowledgeable scientific community worldwide as reasonably could be expected with existing limitations of time and resources. It further permitted an extensive expert weighting of all responses which balances quantitative and qualitative data into an integrated result.

To maintain a balanced emphasis on the biological aspects of GS/PM research, on the one hand, and research related to socio-economic aspects of GS/PM production/utilization, on the other, joint participation was made by biological and social scientists in the internal planning activities, site visits, and interviews. Site visits were made by at least two scientists, one a social scientist and the other a biological scientist. The number of biological scientists in the respondent list is considerably greater than the number of social scientists, which reflects the commodity focus of the research planning involved. This is reflected in the more precise categorization of biological constraints as compared to the socio-economic and institutional constraints.

The usefulness of the responses to the survey instrument would have been enhanced had the respondents been instructed to specify the type of production and utilization system to which their responses were applicable. For the purposes of this report we have identified three general Production/utilization systems:

1. Subsistence production which is primarily consumed directly by the producing family.

2. Small farm production where a significant part of the production is fairly consistently marketed as a food grain.

3. Medium/large farm commercial production marketed primarily as feed grain.

Since the respondents did not have access to this grouping, applicability had to be imputed by the workshop group based on country or region specified by the respondent, and personal knowledge by workshop members as to the production/utilization system with which the particular respondent had experience or was otherwise familiar. In developing the constraints lists major emphasis was given to the subsistence production/utilization system.

Where cases of apparent inconsistencies in data and information that the application of the methodology described generated, these were resolved in the workshop, or they were noted in the discussion of principal constraints and urgent research needs sections of the Interim Report.

Preparation of Interim Report.

The Interim Report was prepared following the workshop on December 20. The Interim Report is reproduced as Part III of this report. Preparation of the Interim Report required expression of the many observations and judgments accumulated through the site visits of UMC scientists, interviews with more than 125 U. S. scientists and 106 foreign scientists and responses of 90 U. S. and foreign scientists to the Constraints Questionnaire, in a concise and organized narrative form.

Three sections of the Interim Report are especially significant:

Section A. The Principal Constraints in the Production, Marketing, and Utilization of Grain Sorghum and Pearl Millet in Less Developed Countries, pp. 1-16.

Section B. The Most Urgent Research Needs, pp. 17-23.

Table C-3. Summary of Interviewer Ratings, pp. 43A-43E.

In addition, a detailed report on the methodology utilized in developing and summarizing the Constraints Questionnaires, including the alternatives attempted and an evaluation of the strengths and weaknesses of the procedures used, is included.

About 10 UMC staff who had been involved in the Grain Sorghum/Pearl Millet CRSP from the beginning, including most of those making site visits to U. S. and foreign institutions, participated in the writing of the Interim Report.

Invitation to Participate in Grain Sorghum/Pearl Millet CRSP.

At the beginning of the planning process, a letter was sent to all U. S. universities and other institutions designated as "eligible" by BIFAD, outlining the major components of the planning process initiated at the University of Missouri for developing a Grain Sorghum/

Pearl Millet Collaborative Research Support Program (see Exhibit D-3). Institutions with a manifest interest in grain sorghum/pearl millet research were invited to identify their areas of interest and indicate their desire for possible participation in the CRSP.

The following institutions responded positively to this request and identified themselves as having a manifest interest:

1. Tuskegee Institute (Alabama)
2. University of Georgia
3. University of California, Davis
4. University of California, Fresno
5. Colorado State University
6. University of Florida
7. Florida A. and M. University
8. University of Georgia
9. University of Illinois
10. Southern Illinois University
11. Purdue University (Indiana)
12. Kansas State University
13. Murray State University (Kentucky)
14. Western Kentucky University
15. Louisiana State University
16. Massachusetts Institute of Technology
17. University of Minnesota
18. Mississippi State University
19. Lincoln University (Missouri)
20. University of Nebraska, Lincoln
21. Cornell University (New York)
22. Oklahoma State University
23. University of Puerto Rico
24. Texas A. and M. University
25. Sam Houston State University (Texas)
26. Texas Tech University
27. South Dakota State University
28. College of the Virgin Islands

After the Interim Report was completed, a copy was sent to each of the institutions listed above, inviting them to prepare and submit research proposals addressed to the "most urgent research needs" identified in the Interim Report. The letter of transmittal, dated December 29, 1977, is included here (see Exhibit D-4).

THE METHODOLOGY UTILIZED IN PHASE II

Phase II of the planning process for the Grain Sorghum/Pearl Millet CRSP included the following steps:

(a) Planning a comprehensive grain sorghum/pearl millet research program based on the most urgent research needs identified in the Interim Report;

(b) Reviewing the research proposals received, identifying the components of the proposals that are applicable to each specific research need in the comprehensive program, and assessing the adequacy of the proposed research to solve the problems;

(c) Developing recommendations for institutions to implement the research projects; and

(d) Developing recommendations for an administrative entity to manage the project and propose a tentative budget.

To accomplish the planning process, the following general procedures were used:

1. A group of internal (UMC) resource persons were selected to implement steps a, b, and c, above, and develop preliminary recommendations.

2. A group of persons with administrative experience including university consortia, AID related projects, and fiscal management

was assembled to suggest alternative procedures for an administrative entity.

3. A two-day workshop was organized, composed of the internal resource group, additional UMC staff intimately associated with the grain sorghum/pearl millet project, and a panel of experts from outside the University of Missouri, which included representatives from the U. S. Department of Agriculture and ICRISAT. The workshop was convened to examine the recommendations of the UMC resource group and the proposals for the administrative entity and to finalize the recommendations to be sent to JRC and BIFAD.

Selection of Internal Resource Scientists.

The UMC internal resource scientists selected to make preliminary recommendations to the workshop and the areas of their expertise are as follows:

Dr. Larry Darrah	Plant Breeding
Dr. Marion Fields	Nutrition
Dr. Roger Hanson	Agronomy
Dr. Armon Keaster	Pest Control
Dr. Herbert Lionberger	Rural Sociology
Dr. Dale T. Sechler	Plant Breeding

Guiding Principles for Internal Resource Scientists.

As the team started discussions, it became apparent that a few guiding principles were needed to delineate the boundaries and structure of the program. To provide these guidelines the following guiding principles were agreed upon:

1. It was assumed that we were planning the project in the broad context that Title XII was designed to "improve the participation of these (the agriculturally related) universities in U. S. governmental

efforts, internationally to apply agricultural sciences more effectively to increasing world food production and provide . . . support to the application of science to solving developing countries' food and nutrition problems."[2]

2. The Grain Sorghum/Pearl Millet Collaborative Research Support Program is being developed as a research project which would contribute primarily to the improvement and utilization of grain sorghum/pearl millet in those areas of the developing world where traditionally they are the principal cereal grains being grown and consumed as human food.

3. The Grain Sorghum/Pearl Millet Research Program is to be planned as a long-term comprehensive program. It was assumed that over the life of the project funds will be available to research the urgent needs identified. We are also aware that over time the content and priority of the urgent needs may change requiring modifications in the program.

4. The research needs should be attacked by multidisciplinary teams, according to the nature of the problem.

5. Recommendation of a university to implement research should be based on the university's demonstrated competence to conduct grain sorghum/pearl millet research as well as the immediate proposals submitted.

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[2]Report 94-442 of the House of Representatives Committee on International Relations, "International Development and Food Assistance Act of 1975."

Component parts of the research plan may be divided among universities in order to utilize the best expertise available. If composite judgments suggest that there are research needs that have not been addressed, or that the proposals submitted do not specifically address the research needs, then they should be rejected and an effort made in the next phase to invite resubmission of proposals that focus more sharply on the need identified.

7. Primary consideration must be given to how the proposal benefits grain sorghum/pearl millet in the developing countries. This requires evaluation of proposed (or possible) establishment of close linkages with national Sorghum/Millet Research Programs and with ICRISAT.

Next, eight Research Areas were identified from the "Most Urgent Research Needs" of the Interim Report. Sections of the "Most Urgent.Research Needs" applicable were grouped under the Research Areas. Internal resource persons were assigned to examine the Research Area (or Areas) where he had expertise. In several of the Research Areas this provided an interdisciplinary team of internal resource persons to (a) develop a program, (b) assess the proposals, and (c) make recommendations to the Workshop for implementation. The Research Areas, section of Interim Report applicable to each area, and the internal resource persons who will address each area are shown in Exhibit D-5.

Workshop to Finalize Recommendations.

A workshop to finalize recommendations was held March 17-18, 1978. The workshop group was comprised of the six internal resource scientists;

J. W. McKinsey, Melvin Blase, E. C. A. Runge, Rex Campbell, and J. M. Poehlman from UMC; and seven external experts as follows:

Dr. George W. Sprague, Corn Breeder and Geneticist, University of Illinois, Champaign/Urbana (formerly USDA).

Dr. Paul Fitzgerald, Agronomist and Administrator, ARS.

Dr. Wm. Thompson, Agricultural Economist, University of Illinois, Champaign/Urbana; Director of INTSOY.

Dr. Harold Capener, Rural Sociologist, Cornell University.

Dr. Charlotte Roderuck, Nutritionist, Ass't. Director, Iowa Agricultural Experiment Station.

Dr. J. C. Davies, Cereals Entomologist and Leader of the Cereals Project, ICRISAT.

The recommendations of the internal resource scientists on the program and the research proposals, and the recommendations of the committee on the administrative entity were presented at the workshop and discussed. As a result of the deliberations, changes were made in parts of the program that had been recommended; other parts were accepted without change. The final program proposed and the administrative entity (sections 2 and 3 of this report) are the composite judgments of the total workshop group.

Table D-1

REGIONALIZATION OF SEMI-ARID COUNTRIES

BY THE ICRISAT METHOD

I. WEST AFRICA
1. Senegal
2. Gambia
3. Mauritania
4. Mali
5. Upper Volta
6. Ghana
7. Togo
8. Nigeria
9. Niger
10. Benin
11. Chad
12. Cameroon

II. EAST AFRICA
1. Sudan
2. Tanzania
3. Ethiopia
4. Kenya
5. Uganda
6. Somalia
7. Zambia

III. SOUTH AFRICA
1. Botswana
2. Lesotho
3. Mozambique
4. Rhodesia
5. Swaziland

IV. ASIA
1. Pakistan
2. Bangladesh
3. Sri Lanka
4. Burma
5. Thailand
6. Afghanistan
7. Nepal
8. Philippines
9. Malaysia
10. Indonesia

V. MIDDLE EAST
1. Lebanon
2. Syria
3. Iran
4. Turkey

VI. SOUTH AMERICA
1. Brazil
2. Venezuela
3. Argentina (Other Americas)
4. Colombia
5. Mexico

VII. INDIA

Table D-2. Results of workshop ratings of the constraint categories for each of the ICRISAT regions plus the U. S. (Table C-3 from Interim Report).

C-3 Summary of Interviewer Ratings of: (A) Principal Constraints to Production and Utilization of Grain Sorghum and Pearl Millet as food sources, and (B) Level of Knowledge Regarding Those Constraints, by Regions Established by ICRISAT plus USA, Rated as per Graduation Scheme Attached.

Constraint Category	West Africa		East Africa		South Africa		Asia		Middle East		South America		India		US	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Fertility & Plant Nutrition																
(1) Nitrogen Fixation	4	4	4	4	4	3	4	4	4	4	4	2	4	2	4	2
(2) Long Term Fertility Maintenance																
a. Intercropping	4	3	4	3	3	3	3	3	3	3	3	2	3	2	1	2
b. Organic residue management	4	3	4	3	3	3	3	3	3	3	3	2	3	2	1	2
c. Soil erosion/water management	4	3	3	3	4	3	3	3	3	3	4	3	3	2	1	2
(3) Use of Manufactured Fertilizer																
a. Variable yields, year to year	4	3	4	3	4	3	4	3	4	3	4	2	4	2	2	1
b. Lack of market and inadequate infrastructure	4	3	4	3	3	3	3	3	3	3	2	2	2	2	1	1
(4) Fertilizer Response and Soil Test Calibration	1	1	1	1	1	1	1	1	1	1	3	2	1	1	2	2
(5) Secondary Nutrients	1	3	1	3	1	3	1	3	1	3	3	3	1	3	3	3
(6) Chemical & Physical Properties of Soil Including Salinity, Acidity, etc.	1	3	1	3	1	3	3	3	3	3	3	3	2	3	3	2

C-3 Summary of Interviewer Ratings of: (A) Principal Constraints to Production and Utilization of Grain Sorghum and Pearl Millet as food sources, and (B) Level of Knowledge Regarding Those Constraints, by Regions Established by ICRISAT plus USA, Rated as per Graduation Scheme Attached.

Constraint Category	West Africa		East Africa		South Africa		Asia		Middle East		South America		India		US	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
I. Cultural Practices & Management																
(1) Stand Establishment																
a. Rate, depth, time of seeding, water control	4	3	4	3	4	3	4	3	4	3	2	2	4	3	3	2
b. Seedling vigor	4	3	4	3	4	3	4	2	4	2	2	2	4	2	3	1
(2) Bird, Rodent, and Animal Control)planting to harvest)	4	3	4	3	4	3	4	3	3	3	3	4	3	3	2	4
(3) Multiple Cropping & Inter-cropping	3	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2
(4) Weed Control	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	1
I. Engineering & Mechanization																
(1) Commercial Storage																
a. Sorghum	3	0	2	0	2	0	3	0	2	0	2	0	3	0	1	0
b. Millet	3	0	-	-	2	0	-	-	-	-	-	-	2	0	-	-
(2) Machinery Development and Availability	3	0	3	0	3	0	3	0	3	0	3	0	3	0	1	0
(3) Farm Storage																
a. Sorghum	3	1	3	1	3	1	3	1	3	1	3	1	2	1	2	0
b. Millet	3	1	3	1	3	1	3	1	3	1	3	1	2	1	-	-
(4) Drying (Sorghum)	-	-	-	-	-	-	-	-	-	-	3	0	-	-	1	0

C-3 Summary of Interviewer Ratings of: (A) Principal Constraints to Production and Utilization of Grain Sorghum and Pearl Millet as food sources, and (B) Level of Knowledge Regarding Those Constraints, by Regions Established by ICRISAT plus USA, Rated as per Graduation Scheme Attached.

Constraint Category	West Africa		East Africa		South Africa		Asia		Middle East		South America		India		US	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
IV. Breeding, Varietal Improvement, and Development																
(1) Productivity																
a. Sorghum	4	2	4	2	4	2	4	3	4	3	3	2	4	2	4	3
b. Millet	4	2	4	3	4	2	4	3	4	3	3	2	4	2	4	2
(2) For Resistance																
a. Sorghum	4	2	4	2	4	2	4	3	4	3	3	2	4	2	4	2
b. Millet	4	2	4	3	4	2	4	3	4	3	3	2	4	2	4	2
(3) For Quality (Acceptability, Nutrition)																
a. Sorghum	4	3	4	3	4	3	4	3	4	3	3	3	4	2	4	2
b. Millet	4	3	4	3	4	3	4	3	4	3	3	3	4	2	4	2
(4) Seed multiplication	4	3	4	3	4	3	4	3	4	4	3	2	3	2	1	0
V. Entomology																
(1) Biology of Economically Imported Insects:																
a. Preharvest:																
1. sorghum	4	2	4	3	4	3	4	3	4	3	4	2	4	2	4	-
2. millet	3	2	3	3	3	3	3	3	3	3	3	2	3	2	-	-
b. Postharvest	4	2	4	3	4	3	3	3	3	3	3	3	3	2	2	2
(2) Insect Control (cultural, chemical, biological)	4	2	4	3	4	3	3	3	3	3	3	2	3	2	3	

C-3 Summary of Interviewer Ratings of: (A) Principal Constraints to Production and Utilization of Grain Sorghum and Pearl Millet as food sources, and (B) Level of Knowledge Regarding Those Constraints, by Regions Established by ICRISAT plus USA, Rated as per Graduation Scheme Attached.

Constraint Category	West Africa		East Africa		South Africa		Asia		Middle East		South America		India		US	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
VI. Plant Pathology																
(1) Economically Important Disease Pathogens:																
a. Sorghum	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2
b. Millet	3	3	3	3	3	3	3	3	3	3	-	-	4	2	-	-
(2) Control of Diseases (cultural, chemical, resistance)																
a. Sorghum	4	3	4	3	4	3	3	3	3	3	4	2	4	2	4	2
b. Millet	4	3	4	3	4	3	3	3	3	3	-	-	4	2	-	-
II. Utilization																
(1) Quality (palatability, digestibility, tannins, texture, protein, color, caloric value, mycotoxins):																
a. Human food	4	3	4	3	4	3	4	3	4	3	3	4	4	3	-	-
b. Livestock feed	-	-	4	3	3	3	3	3	3	3	3	3	3	3	3	2
(2) Forage	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2

C-3 Summary of Interviewer Ratings of: (A) Principal Constraints to Production and Utilization of Grain Sorghum and Pearl Millet as food sources, and (B) Level of Knowledge Regarding Those Constraints, by Regions Established by ICRISAT plus USA, Rated as per Graduation Scheme Attached.

Constraint Category	West Africa		East Africa		South Africa		Asia		Middle East		South America		India		US	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
III. Social & Institutional Factors																
(1) Marketing:																
a. Price and market policy	4	3	4	3	4	3	4	3	4	3	3	1	4	3	-	-
b. Market information	4	3	4	3	4	3	4	3	4	3	2	3	3	3	-	-
c. Market organization and performance	4	3	4	3	4	3	4	3	4	3	2	3	4	3	-	-
d. Transportation	4	1	4	1	4	1	3	1	3	1	2	1	3	1	-	-
(2) Infrastructure (credit, cooperatives, etc.)	4	3	4	3	4	3	3	3	3	2	3	2	3	2	-	-
(3) Communication and Adoption																
a. Organizational structure (Extension)	4	3	4	3	4	3	4	3	4	3	4	2	4	2	-	-
b. Cultural constraints (presige of grains, differences in ethnic groups, etc.)	4	3	4	3	4	3	4	3	4	3	4	3	4	3	-	-
c. Technological compatibility	4	3	4	3	4	3	4	3	4	3	4	3	4	3	-	-
IX. Other Constraints																
(1) Shortage of Research Personnel	4	-	4	-	4	-	4	-	3	-	3	-	2	-	-	-
(2) Inadequate Educational and Research Facilities	4	-	4	-	4	-	4	-	3	-	2	-	2	-	-	-
(3) Limited Financial Resources	4	-	4	-	4	-	4	-	3	-	3	-	3	-	-	

Exhibit D-3. Letter to eligible institutions inviting response regarding a manifest interest in the Grain Sorghum/Pearl Millet CSRP.

UNIVERSITY OF MISSOURI-COLUMBIA

College of Agriculture

Office of the Dean

2-69 Agriculture Building
Columbia, Missouri 65201
Telephone (314) 882-7667

October 10, 1977

Dear

The Board for International Food and Agricultural Development (BIFAD) and the Agency for International Development, under provisions of Title XII of the International Development and Food Assistance Act of 1975 and in accordance with recommendations made by the Joint Research Committee, have given priority to grain sorghum/pearl millet for a Collaborative Research Support Program (CRSP). The University of Missouri has contracted to plan and submit a Collaborative Research Support Program Proposal.

It is our understanding that the BIFAD gave priority to this area for collaborative research after a proposal was submitted and a request for a planning grant was made by a group of interested scientists in several agricultural experiment stations. It was the opinion of General Counsel of AID that to avoid possible conflict of interest under the basic Conflict of Interest Statutues of the United States institutions or organizations hopeful of participating in the execution of a project should not be involved in feasibility studies or planning exercises. AID and BIFAD turned to the University of Missouri with a request to do the planning project. The University of Missouri accepted primarily as a service in the total effort to make the Title XII program operative.

The major components of the planning process are:

1. Identify the research institutions with a manifest interest in research on grain sorghum/pearl millet.

2. Identify the principle constraints in the production, marketing, transportation, storage, processing, nutritional value and utilization of grain sorghum/pearl millet in the developing countries.

an equal opportunity institution

3. Prepare a state-of-the-arts report and a summary of the most urgent research needs in the developing countries pertaining to grain sorghum/pearl millet. Distribute the report and the summary to the research institutions identified as having a manifest interest in this research, and invite an expression of their interest in participating in such research.

4. Recommend to the Joint Research Committee of BIFAD the areas of research to be supported by the CRSP, and the institutions appropriate to conduct that research, within the areas mentioned above.

We are asking you to respond on behalf of the Ohio State University to the following questions:

1. Does your institution have a "manifest interest" in the research program? Specifically, is there current research in the areas mentioned in (2) above? Is there an intent to continue or initiate such research?

2. If the answer to number 1 is yes, will you identify for us the scientist(s) in your institution in each area mentioned in (2) above that is relevant to your interest? Please provide both mailing address and phone number. Our contact with these scientists will be a request for their assistance in identifying problems or constraints.

3. If the answer to number 1 is yes, please provide us with tangible evidence of your "manifest interest. We cannot manage large volumes of material. We don't want to place limits by specifications. A listing of research projects by title, giving objectives; reports of research completed; the names and special qualification of scientists involved; the citation of related activity in developing countries would seem appropriate to include.

We have agreed to accomplish this mission in the shortest possible time, and have a very short time schedule. Therefore, a prompt reply will be appreciated. To accommodate the schedule with which we are working, no response by October 28 will need be treated as a negative response.

Your help in this project will be greatly appreciated. If there are questions, please call me or Dr. E.C.A. Runge, Agronomy Department, 314/882-2801.

Sincerely,

J. Wendell McKinsey
Assistant Dean

JWM/jg

Exhibit D-4. Letter to the institutions which acknowledged a manifest interest in the Grain Sorghum/ Pearl Millet CRSP inviting them to submit research proposals.

UNIVERSITY OF MISSOURI-COLUMBIA

College of Agriculture

Office of the Dean

2-69 Agriculture Building
Columbia, Missouri 65201
Telephone (314) 882-7667

December 29, 1977

Dear

My letter to you of October 10, 1977 outlined briefly the major components of the process initiated at the university of Missouri for planning a Collaborative Research Support Program proposal in grain sorghum and pearl millet. This program was undertaken in response to a request from the Board for Food and Agricultural Development and the Agency for International Development. The first steps outlined were to identify research institutions with manifest interest, identify the principal constraints to production and utilization of these grains as food sources, to ascertain the state-of-the-arts in grain sorghum and pearl millet, and to forward to the institutions so identified a copy of the report, along with an invitation to submit a proposal for participating in a research program that will address these constraints.

The report, entitled An Interim Report Identifying the Principal Constraints in the Production, Marketing, and Utilization of Grain Sorghum Pearl Millet in Less Developed Countries, is forwarded with this letter. The precise instruction from BIFAD and AID is that "institutions wishing to participate will be invited to submit their proposals on a concise form (not over 3 or 4 pages) along with budgetary requests." This letter constitutes that invitation.

In the preparation of your proposal, I think you should be aware of these additional instructions in our Work Order:

> "The contractor will then evaluate the submitted proposals and the qualifications of the potential participants in the CRSP. To accomplish this, he is authorized to utilize appropriate outside experts.
>
> After a detailed analysis of the state-of-the-arts information assembled, the researchable constraints, and a review of the research proposals submitted, the

contractor will make recommendations on research and institutions which he believes should be supported by the CRSP, designating which organizations would be primary participants and which ones might carry a secondary role, for example, on a subcontract basis."

We will submit our report to the Joint Research Committee of BIFAD and to AID. I understand that the JRC will then make recommendations to BIFAD and AID, after which a program of research will be contracted and funded.

I understand from discussions, not from written instructions, that members of JRC, BIFAD and AID anticipate:

(a) the participation of several institutions in the program, with no maximum specified

(b) the identification of "primary participants," and other institutions participating on a subcontract basis (note the Work Order paragraph quoted above)

(c) the possibility of collaboration with LDC research institutions and LDC scientists

(d) that contract or grant funds will be made available only to "eligible universities," and that participation of LDC institutions will be by subcontract

(e) that appropriate cooperation, coordination, and/or collaboration with International Research Centers will be developed

The JRC gave specific instructions that responding institutions be made aware of the possibility of the legitimate expenditure of funds allocated through this program for support of an appropriate in-country portion of the research program in an LDC, and of a plan for disseminating the new knowledge generated. This point is reflected in the following paragraph quoted from our Work Order:

"1. Upon completion of the planning process *** the contractor will *** report ***:

b. The program proposed, with details of all contributing projects, including names of institutions and staff being recommended for participation and estimated budget; plans for disseminating the new knowledge generated; expected impact on developing country food production."

It is our present judgment that linkages between U.S. institutions and institutions in LDC's appropriate for

collaborative research and/or outreach programs will be identified and established by the U.S. institutions in a planning phase that follows the one in which we are now engaged. This, we believe, will be true for linkages with International Research Centers, also.

In evaluating research proposals, the GUIDELINES FOR THE CONDUCT OF COLLABORATIVE RESEARCH SUPPORT ACTIVITY UNDER TITLE XII, more generally known as the JRC Guidelines will be central. A copy is included for your reference.

If you propose to research an area not included in this report, or given a low priority rating, then documentation should be provided to support the inclusion of that area or problem in the grain sorghum/ pearl millet research program.

We are supposing that the various proposals accepted for funding will eventually be put together in one research program. If there is a definite intent that two or more institutions will collaborate, a single proposal on that basis would seem in order. There is no such requirement however, and each institution will make that decision.

In reference to point (e) on a preceding page regarding coordination with International Research Centers, we would make special mention of coordination with ICRISAT. The extensive cooperation between institutions already involved in sorghum and millet research and ICRISAT is noted. Recognizing the extensive program underway there, the concentration of scientific personnel, and the outstanding collection of reference materials, it is suggested that the nature and form of collaboration between U.S. institutions and ICRISAT should be worked out, after the research program is formulated, through consultations that include representatives of the participating institutions and of ICRISAT.

We believe it important that your proposal include a section that deals with he most likely output or results expected as a result of funding at the requested level for some appropriate period of time, three years, or five years, or longer, as appropriate to the research being proposed.

We believe it also useful if in your research proposal you specify the type of production/utilization system upon which this research will be focused. Note Appendix B of the report in this connection. In addition, we could better evaluate your proposal if you would include a brief resume of each scientist that will work on the project.

We also suggest the desirability of submitting porposals so organized that definite "building block" components of a total program are recognizable by project component and budget component. It is not expected that any one institution

will cover all disciplines appropriate to the total research program. There will be an attempt to identify the strongest research resource available for each component of the total research program formulated, and by combining these individual strengths of various institutions, an exceptionally high calibre research program will be organized.

This report constitutes primarily Part III of a larger three-part report which will go to the JRC in mid January. The remainder of that report will be sent to you when it is completed. You should be aware of the possibility of changes in some parts of this letter, and perhaps even in the report, as a result of discussions at the JRC and AID.

I have tried to supply as much detail as is available that will help in your decision to submit a proposal and in the preparation of that proposal. I hope this does not lead you to more extensive effort in your proposal preparation than is warranted at this time. I would emphasize that there will be substantial negotiation with AID and perhaps JRC after our recommendations are completed. What is needed in your proposal now is enough information to reveal how your proposed research will contribute to and fit into a total research program of the highest calibre.

Research proposals should reach the University of Missouri on or before February 6, 1978. An earlier submission will be appreciated. Please address communications to:

J. Wendell McKinsey
2-69 Agriculture Building
University of Missouri-Columbia
Columbia, Missouri 65201

We look forward to receiving your proposal. Any suggestions for making this effort more effective will be appreciated.

Sincerely,

J. Wendell McKinsey
Administrative Coordinator
Grain Sorghum/Pearl Millet
Planning Project

JWM/jg
Enclosures

Exhibit D-5

RESEARCH AREA, SECTION OF INTERIM REPORT APPLICABLE TO EACH RESEARCH AREA, AND INTERNAL RESOURCE PERSONS IDENTIFIED TO EXAMINE EACH AREA

Research Area	Section of Interim Report Applicable	Internal Resource Persons
1. Crop Improvement	B-1 Pl. Breed., Gen. B-3 Pl. Path. B-4 Entomology Crop Physiology B-5 Grain Quality B-8 Trained Manpower	Sechler Darrah Keaster Fields
2. Cultural Practices	B-2 Cultural Practices B-3 Pl. Path. B-4 Entomology B-5 Risks B-14 Farming Systems B-8 Trained Manpower	Hanson Keaster
3. Nutrition	B-13 Nutrition B-8 Trained Manpower	Fields
4. Storage	B-6 Storage B-8 Trained Manpower	Darrah Hanson
5. Technology and Communication	B-7 Tech. and Com. B-8 Trained Manpower	Lionberger
6. Socio-Cultural	B-11 Socio-Cultural B-8 Trained Manpower	Lionberger
7. Marketing	B-9 Market Development B-10 Government Policy B-12 Risks B-8 Trained Manpower	Lionberger McKinsey
8. Data Systems	B-15 Data Systems	

S E C T I O N E

COPIES

OF ALL

REPORTS AND SUMMARIES

TABLE E-1

Estimate of Production of GS/PM, by End Use and in Total, for Countries Producing 50,000 Hectares or More, Grouped by ICRISAT Regions, 1976 (in Thousands of Hectares)

	GRAIN SORGHUM					
	Total hectare	%*	Human Food hectare	%	Livestock Feed hectare	%
W. Africa	7,830	19	7,047	90	783	10
E. Africa	10,150	25	7,612	75	2,538	25
S. Africa	351	1	176	50	175	50
Asia	705	2	564	80	141	20
Mid East	711	2	356	50	355	50
L. America	4,455	11	445	10	4,010	90
India	16,000	40	12,800	80	3,200	20
Totals	40,202	100	29,000	72	11,202	28

	PEARL MILLET					
	Total hectare	%*	Human Food hectare	%	Livestock Feed hectare	%
W. Africa	10,608	31	9,548	90	1,060	10
E. Africa	3,833	11	3,450	90	383	10
S. Africa	555	2	500	90	55	10
Asia	1,047	3	942	90	105	10
L. America	269	1	242	90	27	10
India	18,000	52	16,200	90	1,800	10
Totals	34,312	100	30,882	90	1,430	10

Source: Derived from Foreign Production, Supply and Distribution of Commodities (computer tape), National Technical Information Service, U. S. Department of Commerce, and UMC estimates.

*These percentages refer to per cent of total hectares for all LDC's listed.

SUMMARY OF

Agricultural Experiment Stations and USDA with Research Projects on Grain Sorghum and Pearl Millet Reported in Current Research Information System (CRIS) (as of January 1, 1978)

SORGHUM

I Plant Breeding and Genetics

Arizona	Breeding of sorghum for adaptation and plant protection (CSRS)
California	Improving sorghum, corn and sudan grass in desert valleys (CSRS)
Egypt	Evaluation of Sugar crops germplasm (ARS)
Indiana	Nutrition quality improvement in sorghum (CSRS)
Nebraska	Sorghum breeding and genetics (CSRS)
Nebraska	Physiology of Nutritive value (CSRS)
Nebraska	Improving efficiency of sorghum for mineral nutrients (ARS)
Oklahoma	Sorghum breeding and inheritance (CSRS)
Panama	Corn, sorghum and millet production (ARS)
Puerto Rico	Development of improved cultivars (ASES)
Texas	Inheritance in sorghum (CSRS)
Texas	Breeding and improvement in sorghum (CSRS)
Texas	Genetic, physiological and environmental control of flowering, etc. (CSRS)
Texas	Development of resistance to downy mildew (ARS)

II Cultural and Management Factors

Colorado	Improvement of yield and grain quality (CSRS)
Georgia	Grain Sorghum as a feed grain (CSRS)
Kansas	Ecology and management of crop plants (CSRS)

Kansas	Computer simulation of sorghum growth, etc. (SAES)
Nebraska	Weed control in crop production systems (CSRS)
Nebraska	Climatic resources and agroclimatic relationships (CSRS)
Nebraska	Cultural practices affecting stalk and root rot diseases (CSRS)
Nebraska	Physiology of sorghums under stress (ARS)
New Mexico	Cropping systems for efficient water utilization (SAES)
Oklahoma	Genotype-environment interaction studies (SAES)
Texas	Small seed syndrome in sorghum (CSRS)
Texas	Converted exotic sorghums (CSRS)
Texas	Irrigation systems (CSRS)
Texas	Plant growth, stress, and production physiology (CSRS)
Texas	Water and temperature stress (SAES)
Texas	Night temperature on grain sorghum production (SAES)
Virgin Islands	Sorghum for grain, forage, and silage (CSRS)

[II Fertility and Plant Nutrition

California	Water-soil-plant relations and water conservations (CSRS)
California	Root growth and plant water supply (CSRS)
Kansas	Wind erosion and environmental impact (ARS)
Louisiana	Nitrogen and yield of sorghum and other crops (SAES)
Louisiana	Utilization of C-labeled assimilates in sorghum (SAES)
Maryland	Biological nitrogen fixation in forage legumes and grasses (ARS)
Missouri	Soil fertility/fertilization management (CSRS)

Nebraska	Mineral nutrition of sorghum (CSRS)
Oklahoma	Iron chlorosis in sorghum (SAES)
Texas	Iron and zinc availability in high plain soils (CSRS)
Texas	Management of cattle feed lot waste (ARS)

IV Plant Pathology

Alabama	Viruses and mycoplasma-like diseases of sorghum (CSRS)
Alabama	Viral diseases of grasses (CSRS)
Alabama	Mycology of stored seeds (CSRS)
Arkansas	Corn and grain sorghum disease control (SAES)
Egypt	Diseases of sorghum and genetics of resistance (ARS)
Illinois	Germplasm bank of microorganisms of cereals (ARS)
Illinois	Rhizopus-like fungi from cereal grains (ARS)
Illinois	Microbial spoilage in grain sorghum (ARS)
Kansas	Sorghum diseases and their control (ARS)
Missouri	Physiology of fungi and fungal diseases (CSRS)
Nebraska	Mycotoxins in feeds and foods (CSRS)
Oklahoma	Plant parasitic nematodes on cereal grasses (CSRS)
Texas	Sorghum downy mildew and related diseases (CSRS)
Texas	Etiology and control of sorghum, pearl millet diseases (CSRS)
Texas	Nematodes in field crops (ARS)

V Entomology

Georgia	Sources of resistance to sorghum midge (CSRS)
Georgia	Mechanisms of resistance to sorghum midge (CSRS)
Georgia	Chemical control of sorghum midge (CSRS)
Georgia	Insect-resistant packaging and transport (ARS)

Georgia	Pesticides for stored grain products (ARS)
Georgia	Physical detection of stored grain insects (ARS)
Kansas	Pest management for stored grain insects (CSRS)
Kansas	Resistance to stored grain insects (CSRS)
Kansas	Pathogens to prevent infestation stored grain insects (ARS)
Hawaii	Pest management of aphids on sorghum (CSRS)
Texas	Soil insects and greenbugs (CSRS)
Texas	Sorghum midge control (CSRS)
Texas	Biological control of insects on sorghum (CSRS)
Missouri	Chemical control of midge (CSRS)

VI Utilization and Processing

California	Processing cereal grains for export (ARS)
District of Columbia	Cost components of producing, processing, and handling grain (ERS)
Kansas	Minimizing fuel requirements for drying grain (ARS)
Kansas	Qualities and end-use properties of cereal grains (ARS)
Pakistan	Fungal spoilage of stored grains (ARS)
Texas	Alternate processes of harvesting, storing processing, and feeding of the grain sorghum plant (CSRS)
Mississippi	Cost components of producing, processing and handling grain (ERS)
Nebraska	Cost components of producing, processing, and handling grain (ERS)

VII Research and Educational Factors

Pennsylvania	International agricultural programs (SAES)

PEARL MILLET

I. Plant Breeding and Genetics

Kansas	Breeding and testing pearl millet (CSRS)
Texas	Millet improvement and testing in semi-arid regions (CSRS)

II. Cultural and Management Practices

India	Ecophysiology of weeds in sorghum (ARS)
Texas	Plant growth, stress, and production physiology (CSRS)

III. Fertility and Plant Nutrition

Maryland	Biological nitrogen fixation of forage legumes and grasses (ARS)
Ohio	Ionic interactions in soils in relation to plant growth and nutrient uptake (CSRS)

IV. Plant Pathology

Nebraska	Mycotoxins in feeds and foods (CSRS)
Oklahoma	Nematodes on forage and cereal grasses (CSRS)
Texas	Etiology and control of sorghum downy mildew in pearl millet (CSRS)
Texas	Control of nematodes in field crops (ARS)

LITERATURE SEARCH FOR SORGHUM AND PEARL MILLET

A literature search was made through the UMC Department of Library Science for references concerning grain sorghum and pearl millet in the National Agricultural Library. The search covers the period from 1970 through October 1977. A print out of titles, authors, and citations were obtained. This is a summary of number of references cited.

KEYWORDS	TOTAL NUMBER OF REFERENCES
SORGHUM	3411
BREEDING	83
GENETICS	10
HYBRID	123
VARIETIES OR CULTIVARS	212
SEEDS	42
DRYING	8
STORAGE	21
MARKETING	13
NUTRITION	47
ECONOMICS (6466) or ECONOMY (3002)	16
PATHOGENS	2
SCLEROSPORA (downy mildew)	16
COLLETORICHUM (anthrocnose)	9
MACROPHOMINA (charcoal rot)	4
CERCOSPORA (gray leaf spot)	4
GLOEOCERSPORA (zonate leaf spot)	0
PUCCINIA (rust)	6
ERGOT	1
SMUTS	0
CURVULARIA (head mold)	1
FUSARIUM (head mold)	16
ASPERGILLUS (storage mold)	7
PENICILLIUM (storage mold)	3
VIRUSES	4
NEMATODES	2
PSEUDOMONAS (bacterial stripe)	11
STRIGA (witch weed)	7
INSECTS	22
CONTARINA (midge)	46
SCHIZAPHIS (greenbug)	65
ATHERIGONA (shoot fly)	50
CHILO (stem borer)	22
RHOPALOSIPHUM (aphids)	15
OLIGONYCHUS	4
FORAGE	148

KEYWORDS	TOTAL COMBINED WITH PEARL MILLET
PENNISTEUM	464
PEARLMILLET	333
BREEDING	7
GENETICS	8
HYBRID	38
VARIETIES or CULTIVARS	18
SEEDS	7
DRYING	0
STORAGE	1
MARKETING	2
NUTRITION	1
ECONOMICS or ECONOMY	2
PATHOGENS	0
SCLEROSPDRA (downy mildew)	4
COLLETRICHUM (anthrachose)	0
MACROPHOMINA (charcoal rot)	0
CERCOSPORA (leaf spot)	0
PUCCINIA (rust)	3
ERGOT	13
SMUTS	0
TOLYPOSPORIUM (smut)	2
VIRUSES	0
STRIGA (witch weed)	2
INSECTS	0
CONTARINA (midge)	0
ATHERIGONA (shoot fly)	1
CHILO (stem borer)	1
SESAMIA (pink stem borer)	0
HELLIOTHIS (gram caterpillar)	1
RHOPALOSIPHUM (aphid)	0
OLIGONYCHUS (spider Mite)	0

REPORT ON

VISITS TO TEXAS A. AND M. UNIVERSITY AND TEXAS TECH UNIVERSITY
LUBBOCK, TEXAS

Date: October 13, 14, 1977

Attending from University of Missouri: Melvin Blase, Ed. Runge, Rex Campbell, J. M. Poehlman

Interviewed at Texas A. AND M. AND Texas Tech Universities:

Anson Bertrand	Dean of Agriculture	Texas Tech
R. G. Merrifield	Associate Director, Texas Agr. Experiment Station	College Station
Fred Miller	Sorghum Breeder	College Station
Darrel Rosenow	Sorghum Breeder, conversion of tropical germ plasms	Lubbock
Tom Archer	Entomologist	College Station
Jerry Johnson	Breeder, host plant resistance	Lubbock
Jack Gibson	Physiologist	Texas Tech and Texas A & M
Dwane Miller	Chairmen, Plant and Soil Science, Water stress	Texas Tech
Dan Krieg	Plant Physiology	Texas Tech and Texas A & M
R. A. Frederiksen	Plant Pathologist, sorghum and millet	College Station
Wayne Jordon	Plant physiologist, drought resistance	Temple
Page Morgan	Plant Science, Hormonal regulation	College Station
Lloyd Rooney	Cereal chemist, sorghum quality	College Station
Keith Schertz	Geneticist (USDA)	College Station
William Ott	Director, Texas A & M Station	Lubbock
George Teetes	Entomologist	College Station
Charles Wendt	Drought Resistance Studies	Lubbock
A. B. Onkon	Soil fertility	Lubbock

Each of the above staff described his research as it related to grain sorghum/pearl millet. One half day was devoted to visiting grain sorghum/pearl millet field experiments. The research program was extensive, balanced, and closely integrated among disciplines. Through their AID contract tyey have close linkages in many developing ountries.

The constraint questionaire was used as the vehicle to obtain an assessment from the above scientists on the constraints and research needs of grain sorghum/pearl millet.

REPORT ON
CONFERENCE WITH REPRESENTATIVES OF COMMERCIAL HYBRID SORGHUM SEED PRODUCING COMPANIES AT LUBBOCK, TEXAS

Date: October 14, 1977

While visiting the grain sorghum/pearl millet research at Lubbock, Texas, a conference was held with representatives of four major private hybrid sorghum seed producing companies who are operating in the Lubbock area. The representatives present and the companies they represent are:

Jim Wilson	ASGROW Seed Company
Charles Perry	Cargill-PAAG Seed Company
Bruce Maunder	DeKalb Seed Company
Roy Quinby	Pioneer Seed Company

Mr. Wilson indicated their main market for hybrid sorghum seed was in the Western Hemisphere. They are concerned with high disease and insect resistance.

Mr. Perry said they market seed mostly in the U. S. and Argentina.

Mr. Maunder indicated their interest in the international program is headed by Dr. David Curtis. Argentina and Australia are important markets. Mildew and Midge resistance are important. Also, cold tolerance in South and Central America and drought tolerance in Australia. They also market seed in Europe, particularly France and Italy.

Mr. Quinby indicated more seed is produced in the Lubbock area for sales overseas than for sales in Texas and Oklahoma. Quality has received little attention because it has no additional market value.

In general the corn-sorghum companies represented at the Lubbock meeting indicated they would not be interested in getting in on a basic research program as part of Title XII. They would like to continue to get most of their genetic imput from experiment stations like the Texas A. and M. Experiment Station, and then will develop them for marketable hybrids in their marketing area. As a result of this discussion it appears that the commerical companies do not wish to be included in the grain sorghum/pearl millet program.

REPORT ON
VISIT TO UNIVERSITY OF NEBRASKA, LINCOLN

Date: October 31 to November 1, 1977.

Attending from University of Missouri: Rex Campbell, David Sleper, Marion Fields, E.C.A. Runge, Robert Malin

Interviewed at University of Nebraska, Lincoln:

M. A. Massengale	Dean of Agriculture
E. F. Frolik	Dean-Emeritus of Agriculture
H. W. Ottoson	Acting-Vice Chancellor
Robert Gast	Chairman, Department of Agronomy
Glen Vollmar	Chairman, Agricultural Economics
H. W. Knoche	Chairman, Biochemistry
E. A. Dickason	Chairman, Entomology
M. G. Boosalis	Chairman, Plant Pathology
D. Linsenmeyer	Agricultural Economics
Charles Sullivan	Stress Physiology, ARS
Jerry Eastin	Stress Physiology
Ray Chollet	Biochemistry
O. C. Burnside	Wheat Production on Drylands
W. M. Ross	Sorghum Genetics, ARS
Ralph Clark	Mineral Nutrition, ARS
Robert Olson	Soil Fertility
Dean Kindler	Entomology
Herman Gorz	Sorghum Breeder, ARS
Larry Dunkle	Plant Pathology
Paul Nordquist	Sorghum Breeder, North Platte
Paul Mattern	Cereal Quality Laboratory
Jerry Maranville	Sorghum Physiology and Quality
Max Clegg	Climatology, Physiology, Intrumentation
Charles Francis	Breeding Physiology
C. O. Gardner	Statistical Genetics
R. Staples	Entomology
R. V. Klucas	Biochemistry

Dr. Charles Francis and Dr. Linsenmeyer have had extensive international experience. Dr. Ross is coordinator of the ARS Cooperative Sorghum Breeding Program.

Each of the staff discussed his research interests and particularly as they related to grain sorghum/pearl millet.

Their program gives strong emphasis to physiological research with grain sorghum.

Information was obtained from scientists interviewed on the constraints to grain sorghum/pearl millet production and the research needs. The constraints questionaire was used to quantify the responses.

REPORT ON
VISIT TO PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA

Date: November 7-8, 1977.

Attending from the University of Missouri: E.C.A. Runge, Rex Campbell, David Sleper, W. D. Heffernan

Interviewed at Purdue University:

John D. Axtell	Sorghum Genetics
Larry Butler	Biochemistry
Roy Featherston	Animal Nutrition
R. P. Cantrell	Sorghum Genetics
H. L. Warren	Plant Pathology
V. L. Lechtenberg	Forage Physiology
T. K. White	International Economics
George Foster	Agricultural Engineering
Edward T. Mertz	Biochemistry
R. P. Abernathy	Chairman, Food Science
J. C. Rogler	Animal Nutrition
Johann Hoff	Horticulture

The major focus of the sorghum program at Purdue was on sorghum grain quality, with a long term program in evaluation and identification of strains with high lysine.

Persons interviewed were requested to fill out the constraint questionaire in order to get their assessment of grain sorghum/ pearl millet production constraints and research needs.

REPORT ON

VISIT TO KANSAS STATE UNIVERSITY, MANHATTAN

Date: November 8, 1977

Attending from the University of Missouri: Melvin Blase, J. M. Poehlman, Marion Field, Herbert Lionberger, Dale Sechler, and Robert Condron

Interviewed at Kansas State University:

Floyd W. Smith	Director, Agricultural Experiment Station
Vernon Larson	Director, International Agricultural Programs
C. W. Deyoe	Head, Department Grain Science and Director, Food Grains Institute
James T. Shepard	Head, Department of Plant Pathology
Hyde S. Jacobs	Head Department of Agronomy
Paul L. Kelley	Head, Department of Economics
H. L. Hackerott	Sorghum Geneticist (Hays)
T. L. Harvey	Entomologist (Hays)
W. D. Stegmeier	Agronomist (Hays)
Gerald Wilde	Entomologist
Wm. G. Willis	Extension Plant Pathologist
D. B. Sauer	Stored Grain Fungi, ARS
O. G. Russ	Weed Control
A. J. Cassidy	Sorghum Breeder
L. S. Murphy	Soil Fertility
Ed Kanemasu	Climatologist
G. M. Paulsen	Crop Physiology
R. L. Vanderlip	Agronomist, Director of AID Millet Project
E. Varriani Marston	Grain Science
R. C. Hoseney	Grain Science

Much of the sorghum research is carried out at the Hays Agricultural Experiment Station. Resistance to greenbug and maize dwarf mosaic is being stressed. Have concentrated on ma. sterile lines in hybrid sorghum research. Stressed need for

research on response to soil deficiencies. Studying water relations and developing yield model for sorghum. Developing population of pearl millet at Hays. Have research project with USAID on pearl millet. Will be starting work on nutritional value of pearl millet with AID contract and will be examining disease problems. Expect to develop linkages with several African countries on the millet project.

Those interviewed were questioned regarding the constraints to grain sorghum/pearl millet production and research needs. The constraints questionaire was used to record responses.

REPORT ON

VISIT TO OKLAHOMA STATE UNIVERSITY, STILLWATER

Dates: December 5, 1977

Attending from the University of Missouri: E.C.A. Runge, Marion Fields, Windell McKinsey, Douglas Ensminger

Interviewed at Oklahoma State University:

Paul Santlemen	Chairman, Department of Agronomy
D. E. Weibel	Sorghum Breeder
L. G. Morrill	Soil Fertility
R. Westerman	Soil Fertility
Jewell Crabtree	Agronomist
Wendell Bowers	Agricultural Engineering
R. E. Page	Agricultural Economics, Grain Storage
E. D. Mitchell	Biochemist
Harry C. Young	Plant Pathology
R. L. Burton	Entomology, ARS
K. J. Starke	Entomology, ARS
Richard Wilson	Entomology, ARS
High Rouk	International Programs
F. H. Baker	Dean, College of Agriculture
J. A. Whalley	Associate Director, Agricultural Experiment Station

Dr. Page and Dr. Rouk have had experience in Ethippia, where they worked on grain storage problems.

Emphasis in the sorghum breeding program is being given to greenbug resistance, bloomless character, disease resistance, and bird resistance. Dr. Rouk is in charge of a training program at Oklahoma.

In the interviews information was obtained on their assessment of constraints in grain sorghum and pearl millet, on a worldwide basis.

REPORT ON
VISIT TO MISSISSIPPI STATE UNIVERSITY
MISSISSIPPI STATE

Date: December 6, 1977

Attending from the University of Missouri: E.C.A. Runge, J. W. McKinsey, M. L. Fields, Douglas Ensminger

Interviewed at Mississippi State University:

C. E. Lindley	Dean, College of Agriculture
A. D. Seale, Jr.	Director of Agricultural Experiment Station
R. C. Creech	Chairman, Department of Agronomy
J. W. Turner	Chairman, Department of Animal Sciences
L. M. Gourley	Sorghum Breeding
J. C. DeLouche	Seed Technology
C. H. Andrews	Seed Technology
H. N. Pitre	Entomologist, Sorghum Insects
Stan King	Sorghum and Millet Pathology, ARS
Nat Zummo	Sorghum and Millet Pathology (Meridian)
Mary Futrell	Human Nutrition
B. C. Diggs	Swine Nutrition
B. C. Dillworth	Poultry Nutrition
John W. Lusk	Dairy Nutrition
Fred Tyner	Agricultural Economics
Travis Phillips	Agricultural Economics
C. R. Sollie	Rural Sociology
Harold R. Hurst	Weed Control (stoneville)
Frank D. Whisler	Soil Fertility
Joe Sanford	Soil Scientist, ARS
C. D. Rainey	Area Director, North MI and AL, ARS (Oxford)
W. F. Jones	Soil Fertility

Sorghum breeding is directed toward host plant resistance, and nutrition. There is a strong emphasis in the seed technology area. They have had many overseas contracts and have conducted

many seed technology short courses around the world. Dr. King worked in West Africa from 1967-77. Dr. Summo and Dr. Futrell have had experience in Nigeria.

Suggestions were solicited from those interviewed on constraints and research needs for grain sorghum/pearl millet. The constraints questionaire was used as a vehicle for quantifying responses.

REPORT ON
VISIT TO UNIVERSITY OF ARIZONA, TUCSON

Date: December 13, 1977

Attending from the University of Missouri: Melvin Blase and E. C. A. Runge

Interviewed from University of Arizona:

R. Phillip Upchurch	Chairman, Plant Sciences
Richard Rice	Chairman, Animal Science
W. G. Matlock	Coordinator for International Agriculture
R. G. McDaniel	Biochemical Genetics
Mike Rogers	Plant Physiology
Orrin F. Webster	Sorghum Breeding (formerly ARS)
M. H. Schonhorst	Plant Breeding
R. E. Dennis	Field Crops Extension
Mashito Sato	Sorghum Production
W. H. Hale	Animal Nutrition
R. S. Sivengle	Animal Nutrition

Arizona shares climatological problems with several sorghum/millet production areas of the world. They have had research programs in Niger, Upper Volta, Brazil, Saudi Arabia and currently have a project in Yemen.

Several staff members have had extensive international experiences. Dr. Webster was formerly coordinator for sorghum research for ARS and has spent several years on sorghum research in Africa. Arizona is a particularly favorable location for studies of drought stress.

Experiences of the staff were valuable in assessing grain sorghum/pearl millet constraints and research needs. The constraints questionaire was utilized to quantify these assessments.

REPORT ON
INSTITUTIONS VISITED AND PERSONS INTERVIEWED
ON VISIT TO ICRISAT, HYDERABAD, INDIA

Dates: August 29 to September 2, 1977

Attending from the University of Missouri:

Dr. Roger Hanson — Professor of Agronomy Extension

The purpose of this visit was to attend the International Pear Millet workshop being sponsored by the International Crops Research Institute for the semi-arid tropics (ICRISAT), Hyderabad, India.

Interviewed:

L. D. Swindale	Director ICRISAT
J. S. Kanwar	Associate Director, Research
R. C. McGinnis	Associate Director, Cooperative Programs and Training
Dallis Oswald	Training Officer, ICRISAT
Leland House	Sorghum Breeder, ICRISAT
J. C. Davies	Leader Cereals Improvement
G. Harinarayana	Profect Coordinator (Millets) of the All-India Coordinated Millet Improvement Project (Poona, Maharashtr
R. L. Vanderlip	Professor of Agronomy, Kansas State University
Elven F. Frolik	Consultant USAID

Visited: Punjab Agricultural University, Ludhiana

Interviewed:

Dr. K. S. Gill	Professor and Head, Department of Agronomy and Pearl Millet Breeder

Visited: Indian Council of Agricultural Research

Interviewed:

Dr. O. P. Gautam Associate Director

REPORT ON
VISITS TO ASIA

Dates: November 28 to December 11, 1977

Attending from University of Missouri:

Dr. Dale T. Sechler	Professor of Agronomy
Dr. Herbert Lionberger	Professor of Rural Sociology

INDIA

Visited: International Crops Research Institute for the Semi-Arid Tropics, Hyderabad

Interviewed:

L. D. Swindale	Director
J. S. Kanwar	Associate Director
R. C. McGinnis	Associate Director
J. C. Davies	Leader Cereal Improvement Program
Lee House	Sorghum Breeder
D. J. Andrews	Millet Breeder
F. R. Bidinger	Cereal Physiologist
J. G. Ryan	Agricultural Economist
M. Von Oppen	Economist
R. Jambunathan	Biochemist
M. Johda	Economist
Hans Binswanger	Agricultural Economist
T. C. Jain	Librarian

Visited: Indian Agricultural Research Institute, Sorghum Research Station

Interviewed:

N. G. Prasada Rao	Project Coordinator and Head, All India Coordinated Sorghum Project

Visited: National Institute of Nutrition, Hyderabad

Interviewed:

Bhavani Belavady	Deputy Director

Visited: Andhra Pradesh Agricultural University, Hyderabad

Interviewed:

Hamid Ali	Dean
Vittal Rao	Professor Soils
Mustafa Hussain	Professor Agronomy
K. M. Agam	Professor Entomology

Visited: University, Poona

G. Harinarayana	Project Coordinator and Head, all Indian Millet Project
S. Patel	Professor Plant Pathology
V. Dandekar	Head, School of Political Economics

Visited: Indian Agricultural Research Institute, New Delhi

S. P. Singh	Agronomist and Project Leader Sorghum
S. C. Poichriyal	Senior Geneticist, Millets
G. Jotwani	Entomologist
S. S. Shah	Genetics
M. Ahliwalia	Cummings Laboratory
S. B. Mathur	Microbiologist
K. N. Singh	Joint Director, Extension
Y. P. Singh	Professor, Extension
R. P. Singh	Senior Extension Officer
A. P. Singh	Assistant Professor Psychology

Visisted: Indian Council of Agricultural Research, New Delhi

Interviewed:

S. Singh	Deputy Director

Visited: U. S. Agency for International Development, New Delhi

Interviewed:

George Warner	Agricultural Officer
Mr. Nair	Agricultural Officer

PAKISTAN

Visisted: Technical Service Association, Lahore

Interviewed:

J. R. Lochman	Agricultural Officer

Visited: Yousafwala Maize and Millet Research Institute, Lahore

Interviewed:

A. Raham Chaudhrey	Director

Visited: Barani Project, Lahore

Interviewed:

Larry Ulsaker	USAID Advisor
M. Amin	Agronomist

Visited: U. S. Agency for International Development, Islamabad

Interviewed:

Everett Hedrick	Acting Chief, Agriculture
Ed Rice	Agricultural Scientist

Visited: Agricultural Research Council, Islamabad

Interviewed:

I. Hussain	Deputy Director General
Q. Chattah	Coordinator, Maize, Sorghum and Millet
Dr. Hassan	Director Cereal Disease Research Institute

M. Taber	Coordinator, Wheat Research
B. Khan	Director, Soils and Irrigation
Mugaffar Hussain	Director Extension Information
S. A. Razui	Plant Pathologist
M. A. A. Kermani	Plant Pathologist
L. Khokwar	Plant Pathologist

Visited: Damascus, Syria

Interviewed:

Bhup Bhardwaj	Regional Consultant, FAD
Raghard El-ard	Maize Breeder, Regional Project
L. R. Morsi	Arab Center for Study of Arid Zones
Gordon Ramsey	Mission Director, USAID

REPORT ON
VISITS TO CENTRAL AND SOUTH AMERICA

Dates: November 24 to December 7, 1977

Attending from the University of Missouri:

Dr. Roger Hanson	Professor of Agronomy Extension
Dr. Rex Campbell	Professor of Rural Sociology

MEXICO

Visited: Cimmyt, El Bataan

Date: November 24, 1977

Interviewed:

Dr. Haldore Hanson	Director General
Dr. Elmer C. Johnson	Plant Breeder
Dr. Donald Winkelmann	Principal Economist
Dr. Higo S. Cordova	El Salvador Program

Visited: National School of Agriculture, Chapingo Mexico

Date: March 25, 1977

Interviewed:

Professor Leopaldo Ernesto Mindoza Onofre	Genetics

EL SALVADOR

Visited: Centro Nacional de Technologia Agropecuaria - CENTA

Date: November 29, 1977

Interviewed:

Ing. Agr. Felix Rodolfo Cristales A.	Director General
Ing Agr. Mario Apontes Martinez M.C.	Subdirector General
Ing. Agr. Roberto Antonio Vega Lara M.C.	Jefe de Division
Agr. Rene Clara	Fitomejosador de Sorgo

COLOMBIA

Visited: CIAT - Cali, Colombia

Date: December 1 and 2, 1977

Interviewed:

Dr. John Nichel	Director General
Dr. Kenneth Rachie	Associate Director General
Mr. Alexander Grobman	Associate Director General
Dr. Shree P. Singh	Bean Breeder (Former CIMMYT Sorghum Breeder)

BRASIL

Visited: Instituto Nacional de Alimintacago e Nutricao, Brasilia, D.F

Date: December 6, 1977

Interviewed:

Drs. Feda Cascoal

Visited: National Corn and Sorghum Research Center - EMBRAPA
Sete Lagoas, MG., Brasil

Date: December 5, 1977

Interviewed:

Dr. Richardo Magnavaca	Director
Dr. Francisco Bahia	Assistant Director, Technical
Dr. Robert Schoffert	USAID/Purdue, Breeder
Dr. William Reis	USAID/Purdue, Agronomy

Visited: Empresa Brasileira de Assistencia Tecnica e Extenssao Rural Embrater - Brasilia, D. F., Brasil

Date: December 7, 1977

Interviewed:

Manuel Luis Moscareli	Program Planning
Paulo Menincci Castanheiro	Coordenador, Corn & Beans

REPORT ON
VISITS TO AFRICA

Dates: November 23 to December 10, 1977

Attending from University of Missouri:

Dr. David A. Sleper	Agronomy
Dr. Pat Cantlon	Agriculture Economics

SENEGAL

Visited: Dakar

Dates November 23 to 30, 1977

Interviewed:

C. J. Fredrickson	USAID
Jim Livingston	USAID
Norman Schoonover	USAID
Claude Charreau	ICRISAT
Mr. Buresi	Senegal Extension Service (SODEVA)
Louis A. Sauger	Senegal Agricultural Resear Institute
Clark Ross	CRED

Visited: National Center for Agronomy Research, Bambey

G. Beye	Director
J. Denis	Plant Breeder
Mr. and Mrs. Lambert	Plant Breeders
R. T. Gahukar	Entomologist
J. C. Girard	
E. Loose	Purdue Graduate Student

KENYA

Dates: November 30 to December 6, 1977

Visited: Nairobi

Interviewed:

W. E. Scarborough	USAID
T. Roach	CARE
H. Van Arkel	FAO
Mr. Thairu	Minstry of Agriculture
B. N. Majisu	Director, East Africa Agriculture and Forestry Research Organization (EAAFRO
Hassan M. Nadar	EAAFRO
J. Ian Stewart	EAAFRO

Visited: Katumani

Interviewed:

E. Omolo	Director of Research Station

THE SUDAN

Dates: December 7 to 10, 1977

Interviewed:

Adbel Rahim Saeed	Director of Sudan Food Research Center
A. I. Nustafa	Sudan Food Research Center
Avo S. Izmirlian	Agriculture Business Man
Mohamed El Shavali Osman	Minister of State for Agriculture, Food and Natural Resources
S. M. Badi	Sudan Food Research Center
Mr. MacMher	USAID

REPORT ON

VISIT TO USAID STAFF IN JAMAICA AND WASHINGTON, D. C.

Dates: March 13 to March 20, 1978

Attending from the University of Missouri:

Dr. Melvin Blase	Director International Programs and Studies

Visited: USAID Staff in Jamaica

Date: March 13-14, 1978

Interviewed:

Ralph Jones	Rural Education Officer
Philip Schwab	Deputy Director of the Mission

Visited: USAID Staff in Washington

Date: March 20, 1978

Interviewed:

Dr. Kenneth McDermott	Development Support Bureau
Dr. John M. Yohe	Development Support Bureau

The purpose of these visits was to solicit suggestions from USAID staff in the field and in Washington on the most expeditious procedures for establishing linkages with collaborating LDC national programs and with USAID staffs in the field.

REPORT ON

VISITS TO USAID MISSIONS IN AFRICA

Dates: March 12-24, 1978

Attending from the University of Missouri:

Dr. Douglas Ensminger, Professor of Rural Sociology

Dr. C. Edwin Vaughn, Associate Professor of Rural Sociology

Visited:

U. S.A. I. D. Missions in Egypt, Niger, Upper Volta, and Senegal, and the FAD staff in Rome.

The purpose of these visits was to solicit suggestions from USAID Missions in Africa, on the most desirable way of establishing linkages with the collaborating LDC National Programs and with the USAID Mission Staff in the field.

The attached letter to Dean McKinsey reports on the discussions and conclusions resulting from these visits.

UNIVERSITY OF MISSOURI-COLUMBIA

62 A
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Telephone (314) 882-7558

March 27, 1978

TO: J. Wendell McKinsey
Assistant Dean
College of Agriculture
2-69 Agriculture

FROM: Ed Vaughan
Doug Ensminger

Based on discussions in Egypt, Niger, Upper Volta, Senegal and top staff in FAO concerned with sorghum and millets, we draw the following conclusions about how the United States universities should develop linkages with research institutions in the developing countries:

1. Given the presence of the Semi-Arid Grain Research and Development project (SAF GRAD) and the Organization of African Unity (OAU) which comprises eighteen African Countries (Benin, Central African Republic, Cameroon, Cape Verde, Chad, Ethiopia, Gambia, Ghana, Guinea, Ivory Coast, Mali, Mauritania, Niger, Nigeria, Senegal, Sudan, Togo, Upper Volta) in developing linkages in those countries, it will be important that the U.S. universities selected to participate in the Grain Sorghum/Millet program develop two linkages, one with SAF GRAD and the other with specific research institutions, be they regional or country national.

2. In developing linkages with country national research institutions, the entry point should be through the within country AID Mission. The selection of appropriate within country research institutions to have linkages with U.S. universities should be a joint decision involving the U.S. participating university, the within country AID Mission and the host government of the country. The selection of constraints to be addressed through research should be a joint decision involving the U.S. participating university, the within country AID Mission, the host government, and the participating institution.

3. In all countries visited there was agreement that marketing and institutional infrastructures to serve small farmers were overriding constraints. Little or no attention appears to have been given to those constraints by the seventeen U.S. university proposals submitted to the University of Missouri. Unless this is corrected in the grants, there will be a major void in the overall research program

an equal opportunity institution

4. Since competent trained manpower to engage in research within the African Countries is very limited, all the people we talked to emphasized the necessity for the U.S. universities receiving grants to budget for assigning research staff to the African Institutions selected to link up with the U.S. universities. Forceful arguments were made against the U.S. universities sending a large number of graduate students to fill needed research posts. In-service training was emphasized and, therefore, the need for assigning top staff for work in the Developing Countries. With respect to training, AID and the African leaders emphasize the training be primarily within the countries rather than sending to the U.S. Emphasis in training must take account of culture, working conditions and the needs of the small farmer.

5. Given the complexity of small farm agriculture problems, and the culture of which the small farmer is an integral part, concern was expressed that the U.S. institutions receiving grants under the Sorghum/Millet Program would assume the U.S. generated technology would be applicable to African small farm agriculture. All urged with great emphasis that the "locale" for the larger percentage of the research funds be within the African countries to assure its appropriateness for application on the small African farms.

6. While accepting the need to develop additional and more appropriate technology, we were told over and over that technology per se is not the limiting factor in increasing production of grain sorghum and millets. The exceptions are few when one or more farmers in the villages are not producing fifty percent or more per hectare than the village average. The major constraints are political, institutional, cultural, economical, and manpower.

For example, in Upper Volta it costs the farmer 85 CFA to produce one kilo of millet. The government purchase price is 32 CFA. Government policy decisions are made to be pleasing to the five percent of the population which is urban--these are the elitist supporters of the government. The ninety-five percent of the population which is rural, lack political clout.

7. In the African countries there is abundant evidence that presently available technology is not being applied because existing institutions are not committed to and capable of serving the needs of the small farmer. Culturally acceptable approaches to extending technology to small farmers is lacking. U.S. Extension institutional arrangements and methods have proven to be inappropriate for Africans.

8. Wherever possible, the institutional linkage in the Developing Countries should interrelate research, training and farmer application.

cc: Mel Blase

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THE INTERIM REPORT

The Interim Report was prepared and distributed to all eligible Universities manifesting an interest in participating in the Grain/Sorghum/Pearl Millet Collaborative Research Program.

The Interim Report is reproduced in full in part III of this report.

S E C T I O N F

MINUTES

OF ALL

MEETINGS AND CONFERENCES

Minutes of the
Grain Sorghum/Pearl Millet Ad Hoc Planning Committee
September 26-27, 1977

An ad hoc planning committee was convened on September 26-27, 1977, to develop a procedure for planning the Grain Sorghum/Pearl Millet Collaborative Research Support Program. Those in attendance were:

J. W. McKinsey, Assistant Dean for International Programs, UMC
Melvin Blase, Director, International Programs and Studies, UMC
Douglas Ensminger, President, Mid-Mo. Assoc. Colleges/Univ., UMC
Larry Darrah, Research Associate, Agronomy, UMC
Roger Hanson, Professor of Agronomy Extension, UMC
John M. Poehlman, Professor of Agronomy, UMC
E. C. A. Runge, Professor and Chairman, Dept. of Agronomy, UMC
Herbert Albrecht, Former Director, IITA, Ibadan, Nigeria
Glen Burton, Geneticist, Ga. Coastal Plains Expt. Station
Elvin Frolik, Consultant for USAID
Leland House, Sorghum Breeder, ICRISAT, Hyderabad, India
Vernon Larson, Director, Internal Programs Agriculture, Kansas St. U.

The committee was chaired by Dean McKinsey, who introduced those present and requested each to relate something about their previous international experiences.

Dr. House commented on the sorghum workshop at ICRISAT in April at which representatives from Africa, India, and Thailand tried to identify research priorities and interests. Objectives high on the priority list were earliness, grain mold tolerance, weathering tolerance, striga resistance, and bird resistance. Importance of stable yield rather than highest yield was stressed.

Dr. Hanson and Dr. Frolik reported on the pearl millet workshop held in August at ICRISAT. Workshop participants attended from Africa

and India. Areas of research which received most concern were (a) need for production programs, (b) need for basic research, and (c) need for training, both degree and non-degree.

Most of the discussion centered on an approach to the planning process. The basic planning procedures identified were:

1. Site visits by teams of UMC scientists to U. S. institutions engaged in sorghum/pearl millet research.

2. Site visits by teams of UMC scientists to foreign research institutions engaged in sorghum/pearl millet research. Some U. S. institutions identified included Texas A and M, Univ. of Nebraska, Kansas State University, Purdue University, Mississippi State University, University of Oklahoma, University of Arizona. Some foreign countries identified for visits included Senegal, Upper Volta, Sudan, Kenya, India, Pakistan, Guatemala, Syria, Brazil, and Nigeria. Since not all areas of the world can be covered by travel, it was suggested that we should pick the locations from which the most information could be obtained.

3. A questionnaire designed to identify constraints to sorghum/pearl millet production was presented and discussed. It was proposed that the questionnaire be filled out by U. S. and foreign scientists knowledgeable about grain sorghum/pearl millet. Ratings would be made both for the importance of identified constraints and the level of available knowledge. This information would be useful in developing the statement on the "state of the arts" in grain sorghum/pearl millet research. It was agreed that the questionnaire would be a suitable procedure for obtaining this information and should be tried.

Questions were raised about the magnitude of the project to be planned. Information from USAID indicated that a total program should be planned at this stage.

Minutes of the
Grain Sorghum/Pearl Millet Committee Meeting
September 29, 1977

Those in attendance: McKinsey, Cantlon, Runge, Poehlman, Ensminger, Calvert

The meeting was convened to firm up some plans for site visits.

The following Agricultural Experiment Stations in the U. S. were selected for visitation:

Texas	Oct. 10-14
Nebraska	date not scheduled
Kansas State	"
Arizona	"
Oklahoma State	"
California	"

The need to identify the persons to go as early as possible was stressed. Also, it would be useful to have a few key people making as many visits as possible.

Discussion of country groupings for foreign visits followed. The following groupings were proposed:

Africa: Senegal, Upper Volta, Nigeria, Kenya, Sudan
Central and South America: Mexico (CIMMYT), Colombia (CIAT), Brazil, Argentina
Asia and Mid East: India (ICRISAT and AISRP at Hyderabad; AIMRP in Poona), Pakistan, Syria (FAO)
Administrative: COPR in London, IRAT in Paris, FAO in Rome, ICRISAT in India, Thailand

Dr. Sleper and Dr. Cantlon were identified to make the Africa trip.

U. S. visits would be made first. Foreign visits would start in mid- or late-November.

Minutes of the
Grain Sorghum/Pearl Millet Committee Meeting
December 15, 1977

Those in attendance: McKinsey, Cantlon, Lionberger, Sechler, Hanson, Campbell, Runge, Fields, Mann, Blase, Poehlman, Malin.

The purpose of the meeting was (a) to assess the results of the overseas visits, and (b) to formulate plans for the workshop to be held on December 20.

Staff members who had traveled overseas gave reports of their visits. All responded favorably as regards their reception and the value of the trips.

Discussion followed on the constraints questionnaires and the best procedure for quantifying the data for presentation at the workshop. It was tentatively agreed to complete the compilation of the questionnaires which had been filled out during the interviews. It was suggested that some sections could be presented quantitatively, but other sections may need to be treated qualitatively.

Minutes of the
Workshop to Formulate and Finalize a List of Constraints and
Urgent Research Needs for Grain Sorghum/Pearl Millet CRSP

December 20, 1977

A day-long workshop was convened to interpret, integrate, and summarize the information gained from the constraints survey questionnaires and site visits. Attending the workshop was an institution-wide group of internal scientists who had participated in the site visit interviews and other knowledgeable scientists collaborating in the planning effort.

Those in attendance were:

W. J. McKinsey, Assistant Dean for Agriculture

E. C. A. Runge, Professor and Chairman, Department of Agronomy

Rex Campbell, Professor and Chairman, Department of Rural Sociology

Oscar H. Calvert, Professor Plant Pathology

Pat Cantlon, Assistant Professor, Agricultural Economics

Marion Fields, Professor of Food Science and Nutrition

Roger G. Hanson, Associate Professor Agronomy Extension

Armon J. Keaster, Professor of Entomology

Robert Malin, Graduate Student, Agronomy

Fred Mann, Consultant

J. M. Poehlman, Professor of Agronomy

Dale T. Sechler, Professor of Agronomy

Herbert Lionberger, Professor of Rural Sciology

David Sleper, Assistant Professor of Agronomy

Larry Darrah, Research Associate in Agronomy

Donald Brooker, Professor of Agricultural Engineering

George Garner, Professor of Biochemistry

Douglad Ensminger, Professor of Rural Sociology

Wm. D. Hefferman, Graduate Student, Agricultural Economics

Melvin Blase, Director International Programs and Studies

The Constraints Questionnaire was used as the basis of the discussions. Various evaluation alternatives were considered after compilations of data from the Constraints Questionnaire had been presented. The procedure finally agreed upon consisted of:

1. Dividing the countries of the world into the ICRISAT grain sorghum/pearl millet areas plus the U. S.

2. Rating each item in the "constraints categories" with regard to (A) "the importance of the problem or constraint" on a scale of 1 (little importance) to 4 (wide-scale importance), and (B) "the level of present knowledge and programs underway to gain necessary knowledge" on a scale of 0 (problem solvable by transfer of present technology) to 4 (total research effort needed).

3. Separate ratings to be made for each ICRISAT region plus the U. S.

4. Ratings to be the collective judgment of the group based on (a) compilations of constraint questionnaires completed by respondents interviewed on site visits in the U. S. and in foreign countries, (b) information obtained by UMC workshop scientists on site visits in U. S. and abroad in addition to the questionnaires, (c) personal judgments of UMC workshop scientists from previous U. S. and foreign experiences in their areas of expertise.

5. Experience in the use of the constraints questionnaire had indicated that a few of the "Constraints Categories" as listed did not always describe the problem accurately. It was agreed that modifications in the wording of the questionnaire could be made in those cases in order to express the constraint more precisely.

Unanimous agreement was reached on rankings for most of the constraints. It was also agreed that the constraints ratings would provide the basis for depicting the state of the arts and the urgent research needs in order to develop a comprehensive grain sorghum/pearl millet CRSP.

Minutes of the
Grain Sorghum/Pearl Millet Committee Meeting
December 27, 1977

Those in attendance: McKinsey, Runge, Poehlman, Blase, Hanson, Lionberger, Malin.

The meeting was called to discuss the first draft of the Interim Report and to solicit suggestions for changes.

The role of ICRISAT and its relation to the grain sorghum/pearl millet CRSP was discussed. The opinion was unanimous that linkages with ICRISAT should be an integral part of any research program. It was also established that it would be more expedient for the linkages to be developed as the project was being implemented, at which time a meeting could be convened with representatives of both the grain sorghum/pearl millet CRSP and ICRISAT present.

Concern was expressed that the Interim Report be sent to all who should receive it. It was hoped that the format would be understood and that it would facilitate submission of research proposals by interested institutions.

Report on Meeting to Consider an Administrative Entity
for the Grain Sorghum/Pearl Millet CRSP

Date: February 1, 1978

Place of meeting: Chicago, Illinois

Attending:

J. Wendell McKinsey, Assistant Dean, College of Agriculture, UMC
Douglas Ensminger, Professor of Rural Sociology, UMC
C. F. Doane, Center for Intern'l. Programs, Michigan State Univ.
John T. Murdock, Assoc. Director, Intern'l Agri. Programs, Univ. of Wisconsin
W. D. Buddemeier, Assoc. Dean, Director Intern'l. Agri. Programs, Univ. of Illinois
Wm. N. Thompson, Assoc. Director, Intern'l Agri. Programs, Univ. of Illinois
J. S. Robins, Dean, College of Agri., Washington State Univ.
Elmer Kiehl, Dean, College of Agri., Univ. of Missouri
Melvin Blase, Director Intn'l. Programs and Studies, Univ. of Missouri
Jack Kamerer, Contract Officer, Univ. of Illinois

The purpose of the meeting was to examine alternative organizational arrangements for an administrative entity for the Grain Sorghum/Pearl Millet, Collaborative Research Support Program.

The attached communication from Dr. Ensminger to Dean McKinsey records his impressions of the meeting.

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UNIVERSITY OF MISSOURI-COLUMBIA

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2 February 1978

TO: J. Wendell McKinsey
Assistant Dean, College of Agriculture

RE: Report on International Sorghum/Pearl Millet Research and International Foreign Consultancy Program Meeting Held on 1 February 1978 in Chicago, Illinois

FROM: Douglas Ensminger
Professor, Rural Sociology

One of the requirements in the University of Missouri grain sorghum/pearl millet contract was to recommend a management entity to implement an international sorghum/pearl millet research and international foreign consultancy program.

To assist the University in examining alternative organizational arrangements for managing an international research and foreign consultancy sorghum/pearl millet program, J. Wendell McKinsey, Assistant Dean and University of Missouri leader for the sorghum/pearl millet program, invited ten people to a meeting at Chicago O'Hare Airport on 1 February 1978.

In opening the meeting, Dean McKinsey urged an open and unbiased examination of alternative innovative organizational arrangements for managing an international sorghum/pearl millet research and foreign consultancy program.

The discussion opened with an examination of: (1) consortia--either grouping the major U.S. institutions that will be submitting research proposals into a new "special purpose" consortium, or calling on an existing consortium to consider broadening its orientation to accept management of the sorghum/pearl millet program; (2) designating one of the U.S. institutions having a major sorghum/pearl millet research program to be the lead institution serving as the prime contractor in receiving and subcontracting to other institutions approved to participate in the sorghum/pearl millet program; and (3) the University of Illinois INTSOY model.

an equal opportunity institution

The discussion on alternative organizational arrangements then focused sharply on what kind of a management entity would be best suited for the sorghum/pearl millet program.

We started with four knowns.

First, present indications are that five to seven institutions having significant sorghum/pearl millet research programs and international experience will respond to the University of Missouri's invitation to submit research proposals.

Second, each of the institutions will be emphasizing, in submitting their proposals, the specific areas of sorghum/pearl millet research where they have some specialization and have made their reputation.

Third, when these institutional research proposals are scrutinized by the University of Missouri and recommended for approval, each proposal will be examined against the major constraints which the University has identified. When these research proposals are approved, it will be clear that each participating institution will have a significant, specialized segment focusing on researching major constraints.

Fourth, it will be the responsibility of each institution approved for participation in the international sorghum/pearl millet project to develop linkages with other institutions, especially the international centers and institutions in the developing countries. Each major U.S. participating institution in the program will have both a research and international consultancy role to discharge.

Once the group understood that the research focus of the participating U.S. institutions would be on segments of the constraints, consensus emerged that in their particular specialized research areas, each of the participating U.S. institutions would be a lead institution in its research area for the international sorghum/pearl millet program.

A couple things followed from this understanding. One, all the major U.S. institutions which are approved to participate in the program should function as equals among equals, thus ruling out further consideration of one being designated as the lead institution for the program. Two, appropriate representatives from the approved institutions should constitute the nucleus of a Policy Committee for

the international sorghum/pearl millet research and foreign consultancy program.

When we moved to consider management functions for the program, we quickly separated these into fiscal and program. It was general opinion that one of the approved participating U.S. institutions could serve as the prime contract institution in being the recipient of funds for the international sorghum/pearl millet program; and through memorandum agreements, it would dispense funds to the other major participating institutions. With respect to the program management function, there was consensus that an Executive Director for Programs should be selected by the Policy Committee and be responsible solely to the Policy Committee. Arrangements should be worked out for the Executive Director and support staff to be housed, payrolled, and serviced by one of the institutions on the Policy Committee.

The group felt the initial policy arrangements for which institutions would manage fiscal matters should provide for rotation every five years. Likewise, rotation of the location of the Executive Director for Programs should be provided as an option.

More on the Policy Committee: In addition to the U.S. institutional representatives on the Policy Committee, there should be a representative from BIFAD, JRC, the International Agricultural Research Centers, and one or more scientists from developing countries.

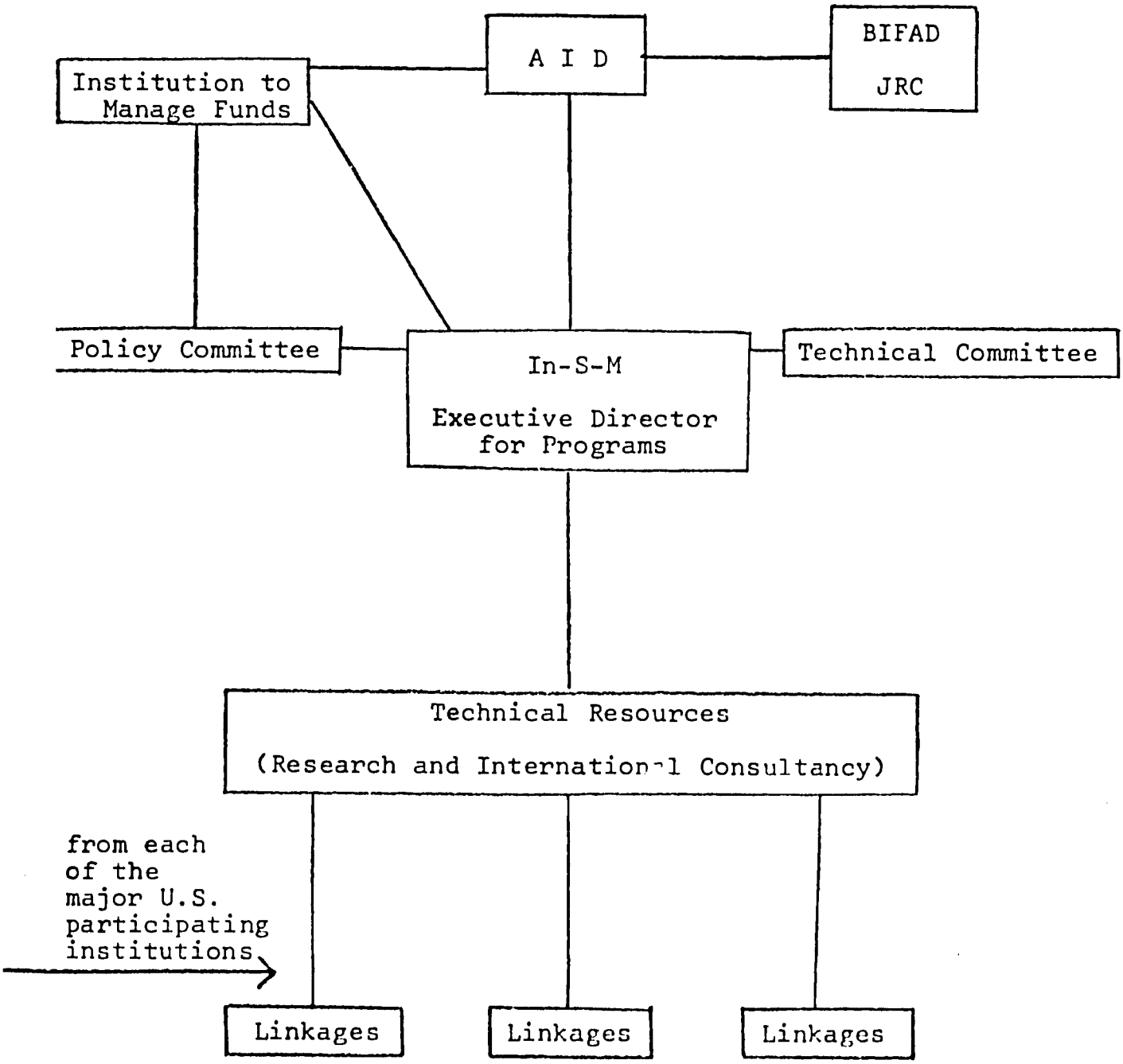
There was considerable discussion on auditing funds. The group felt each institution should stand audit and this be through established audit procedures.

From the above discussions, the group centered its attention on a blackboard and evolved an organizational chart. Since we wanted to name the program management entity, we used In-S-M shorthand for international grain sorghum/pearl millet.

While the Executive Director for Programs will look to the Policy Committee for policy guidance, the group felt there would be a need for a Technical Advisory Committee which might be made up of the leaders for each institution's approved research program.

kld
Attachment

ORGANIZATIONAL CHART FOR MANAGEMENT OF INTERNATIONAL SORGHUM/PEARL MILLET RESEARCH AND INTERNATIONAL CONSULTANCY PROGRAM



Minutes of the Workshop to Finalize the Grain Sorghum/Pearl Millet Collaborative Research Support Program and the Recommendations to JRC and BIFAD for its Implementations March 17-18, 1978

The workshop was held on the University of Missouri, Columbia campus to finalize recommendations to JRC and BIFAD for the implementation of the Grain Sorghum/Pearl Millet Collaborative Research Support Program. The active workshop participants included:

The Expert Panel:

Dr. George W. Sprague	University of Illinois, Champaign/Urbana
Dr. Paul Fitzgerald	ARS, USDA, Peoria, Illinois
Dr. Wm. Thompson	University of Illinois, Champaign/Urbana
Dr. Harold Capener	Cornell University
Dr. WM. Wright	International Agricultural Dev. Service
Dr. Charlotte Roderuck	Asst. Director, Iowa Agric. Experiment Station
Dr. J. C. Davies	International Crops Research Institute for the Semi-Arid Tropics

The Internal Resource Scientists:

Dr. Larrah Darrah, Plant Breeding
Dr. Marion Fields, Nutrition
Dr. Roger Hanson, Agronomy
Dr. Armon Keaster, Entomology
Dr. Herbert Lionberger, Rural Sociology
Dr. Dale T. Sechler, Plant Breeding

Additional UMC Staff:

Dean Wendell McKinsey	Dr. Rex Campbell
Dr. Melvin Blase	Dr. J. M. Poehlman
Dr. E. C. S. Runge	Dr. Richard Lee

From the U. S. Agency for International Development:

Dr. John M. Yohe

Dean Wendell McKinsey opened the workshop with introduction, reviewed how the University had been chosen to plan the grain sorghum/pearl millet CRSP, discussed the procedures, that had been followed to date, and outlined the activities of the workshop.

The job of the Workshop is to develop a comprehensive grain sorghum/pearl millet Collabrative Support Research Program, review the JRC the components of the program and identify institutions to intiate the project.

Proposals were received from 20 institutions. It was pointed out that at the outset of the project, the instructions were given that the University of Missouri could not submit a project. This decision was later reversed, Missouri has submitted a project. UMC representatives will answer questions from the external expert panel then will excuse themselves from the Workshop. Decisions on the Missouri project will be made by the external expert panel.

Comments, suggestions, and concerns were considered by the group.

Eight Research Areas were identified, with one member of the UMC internal resource scientist group leading the discussions. Through the discussions the nature of the research components contributing to each Research Area was explored. Most research components proposed were accepted, others modified, and some dropped, or reduced to a lower priority. The composite was brought together to develop the comprehensive research program.

Each component of the research program was taken up in turn, and proposals reviewed which had elements of research contributory to that specific component. The proposed research was discussed by the workshop group and each proposal accepted or rejected on the basis on its relevance to the research need, proposed or potential linkages with the LDC's and ICRISAT, resources the institution could assemble to attack the problem, and merit of the proposal as written. In the socio-economic area the Workshop recommended the development of a multidisciplinary study to focus on the problems More sharply.

A plan for an administrative entity was presented and discussed. General agreement was given to the plan with some modifications suggested.

SECTION G

LIST OF INDIVIDUALS INVITED TO CONTRIBUTE INFORMATION ON PROBLEMS AND RESEARCH NEEDS

G. LIST OF INDIVIDUALS INVITED TO CONTRIBUTE INFORMATION ON PROBLEMS AND RESEARCH NEEDS

University of Missouri Staff Participating in the Project

J. W. McKinsey	Pat Cantlon
Melvin Blase	Oscar H. Calvert
Douglas Ensminger	Herbert Lionberger
Larry Darrah	Dale Sechler
Roger Hanson	Rex Campbell
J. M. Poehlman	Marion Fields
E. C. A. Runge	Armon Keaster
David Sleper	Robert Malin
Elmer Kiehl	W. D. Heffernan

Outside Experts Participating in Ad Hoc Committee Meetings and Workshops

Herbert Albrecht	Former Dir., IITA, Ibadan, Nigeria
Glen Burton	Ga. Coastal Plains Expt. Station
Elven Frolik	USAID
Leland House	ICRISAT
Vernon Larson	Kansas State University
Fred Mann	Consultant
C. F. Doane	Michigan State University
John T. Murdock	University of Wisconsin
W. C. Buddenmeier	University of Illinois
Wm. N. Thompson	University of Illinois
J. S. Robins	Washington State University
Jack Kamerer	University of Illinois

U. S. University Staff Members Interviewed

TEXAS TECH

Anson Bertrand	Jack Gibson
Dwane Miller	Dan Krieg

TEXAS A. AND M.

R. G. Merrifield	Fred Miller
Darrel Rosenow	Tom Archer
Jerry Johnson	R. A. Frederiksen
Wayne Jordan	Page Morgan
Lloyd Rooney	Keith Schertz
Wm. Ott	George Teetes
Charles Wendt	A. B. Onkon

UNIVERSITY OF NEBRASKA

M. A. Massengale	Herman Gorz
E. F. Frolik	Larry Dunkle
H. W. Ottoson	Paul Nordquist
Robert Gast	Paul Mattern
Glen Vollmar	Jerry Maranville
H. W. Knoche	Max Clegg
E. A. Dickason	Charles Francis
M. G. Boosalis	C. O. Gardner
D. Linsenmeyer	R. Staples
Charles Sullivan	R. V. Klucas
Jerry Eastin	Ray Chollet
O. C. Burnside	W. M. Ross
Ralph Clark	Robert Olson
Dean Kindler	

PURDUE UNIVERSITY

John D. Axtell	Larry Butler
Roy Featherston	R. P. Cantrell
H. L. Warren	V. L. Lechtenberg
T. K. White	George Foster
Edward T. Mertz	R. P. Abernathy
J. C. Rogler	Johann Hoff

KANSAS STATE UNIVERSITY

Floyd W. Smith	O. G. Russ
Vernon Larson	A. J. Cassidy
C. W. Deyoe	L. S. Murphy
James T. Shepard	Ed Kanemasu
Hyde S. Jacobs	G. M. Paulsen
Paul L. Kelley	R. L. Vanderlip
H. L. Hackerott	E. Varriani-Marston
T. L. Harvey	R. C. Hoseney
W. D. Stegmeier	Gerald Wilde
Wm. G. Willis	D. B. Sauer

OKLAHOMA STATE UNIVERSITY

Paul Santlemen	Harry C. Young
D. E. Weibel	R. L. Burton
L. G. Morrill	K. J. Starke
R. Westerman	Richard Wilson
Jewell Crabtree	Hugh Rouk
Wendell Bowers	F. H. Baker
R. E. Page	J. A. Whalley
E. D. Mitchell	

MISSISSIPPI STATE UNIVERSITY

C. E. Lindley	B. C. Dillworth
A. D. Seale, Jr.	John W. Lusk
R. C. Creech	Fred Tyner
J. W. Turner	Travis Phillips
L. M. Gourley	C. R. Sollie
J. C. DeLouche	Harold R. Hurst
C. H. Andrews	Frank D. Whisler
H. N. Pitre	Joe Sanford
Stan King	C. D. Rainey
Nat Zummo	W. F. Jones
Mary Futrell	B. C. Diggs

UNIVERSITY OF ARIZONA

R. Philip Upchurch
Richard Rice
W. G. Matlock
R. G. McDaniel
Mike Rogers
Orrin F. Webster
M. H. Schonhorst
R. E. Dennis
Mashito Sato
W. H. Hale
R. S. Sivengle

Foreign Sorghum/Millet Research Workers and Other Knowledgeable Persons Interviewed

ASIA

India

International Crops Research Institute for the Semi-Arid Tropics, Hyderabad

L. D. Swindale
J. S. Kanwar
R. C. McGinnis
J. C. Davies
Leland House
D. J. Andrews
F. R. Bidinger
R. L. Vanderlip
M. Von Oppen
R. Jambunathan
M. Johda
Hans Binswanger
T. C. Jain
Dallis Oswald
J. G. Ryan
Elven F. Frolik

Indian Agricultural Research Institute, Sorghum Research Station

N. G. Prasada Rao

National Institute of Nutrition, Hyderabad

Bhavani Belavady

Andhra Pradesh Agricultural Univ., Hyderabad

Hamid Ali
Mustafa Hussain
Vittal Rao
K. M. Agam

Agricultural University, Poona

G. Harinarayana
V. Dandekar
S. Patel

Indian Agricultural Research Institute, New Delhi

S. P. Singh
S. C. Poichriyal
G. Jotwani
S. S. Shah
R. P. Singh
M. Ahliwalia
S. B. Mathur
K. N. Singh
Y. P. Singh
A. P. Singh

Indian Council of Agricultural Research, New Delhi

S. Singh
O. P. Gautam

U. S. Agency for International Development, New Delhi

George Warner
Mr. Nair

Punjab Agricultural University, Ludhiana

K. S. Gill

Pakistan

Technical Services Association, Lahore

J. R. Lochman

Yousafwala Maize and Millet Research Institute, Lahore

A. Rahman Chaudhrey

Barani Project, Lahore

Larry Ulsaker
M. Amin

U. S. Agency for International Development, Islamabad

Everett Hedrick
Ed Rice

Agric. Research Council, Islamabad

I. Hussain
Q. Chattah
Dr. Hassan
M. Taber
B. Khan
Mugaffar Hussain
S. A. Razui
M. A. S. Kermani
L. Khokwar

Damascus, Syria

Bhup Bhardwaj (FAO)
Gordon Ramsey (USAID)
Raghard El-ard (Regional Project)
L. R. Morsi (Arab Center for Study of Arid Zones)

AFRICA

Senegal

Dakar

C. J. Fredrickson (AID)
Jim Livingston (AID)
Norman Schoonover (AID)
Claude Charreau (ICRISAT)
Mr. Buresi (SODEVA)
Clark Ross (CRED)
Louis A. Sauger (Senegal Ag. Res. Inst.)

National Center for Agronomy Research, Bambey

G. Beye
E. Loose
J. Denis
Mr. and Mrs. Lambert
R. T. Gahukar
J. C. Girard

Kenya

Nairobi

W. E. Scarborough (AID)
T. Roach (CARE)
B. N. Majisu (EAAFRO)
Hassan M. Nadar (EAAFRO)
J. Ian Stewart (EAAFRO)
H. Van Arkel (FAO)
Mr. Thairu (Ministry of Agriculture)

Katumani

E. Omolo

The Sudan

Kartoum

Abdel Rahim Saeed (Sudan Food Research Center)
A. I. Nustafa (Sudan Food Research Center
Avo S. Izmirlian (Agricultural Businessman)
Mohamed El Shavali Osman (Minister of State for Agriculture, Food, and Natural Resources)
S. M. Badi (Sudan Food Research Center)
Mr. MacMher (AID)

MEXICO

CIMMYT - El Bataan

Haldore Hanson
Elmer C. Johnson
Donald Winkelman
Hugo S. Cordova

National School of Agriculture, Graduate School, Chapingo

Leopaldo Ernesto Mindoza Onofre

EL SALVADOR

Centro Nacional de Technologia Agropecuaria - CENTA

Felix Rodolfo Cristales A. — Mario Apontes Martinez M.C.
Rene Clara — Roberto Antonio Vega Lara M.C.

COLOMBIA

Instituto Colombiano Agropecuario - ICA, Bogota

Jaime Navar Alvarado — Fernando Arboleda Rivera
Manuel Torregroza

CIAT, Cali

John Nichel — Kenneth Rachie
Alexander Grobman — Shree P. Singh

BRASIL

Instituto Nacional de Alimintacago e Nutricao, Brasilia, D.F.

Dra. Feda Cascoal

National Corn and Sorghum Research Center - EMBRAPA, Sete Lagoas, MG

Richardo Magnavaca — Francisco Bahia
Robert Schoffert — William Reis

Empresa Brasileira de Assistencia Tecnica e Extenssao Rural Brasilia, D.F.

Manuel Luis Moscareli — Paulo Menincci Castanheiro

University Federal of Brasilia, D.F., Brasilia

Roberto Meirelles de Miranda

Empresa Brasilieira de Pesquisa Agropecuria

Almiro Blumenschein

IPA - Recife - P.R.

Mario de Andrada Lira

S E C T I O N H

LIST OF INSTITUTIONS SUBMITTING PROPOSALS AND SUMMARIES OF THE PROPOSALS

H. LIST OF INSTITUTIONS SUBMITTING REQUESTS FOR PARTICIPATION IN CRSP

UNIVERSITY OF ARIZONA

Title: A Sorghum/Millet Crop Improvement Program for Less Developed Countries Engaged in Semi-arid Land Agriculture.

PROPOSAL 1

I. Title: Sorghum Genetics - Cytogenetics.

Justification: The inheritance of a number of morphologic characters in sorghum is known but little effort has been expended recently on developing linkage groups. Texas A & M University has developed a set of reciprocal trans-locations which will be useful tools in locating genes into linkage groups. Increased knowledge of the inheritance of these characters will be beneficial in making sorghum breeding programs more efficient wherever they are conducted in the world.

PROPOSAL 2

I. Title: Evaluation and Development of Sorghum and Millet Germplasm adapted to Arid Land Agriculture.

Arizona's desert climate is ideal for isolating and developing sorghum and millet germplasm that can be identified as being heat, salt, and drouth tolerant. Sorghum and millet lines and hybrids of diverse origin will be used as experimental germplasm. An irrigation water gradient will be established using sprinklers arranged so that plants near the sprinkler head output will receive 76 cm of water and this irrigation application will taper to the outside edge of the sprinkler pattern. Each germplasm source will be grown in a gradient from 76 cm of water to natural rainfall (10-15 cm).

Promising germplasm will be used in the University of Arizona's and the University of Nebraska's plant breeding programs to develop superior drouth tolerant and semi-drouth tolerant hybrids and lines.

A new method of measuring photosynthesis and respiration developed by Dr. J. D. Eastin will be used in the field to identify sorghum genotypes within populations which have high and low respiration rates at extremely high temperatures. Growth chambers will be used to identify heat tolerant plants during the germination period.

PROPOSAL 3

I. Title: Evaluation of Soil and Water Management Practices on Sorghum Production.

Many university-operated farms are located throughout the state and exhibit various degrees of salinity and alkalinity. Greenhouse and field studies at these university farms will be used to evaluate the tolerance of various sorghum lines and hybrids of diverse world origin, to soil salinity and sodium toxicity. Preliminary greenhouse studies will allow many lines to be screened. The most promising of these will be field tested at various locations within the state.

On-site inspection of soils and soil and water testing in target areas where potential sorghum production is promising will help evaluate the potential salinity problems in lesser developed countries. Irrigation scheduling techniques will be applied to the spatial and temporal application of available water under possible surface, sprinkler, or drip irrigation. This control strategy will provide guide ines for the management of soil moisture and salinity for successful sorghum production.

PROPOSAL 4

I. Title: Preservation of Native Strains and Wild Relatives of Grain Sorghum and Pearl Millet.

The basis of a strong plant breeding program lies in the breadth and quality of its germplasm collection. The germplasm of native strains and wild relatives of grain sorghum and pearl millet contain a wide range of genetic traits, i.e. disease resistance, insect resistance, etc., which would be of value in future crop improvement programs. These germplasms must be preserved and characterized by methodology which would make them readily available to the plant breeder on a long term basis.

PROPOSAL 5

I. Title: Nutritional Evaluation of Grain Sorghum and Pearl Millet.

II. Objectives:

1. To develop calibration curves for determining by infrared reflectance spectroscopy, the crude protein content, amino acid balance and availability, tannin content and metabolizable energy values (poultry) for sorghum and millet grains and in vitro dry matter disappearance and crude protein content in their vegetative residues, and to provide a rapid, accurate service for screening these grains and their residues for nutritional quality.

   Samples of grain and stover will be screened for the specific nutritional characteristics using conventional small sample techniques. These data will be utilized to develop calibration curves for determining the parameters by infrared reflectance spectroscopy (Technicon Infraalyzer Plus). All curves will be fully tested for predictive usefulness and accuracy. Those which are evaluated as being suitable will be used to provide rapid analysis of nutritional quality for plant scientists and extension personnel, and for testing the germplasm developed in the physiology and plant breeding programs.

PROPOSAL 6

I. Title: A Plan for Apprentice Training of Four Extension Agronomists to Serve in Niger.

Extension Agronomy Specialists in the United States have developed expertise in methods of adapting and sharing information to solve specific problems. These agronomists are in a unique position to assist others in developing such skills.

The Field Crop Agronomist at the University of Arizona is well qualified by training, experience and temperament to provide a strong, carefully thought and well executed apprentice program for extension agronomists from a developing country such as Niger.

II. Objectives:

1. To train four Extension Agronomists from Niger so that they may more effectively plan and conduct extension programs and applied research in their country.

2. To better document relevant agronomic research from all sources as it may apply to Arizona and Niger with emphasis on that concerned with the production of food crops with minimum water use.

Proposed Budget:

Proposal 1	3 years	Total $ 51,500.
Proposal 2	3 years	Total 172,000.
Proposal 3	3 years	Total 137,540.
Proposal 4	3 years	Total 192,880.
Proposal 5	3 years	Total 87,000.
Proposal 6	3 years	Total 128,450.

CALIFORNIA STATE UNIVERSITY, FRESNO

STUDENT AGRICULTURAL TRAINING

PROJECT FOR LESS DEVELOPED COUNTRIES

The development of research capabilities in the less developed countries (LDC) has been the result of direct application of the technology found in developed nations and the education of many LDC persons at universities in the developed countries (DC). To contribute more directly to in-country problem solving capability in the LDC, it is proposed that in-country and/or third country research be combined with U. S. university degree programs.

At California State University, Fresno (CSUF), a student project program has been successfully used to incorporate "learn by doing" into the undergraduate curriculum.. A similar activity at the graduate master's degree level is feasible. Utilizing research activities at CSUF in conjunction with standard course curriculum materials, students will be prepared to conduct actual research in the home country (or a third-country program, e.g., ICRISAT). This approach will allow each student to gain specific abilities relating to real problems in his/her country. The home country will benefit in that applied research will be working to resolve real problems while at the same time students will be receiving the educational training they need to become competent agricultural researchers.

The Grain Sorghum/Pearl Millet project is an ideal project to use for developing the capability for cooperation of CSUF, home country, and the international research center. CSUF has the degree program and research capability for the training aspects of the program. The international center (ICRISAT) has the capability for an ongoing research program on problems of unique interest to home countries. The home countries with U. S. AID programs have unique capabilities to provide well selected students who can benefit from this program.

In order to alleviate food production problems, this program offers the LDC a way to simultaneously acquire, learn, and adapt appropriate technology. The program would function as follows:

I. Professional agronomist from CSUF would be stationed at ICRISAT (or appropriate LDC research station). His role will be to conduct research on problems of current need in the LDC's. Such problems will be related to those for which LDC student participants are selected

to receive additional education and training. Furthermore, his program will include specific research projects conducted by the LDC's participants as a requirement for their M. S. Degree in agriculture (MSA) at California State University, Fresno.

II. LDC participants will be selected for this program on merit, considering their preparation and potential for success. The home country agency will select persons with the help of the U. S. AID mission (or other appropriate agency), in conjunction with CSUF admission policies. Each participant will need to have a B. S. level agricultural background and adequate proficiency in English. If English proficiency is lacking but participants are otherwise qualified, students may first be directed into special language classes offered by CSUF. This would result in some program entry delay.

III. California State University, Fresno will provide an academic advisor and the Master's of Science in Agriculture degree program (one faculty advisor for every 3-5 graduate students). There are a variety of specialty areas in the MSA program available, e.g., plant breeding,plant protection, soils, irrigation. Courses to be taken for fulfilling 30 units would be selected from: Biometrics, plant-water relationships, plant disease control, advanced plant breeding, plant nutrition, laboratory analysis techniques, physiology of cultivated crops, pesticides, plant hormones and regulation, water quality, pest management. Each participant will work with an academic advisor in outlining an appropriate program. To achieve the goal of contributing directly to the problems in the LDC, the participant and academic advisor will visit with persons in the LDC and/or at ICRISAT to outline the MSA plan, including the research by the participant, in lieu of a thesis.

The following time frame is based on a participant ready to begin at CSUF in fall semester 1978 (could be started in spring semester and adjust all activities by 5 or 6 months).

I. August to December, 1978

Participant arrives at CSUF in early August. Enrolls in course in biometrics, literature search and seminar, and other selected international student courses.

II. January, 1979 (between Fall and Spring semesters)

The participant and academic advisor travel to the LDC (and ICRISAT if indicated) for the purpose of:

(1) Observing and discussing current critical problems.

(2) With aid of the resident CSUF agronomist, outlining a research plan.

(3) Outlining a supportive study plan with relevant training for the type of research proposed.

(4) Outlining the acceptable publication requirement in lieu of thesis.

(5) Preparing specific budget needs.

III. Late January to December, 1979

Enroll in spring semester, summer session and fall semester

(1) Take appropriate courses.

(2) Carry out a pilot research plan relevant to the proposal for research in lieu of thesis.

a. Do research design, data collection, statistical analysis, and written interpretation.

b. Derive information leading to design of in-country research project.

(3) Complete required examination.

IV. January, 1980

Participant returns to home country (or ICRISAT) for conduct of research on original selected specific problem. This work is supervised by the resident agronomist.

V. Final evaluation and degree certification is made when the research results are published in a source acceptable to the original proposal.

For the CSUF on-campus work, this program would extend from August one year to December sixteen months later. In some cases participants may require two years to complete the on-campus portion.

The faculty involved should be able to handle from three to five participants at one time, thus reducing the overall expense per participant.

BUDGET REQUIRED: Total $ 141,348

COLORADO STATE UNIVERSITY

Ttile: A Proposal for Pearl Millet Improvement under the Collaborative Research Support Program submitted by Colorado State University

I. Plant Breeding Aspects:

The semi-arid conditions and relatively high elevation at the U.S. Central Great Plains Research Station near Akron, Colorado, provides a site for investigation into a definite set of constraints of pearl millet (Pennisetum glaucum or P. typhoideum) production. Our average annual precipitation is 16 inches (40.5 cm) with a seven month free-water evaporation average of 46 inches (117 cm). Drouth stress is encountered every year, ranging from moderate to extreme. A short growing season of 140 days is partly a result of the elevation (4600 feet or 1400 m) This location, together with other experiment station sites available in eastern and western Colorado, can provide the environment in which to develop germplasm and cultivars which are short seasoned and able to produce under drouth-stress conditions. Early, drouth tolerant genotypes are generally not favored in breeding programs conducted in regions with better agricultural environments, thus this valuable source of genetic diversity can be lost. Our environment in eastern Colorado is typical of that in much of the world and in particular of many LDC's, being too hot and too dry with too short a growing season for many of the more favored crops.

We obtained the Indian (Rockefeller) collection of pearl millet from Dr. Leland House in 1970. This collection has been grown each year since then and mass selected for mature heads. As a consequence we now have a population of diverse types which is able to consistently mature seed in northeastern Colorado under even the extreme stress of 1977 (1) inches of total ppt., Jan.-Sept.). This population could provide the nucleus of germplasm from which to develop advanced materials and cultivars for areas with environmental constraints similar to ours.

Our research would generally apply to subsistence or small farm production. To reduce genetic vulnerability and to simlify seed production, we would seek to produce synthetic populations. The genetic base of our present population will be widened by including early types from other programs. We have developed exchange of material and testing work with Dr. Glenn Burton, and would expand this and other contacts. We propose research in the following categories.

A. Selection for stand establishment. Experience with all crops adapted to our region illustrates the

importance of obtaining adequate stands. We also know that it is possible to select material with superior ability to germinate and establish under cool, dry soil conditions. This will be approached through laboratory experiments to determine planting depth vigor and soil temperature differences of emergence, as well as actual field emergence.

B. Water use efficiency and ability to tolerate drouth stress. From the time of Briggs and Shantz before 1920 the Akron location has studied water use and the various aspects of yield and water. An excellent ARS-USDA support staff is available to assist and advise with studies of water-use efficiency and rooting depth, two factors which would help identify pearl millet germplasm able to tolerate drouth stress.

C. Breeding for yield and quality. Quality improvement must accompany yield improvement. We will test for quality and nutritional factors at each stage of germplasm development. These will be concentrated in broad-based populations capable of producing high average yields of acceptable food.

II. Quality and Nutritional Evaluation of Pearl Millet:

A. Initial screening of available pearl millet lines (1st year)

The cereal plant breeder, the analytical chemist, and the nutritionist need to cooperate to improve the nutritive value of cereals. Lines with potential for higher protein or for protein of superior amino acid composition will have to be selected. Genotypes with factors which make millets acceptable or non-acceptable in human nutrition need to be identified. Selection of lines with increased nutritional characteristics and acceptability will be based on a) the amount of lysine - the first limiting amino acid in cereal grains, b) total nitrogen content, c) digestibility of the grain and d) the organoleptic acceptability as indicated by tannin content.

III. Methods:

1) lysine - dye binding capacity (method suggested by the Protein-Calorie Advisory Group of the United Nations - PAG; PAG Bull. 5(2), 22 (1975).

2) total nitrogen - micro Kjeldahl method (on lines with promising lysine contents).

3) digestibility - multienzyme in vitro method (Hsu et al., J. Food Sci. 1977) digestion of an aqueous protein suspension at 37°C, pH 8 using a combination of trypsin, chymotrypsin and peptidase and measurement of pH change (method suggested by Food Protein Res. Group, Univ. of Nebraska and NSF, RANN Div., in "New Concepts for rapid determination of protein quality" - Feb. 1977).

4) tannins - method of Burns, Agron. J. 1971. (Tannin determinations have been suggested in "Improving the nutrient quality of cereals", AID Workshop, Sept., 1976).

B. Evaluation of advanced lines (years 2-5)

Cereal grains contribute more than any other single group of food staples to both calories and protein in human nutrition. Therefore, in addition to the analyses of lysine, total nitrogen, digestibility, and tannin content on advanced lines from the agronomy program of this project, (Part I) the following additional tests and analyses will be peformed:

1) proximate analyses - moisture, ash, fat, fiber (American Association of Cereal Chemists - Approved Methods). Millets are rather high in fat compared to other cereal grains which affects total caloric intake in millet consuming populations. Fiber has received much publicity recently because of its possible connection with several diseases of modern civiliation.

2) relative protein value RPV - The RPV method is recommended for the biological evaluation of advanced lines. In this assay the rate of body weight change of rats fed various levels of the test protein is compared with that obtained with animals fed a reference protein. (PAG recommended; Bull. V (2), 39 (1975)

3) organoleptic evluation of millet varieties - Samples of millets will be milled with a simple hammermill as it might be found in rural areas of LDC's. The color of the millet meal, which affects acceptability, will be determined with the Hunter Color Difference meter. Acceptable color standards will be developed. The millet meals will then be cooked into a gruel and evaluated organoleptically using the Flavor Profile Method, one of the most sophisticated forms

of sensory evaluation available. Through the use of a trained panel, the aroma, flavor, and aftertaste of a product can be defined with regard to individual sensory sensations and also to intensities inherent to the product.

4) functional characteristics of millet meals - Among the functional characteristics of millet meals, water absorption capacity and viscosity are of special importance to LDC's. These characteristics influence food application possibilities as well as the amount of millet meal that can be consumed as a gruel, which is important especially in infant feed. Viscosity of gruels of a fixed millet-to-water ratio will be measured with the Brookfield viscosimeter. Water absorption capacity will be measured by suspending a fixed amount of millet meal in a given amount of water, followed by centrifugation and determination of the amount of bound water. Both of these characteristics will also be determined as influenced by millet meal particle size. Results of the evaluations of nutritional, sensory, and functional qualities of each year's millet crop samples will be reported to the agronomist of the project.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$37,400.	$39,650.	$42,260.	$45,170.	$49,350.

CORNELL UNIVERSITY

Note: Cornell University has submitted two proposals. Only the Title, The Problem, the Objectives and the Proposed Budget are reproduced here.

PROPOSAL 1

I. Title: Adaptive drought tolerance of grain sorghum and Pearl Millet.

II. The Problem:

Limitations of crop production due to drought are a world wide problem, and most agricultural regions differ only in the frequency and intensity of drought stress. The many problems now posed by moisture stress will be multiplied as demands for increased productivity arise and crop production is extended to new and less favorable regions of cultivation. As the repercussions of drought are most devestating to the subsistence farmers of the less developed countries of the world, this constraint is best alleviated through plant breeding efforts directed to improving yield stability under drought conditions. Presently, there is a substantial commitment to such breeding programs, however, plant breeders are hampered in their efforts by the lack of suitable screening procedures for evaluating germplasm for drought resistance. Clearly, there is an urgent need for a more basic research oriented foundation in order to provide for the development of techniques to fully explore germplasm resources.

III. Objectives:

1. To develop a system to induce plant water stress in a temporally well-defined and uniform manner.

2. To determine the extent of species and cultivar differences in adaptive drought tolerance as evidenced by the maintenance of turgor potential.

3. To investigate the physiological and biochemical factors responsible for maintenance of turgor potential.

4. To formulate appropriate techniques and systems for screening and selecting for adaptive drought tolerance.

Proposed Budget:

1st Year	2nd Year	3rd Year
$ 126,533	$ 127,183	$ 131,557

PROPOSAL 2

I. Title: Expansion of Utilization of Sorghum in Foods in LDC.

II. The Problem:

Sorghum grown in semi-arid areas of Africa and India is an important dietary component of the inhabitants of these areas. In the U.S. approximately 20 million tons of sorghum is grown, but only 0.5% is used in food. There is little information available on the physical properties of the starch and protein of sorghum. Unlike wheat protein, sorghum protein does not form a viscoelastic dough upon the addition of water. For the development of improved or new products from sorghum, much additional inormation is needed concerning the physical properties of the protein and starch components.

III. Objectives:

1. In conjunction with our ongoing research and proposed Title XII research, it is our intent to conduct research on the isolation and determination of the physicochemical properties of the protein from sorghum and to concurrently study the composition, structure and physical properties of the starch. We plan to develop a practical procedure for the isolation of a protein isolate in an undenatured state. The physical properties of the protein will be systematically determined to assess its potential as a raw material for high protein foods; as a functional ingredient in food blends, and as a texturizing agent in starch-rich foods. Thus, we will determine composition, susceptibility to proteolysis, solubility, extensibility, emulsifying and foaming properties, water-holding capacity, and the texturing capacity of the protein. Elucidation of these physical chemical properties will enable us to predict the functional properties of sorghum protein. These properties are critical in determining the usefulness of this protein as a protein ingredient and as a starting raw material for high-protein foods.

2. We plan to evaluate the flavoring of products made from sorghum protein. One of the major limiting factors in the utilization of novel sources of protein in the fabrication of protein-rich foods (which simulate traditional food items) has been the inability to flavor the novel product so that it faithfully reproduces the taste, texture and flavor of the original product. An important facet of this research will attempt to elucidate tannin protein interactions and develop methods to control it.

3. Concurrently, we propose to examine methods for enhancing the nutritive value of sorghum protein:

a. By blending this protein with other lysine and methionine rich proteins, e.g., protein of certain beans or protein whey powders.

b. By fortification with stabilized amino acids, i.e, methionine/lysine rich peptides.

The stability of these fortified proteins in typical food applications in chapatis will be studied.

Proposed Budget:

1st Year	2nd Year	3rd Year
$58,708.	$58,508.	$58,778.

FLORIDA A & M UNIVERSITY

Note: Florida A & M University has submitted six project proposals. Only the Title, Proposed Objectives and Proposed Budget is reproduced here.

PROPOSAL 1

I. Title: Nutritional Characterization and Genetic Improvement Monitoring of Grain Sorghum and Pearl Millet (GS/PM) Seed.

II. Objectives:

1. To perform chemical characterizations and determine the nutritional value of each wild strain and new cultivar. (This will include total protein, polyacrylamide electrophoretic resolutions and identification, amino acid composition, and oil).

2. To monitor breeding/genetic experimentation by various analytical technology (polyacrylamide gel electrophoresis, etc.).

3. To develop if possible a genotypic classification system based on seed protein component electrophoretic profiles of developed cultivars and wild species.

4. To monitor the presence of any contaminant mycotoxin in seed stock prior to releasing for cultivation.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$69,875.	$72,770.	$75,461	$78,771.	$82,927.

PROPOSAL 2

I. Title: Development and LDC field testing of culturally acceptable Recipes Utilizing Grain Sorghum/Pearl (GS/PM)

II. Objectives:

1. To determine the appearance, flavor, cooking quality, texture, etc. of selected GS and PM flours (ones that are determined to be high in quality and nutritional value).

2. To modify or develop recipes utilizing GS/PM which are in keeping with traditions of the LDC.

3. To test recipes utilizing equipment and utensils similar to those actually used in the LDC.

4. To transfer the information via nutrition education channels to the LDC and aid in family use.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$86,610.	$82,037.	$103,346.	$884,497.	$121,142.

PROPOSAL 3

I. Title: Field Research Experimentation and Cultivation of Grain Sorghum/Pearl Millet (GS/PM) Wild Strains and Developed Varieties.

II. Objectives:

1. To field test new and promising varieties as they are developed and made available by plant breeders and geneticists.
   a. To monitor growth as to height, tillering (Number of stalks), lodging, effect of intercropping, etc.
   b. To record natural resistance to:
      i. Diseases (anthracnose, smut, etc.)
      ii. Insects
      iii. Birds, rodent pests
      iv. Mycotoxins (aflatoxin, etc.)

2. To serve as a reproductive station to increase the quantity of seed of wild strains as they are collected and of new varieties after new development by the breeder/geneticist.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$104,815.	$99,223.	$101,681.	$111,508.	$111,231.

PROPOSAL 4

I. Title: Research on Entomological Problems of Grain Sorghum/ Pearl Millet (GS/PM) in Latin America.

II. Objectives:

1. Survey of destructive and beneficial insects associated with GS/PM crop systems. This survey must be carried out in each region where GS/PM is grown since insect species will vary from region to region. Synoptic voucher collections will be set up for each region, on site in the United States.

2. Search out alternative hosts of pest species, for potential control measures.

3. Life history studies of pest species in various areas planted in GS/PM, especially in areas where the crop has been recently introduced.

4. Investigate possibilities of alternative controls using minimal amounts of insecticides along with biological and cultural controls.

5. Train people in the area of study to do all of the above.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$132,628.	$132,106.	$138,367.	$144,499.	$151,702.

PROPOSAL 5

I. Title: Pre-proposal for a Data Base Management System for the Grain Sorghum/Pearl Millet Project.

II. Objectives:

The prime elements of any data base management system are:

1. The data,
2. Computers and associated teleprocessing equipment
3. Computer software (programs) for generalized data base management.

Although attention is usually focused on the computer and associated software as the most complex parts of the system, the Proposers will place the bulk of their effort on the definition and acquisition of the data.

The technology of data base management systems is well established. Proven, operational techniques exist for connecting a network of computers to one another and to a network of users (who are also interconnected via the computer connections). Hence, regardless of the most stringent needs of the GS/PM project, the question is not how to manage the data, but rather, which one of many existing systems should be chosen. Thus, the proper focus for the development of a data base management system is the development of the data base.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$73,468.	$95,209	$96,741.	$98,501	$100,507.

PROPOSAL 6

1. Title: Cultural, Social and Ecological Factors in the Adoption of Grain Sorghum and Pearl Millet by Small Farmers.

II. Objectives:

1. To organize institutional linkages between an international university and Florida Agricultural and Mechanical University in an cooperative effort to develop programs of research, training and dissemination of research results that will facilitate increased production and consumption of grain sorghum and pearl millet.

2. To survey and identify characteristics of resources; determine land and resource use patterns; investigate responses of humans, crops and animals to ecological factors; investigate production practices and analyze their relationships to environmental, sociocultural and institutional factors.

3. To obtain and analyze basic information about small farmers and rural families dependent upon agriculture. Emphasis will be on personal, family, and group characteristics, traditional values, attitudes and beliefs, and the incentives and constraints under which small farmers and consumers operate in making decisions.

4. To investigate and analyze patterns of food cosumption, nutrient intake and food expenditures and their relationship to different characteristics of individuals, households, families and groups in zones and areas. Emphasis will be on factors that influence individual food and expenditure choices as well as group food habits and consumption patterns.

5. To determine market participation of small farmers and its significance: analyze importance of different factors that might change with increased production and consumption of GS/PM. Attention will be given to farmer's perception of market operations and consumer needs and attitudes.

6. To evaluate existing programs for disseminating information to small farmers, and determine ways by which information can be adapted and presented effectively in the local situation.

7. To train a group of investigators who can continue progress toward the objective.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$100,517.	$103,051.	$107,493.	$112,173.	$119,436.

UNIVERSITY OF FLORIDA

Note: The University of Florida has submitted three proposals. Only portions of the proposals are reproduced here.

PROPOSAL 1

I. Title: Cytological Investigations of Cytoplasmic Sterility Systems in Sorghum and Pearl Millet.

We will attempt to determine sites of cytoplasmic sterility factors and intracellular effects of these factors with light and electron microscopy.

Commercial hybrid seed production in sorghum and millet is based on manipulations of pollen production through combinations of male sterile, maintainer, and restorer lines. However, the mechanisms by which cytoplasmic factor-nuclear interactions control pollen abortion and fertility restoration are not understood (Edwardson 1970. Bot. Rev. 36:341-420). There is evidence supporting the location of sterility factors in plastids of Oenothera (Stubbe 1959. Zeits. Vereb. 90:288-298), Epilobium (Michaelis 1969. Cytologia 34:1-114, Supplement), and tobacco (Chan, Kung, Gray, Wildman 1975. Biochem. Gen. 13:771-778), and in non-organelle bodies in Vicia raba (Edwardson, Bond, Christie 1976. Genetics 82:443-49), but sites of sterility factors in other species are unknown. In milo-type sterile sorghum, electron microscopy has shown tapetal (Overman, Warmke 1972. J. Heredity 63:227-234), and callose abnormalities (Warmke, Overman 1972. J. Heredity 63:102-108.

To date electron microscopic comparisons of growing points of milo-sterile and normal sorghum lines and of several non-milo sterile lines obtained from India (Nagur 1972 Ph.D. Thesis, Tamil Nadu Ag. Univ., Coimbatore, India) have not shown consistent differences in cytoplasmic constituents (Edwardson, unpublished). We propose to continue these comparisons and to expand the studies to include feterita cytoplasmic sterile (Tatwadi, Shekar, Bhatambrekar, Wadhokar 1972. Punjabra Krishi Vidyapeeth Res. J. 1:137-136), other non-milo steriles (Duvick 1977. Ann. N.Y. Acad. Sci. 287:86-96), and male sterile millet lines. Also light and electron microscopy will be applied to investigation of filament development,

pollen formation, and tapetal behavior in non-milo sterile sorghum and in sterile millet lines. These investigations should increase our understanding of the mechanisms of pollen abortion, and may lead to determining sites of sterility factors in sorghum and pearl millet. These studies should also be of value to programs involving induction of mutations in cytoplasmic factors, and in parasexual transfer of cytoplasmic factors..

Graft transmission of cytoplasmic male sterility in petunia (Frankel, 1956. Science 124:684-685; Edwardson, Corbett 1966. Proc. Nat. Acad.Sci. 47:390-396), sugarbeet (Curtis 1967. Euphytica 16:419-424), and alfalfa (Thompson, Axtell 1978. Crop Sci., in press) suggests that in some cases sterility factors may not be associated with organelles, but may be virus-like entities. The light and electron microscope techniques utilized in studying the cytoplasm of sterile and normal sorghum and millet lines will be the same as those employed for the virus investigations described in the following section. It is possible that sterility factors in some lines are virus-like; our techniques should permit us to detect such entities (Edwardson, Bond, Christie 1976. Genetics 82:443-449).

Facilities available for the proposed research are screened air-conditioned Orlyt greenhouses, growth chambers, cytological laboratory including research microscopes and cameras, cryostat, ultramicrotomes, vacuum evaporator, and a Phillips EM 200 electron microscope.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$14,700.	$8,200.	$7,700.	$8,200.	$8,000.

PROPOSAL 2

I. Title: Associative N_2-Fixation in Pearl Millet and Sorghum.

Inadequate soil nitrogen has been listed as a major constraint to the production of sorghum and millet. Priorities listed in "An Interim Report Identifying Principle Constraints in Production, Marketing and Utilization of Grain Sorghum and Pearl Millet in Less Developed Countries" indicated that increasing soil

fertility from non-market, non-monetized sources should receive attention. Specifically, research on nitrogen fixation had high priority. Biological nitrogen fixation in legumes has already proven to be an effective non-monetized means of supplying legumes with nitrogen and improving soil fertility.

We now have evidence that nitrogen-fixing bacteria associate with the roots of sorghum and millet and this association can result in increased productivity. Florida data taken over a three-year period have shown dry matter yield increases up to 32% and protein increases up to 39% in pearl millet as a result of inoculation with the nitrogen fixing bacterium, Azospirillum brasilense (Smith et al., 1976. Science 193:1003-1005; Smith et al., 1976. Proc. 11 Intern. Symp. N_2-fixation, in Press; Bouton et al., Crop Sci., submitted). In the Bahamas, Dr. R. W. Thomas demonstrated a 29% increase in dry matter yield of pearl millet after inoculation with Floridian and Brazilian strains of A. brasilense (personal communicatin).

Nitrogenase activity has been reported numerous times in both sorghum and millet roots. ICRISAT screened many sorghum hybrids and found the most active had an activity of 325 ug N/core/day or about 184 g n/ha x day (=18.4kg N per 100 days). Activity varied considerably from hybrid to hybrid and was dependent upon sorghum growth stage and soil temperature. Pearl Millet nitrogenase activity has higher than sorghum (Joint UNOP/CIMMYT/ICRISAT Policy Advisory Committee report 1977).

In Florida we measured nitrogenase activity, using intact soil-root cores, at about 100g N/ha x day (unpublished data, 1977).

II. Proposed Research Plan:

1. Factors affecting associative grass-bacteria associations in the field and/or greenhouse and growth chamber. Factors of major interest:

   a. Soil fertility (major and minor elements
   b. 0_2 effects in root zone
   c. Temperature
   d. Inoculation techniques.

2. Collection of bacteria capable of associating with grass roots and producing high relative nitrogenase activity.

3. Sorghum and millet genotypes which match bacteria

strains for optimum response including:

a. Field trials
b. Greenhouse trials with and without control of competing organisms
c. Axenic cultures.

4. Genetic variability for response to associative N_2-fixing bacteria.

5. Soil ecology and longevity of introduced N_2-fixing bacteria. Techniques will include:

a. Immunoflorescent microscopy
b. Double marked strains
c. Standard microbiological methods
d. Standard cytological techniques.

6. ^{15}N in determining quantitative amounts of nitrogen fixed, in both greenhouse and field.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$97,155.	$88,936.	$87,892.	$94,028	$100,555.

PROPOSAL 3

I. Title: Breeding Grain Sorghums for Sub-Tropical Adaptation with Emphasis on Anthracnose and Midge Resistance

Sorghum (Sorghum bicolor (L) Moench) is considered to be of tropical origin, but the major U.S. production and research effort is in the temperate semiarid Great Plains. Cultivars and hybrids generated from Federal, State, and commercial breeding programs are often ill-adapted to warm-humid conditions of the sub-tropical regions of the U.S. and countries with similar environments. Resistance to leaf and stalk diseases, especially anthracnose (Collectotrichum graminicola (Ces.) Wils), seed molds and sprouting; and resistance to midge and bird damage are major considerations in breeding for these conditions (Harris, 1971. University of Georgia, College of Agriculture-Experiment Stations, Research Report 98). Highly productive grain sorghums with resistance to several of these factors are not available.

In all research, efforts will be made to monitor nitrogen content of plants and soil (where appropriate), acetylene reduction, dry matter yields, and presence or absence of various bacterial strains.

We expect to produce technology that will permit use of these systems by subsistence and small farmers as well as other producers not capable of using high rates of nitrogen fertilizer. This technology will include genotypes of sorghum and millet and strains of N_2-fixing bacteria capable of producing best increases in productivity.

III. Research Plan:

1. Accumulate and evaluate germplasm for resistance to anthracnose and midge (in the field).

   a. Anthracnose-- Sorghum germplasm will be rated in the field for degree of infection and damage at physiological maturity (leaf, head, and stalk evaluations).

   b. Midge-- plantings will be made to produce heading during high midge populations. Evaluations will be based on reduction in seed set and midge emergence from selected panicles.

2. Make crosses (field and greenhouse) of resistant selections to productive susceptible lines and follow backcross and pedigree section procedures to develop productive lines with resistance to both pests.

   a. Cross F_1's to combine resistance for both pests.

   b. Evaluate as in 1.a and b.

3. Release productive lines and bulk populations with resistance to both pests.

4. Publish appropriate data concerning the development and performance of said lines and bulk populations.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$44,785.	$38,596.	$37,378.	$39,925.	$42,177.

UNIVERSITY OF GEORGIA

Note: The University of Georgia has submitted three separate proposals. Only Title, Need or Introduction, Proposal/Procedures and Proposed Budget are reproduced here.

PROPOSAL 1

I. Title: Pearl Millet Breeding

II. Need:

There is a need for more efficient methods for the genetic improvement of pearl millet. Plant breeders frequently mention 10 years as the time required to breed a new variety of crop. Where more than one generation can be grown in a year this time requirement can be reduced but it still may be too long to save an outstanding variety of hybrid from the ravages of a new disease or other pest. A specific example is the fate of HB1 hybrid pearl millet (Tift 23A x Bil 3B) released in India in 1965.

III. Proposal.

We believe that it will be possible to develop a millet breeding method that will enable millet breeders to incorporate into outstanding hybrids or varieties major genes for pest resistance, early maturity, etc. in 2 to 2 1/2 years. Such a method could save outstanding varieties and hybrids such as HB1 pearl millet. The development of this method will require the combination of what we have learned in over 40 years about the physiology and genetics of pearl millet.

Since downy mildew on pearl millet does not occur in the U.S., we propose to develop the method by inroducing an early maturing gene we have recently isolated into 3 outstanding normal season pearl millet hybrids. Parents for two of these hybrids were supplied by Dr. David Andrews from the ICRISAT program in October, 1977. We would hope to cooperate with geneticists at ICRISAT and perhaps in Africa in developing the proposed method with them introducing resistance to downy mildew or some other local pest into superior varieties or hybrids.

If our method is successful, the early maturing hybrids should be of great value in many parts of the world including the U.S. On the edge of the desert where it is often necessary to make a crop after a single rain, such early hybrids should have great value.

With this support we would also hope to study other improved breeding methods for pearl millet genetic improvement. The modification of our Recurrent Restricted Phenotypic Selection method to apply to pearl millet improvement will be one such additional effort.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$25,000.	$25,000.	$25,000.	$25,000.	$25,000.

PROPOSAL 2

I. Title: Breeding of Sorghum for Soil Stress Environments

II. Introduction:

The Agronomy Department at the Georgia Experiment Station assumed a leadership role several years ago in microelement research. Four soils specialists and a plant physiologist comprise the present nucleus for the developing microelement research center. In addition a minimum tillage, multiple cropping fertility program is well established. The major commodity breeding programs (sorghum, corn, small grains) at the Station have initiated projects aimed at development of varieties tolerant to the acid soil conditions of the southeastern U.S. and the nutritional problems associated with these conditions.

III. Objectives;

The following objectives are intended to be organized under a cooperative research program involving the University of Georgia and the LDC's experiencing such problems.

1. a) Simultaneously screen exotic and U.S. sorghum lines in the U.S. and LDCs for sources of tolerance to acid soils.

   b) Identify genetic and physiological characteristics contributing to adaptation in an acid soil environment. (The technical studies may have to be conducted solely in the U.S., depending on availability of equipment in the LDC).

   c) Begin development of A, B, and R lines tolerant to acid soils (both U.S. and LDC).

2. Parallel screening of sorghum lines and development of germplasm adapted to production under various minimum tillage and double cropping situations in the U.S. and LDC. Characteristics being sought include ratooning ability for grain and forage, disease and insect resistance, low seed tannin, weathering resistance, bird resistance.

3. Cooperatively identify sorghum lines which require lesser inorganic nutrients and/or which exhibit improved efficiency in the utilization of limited nutrients. Physiological studies, specific production systems (i.e. winter legume-sorghum rotation as nitrogen source), and analysis of plant samples for element uptake will be utilized in the screening process. (The technical studies and subsequent analyses may have to be conducted solely in the U.S., depending on availability of equipment in the LDC).

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$101,020.	$71,571.	$72,500.	$73,565.	$77,319.

PROPOSAL 3

I. Title: Breeding for Resistance to Anthracnose in Sorghum Collaborative Research Support Program

II. Introduction:

The University of Georgia has conducted a sorghum anthracnose screening nursery for the benefit of public institutions and private companies during the past several years. The predominant climatic conditions (warm temperatures, high rainfall, high humidity) of the state are conducive to fairly uniform and dependable disease infestations most years. Supplemental artificial inoculation (conidial injection) helps to insure uniformity of infestation and improves reliability of disease ratings, especially during years when climatic conditions prevent or delay disease development.

Type of Production/Utilization System:

Grain sorghum production in the humid Southeast is geared mainly for minimum tillage and double cropping practices in an effort to alleviate the problem of feed-grain deficiency. Livestock are predominantly grass-fed and supplemented with various feed grains. Georgia is also the leading state in poultry and egg production. Some of the sorghum grown in the state will be fed directly on the farm while the remainder will be marketed as a feed grain.

III. Objectives:

The following objectives are intended to be organized under a cooperative research program involving the University of Georgia and the LDC's experiencing such problems.

1. Investigate the host-pathogen interaction regarding foliar, culm-peduncle, and panicle infestation and subsequent disease development during both juvenile and reproductive growth.

2. Compare pathogenic organisms found in Georgia (and remainder of U.S.) vs. organisms in the LDC's to ascertain the scope of race specificity.

3. Continue identification (via screening techniques) both in LDC and the U.S. of available material for new or improved sources of resistance.

4. Transfer anthracnose resistance to elite lines.

5. Introduce all possible sources of anthracnose resistance into a population of elite lines to attempt to build an improved and more stable resistance by selecting for horizontal type of resistance. The LDC's and the U.S. will develop this new population simultaneously.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$95,936.	$65,608.	$68,655.	$69,330.	$72,693.

KANSAS STATE UNIVERSITY

Title XII Sorghum and Pearl Millet

Kansas has long been a major producer of sorghum both as a grain and a forage crop. Approximately 25% of the total U.S. grain sorghum production is in Kansas and nearly 35% of the total forage sorghum production is in this state.

Similarly, sorghum research historically has been, and presently is, an important segment of the research of the Kansas Agricultural Experiment Station. In 1975, according to the CRIS records on research by commodity, the Kansas Agricultural Experiment Station had 17.5 scientist man years devoted to sorghum research with an annual expenditure of approximately one million dollars. Approximately 30 research projects were primarily devoted to sorghum research. These projects were in the Departments of Agronomy, Animal Science, Plant Pathology, Entomology, Grain Science, and Agricultural Engineering, with many of the projects being cooperative between more than one department. Kansas State University and ARS, USDA led in introducing pearl millet and developing improved populations for grain use in the U.S. This led to an AID contract in 1977 aimed at improving pearl millet, particularly in yield, water relations, stand establishment, and quality for the developing countries.

It is an anticipated that Kansas State University might provide the leadership role in the research regarding pearl millet and substantial involvement in grain sorghum. The urgent research needs identified by the Missouri group would be approached with the following objectives. In many cases these would be coordinated with other agricultural experiment stations as indicated and/or with ICRISAT as the present pearl millet project is being developed.

1. Plant breeding and genetics (Hackerott, Stemeier, Harvey, Mills, Wilde, unidentified plant pathologist, unidentified sorghum breeder). A vigorous plant breeding program is central to utilization of much of the other information grained in the various segments of the research. This program would incorporate urgent research needs (3) plant pathology and (4) entomolgoy and recognizes that the major disease and insect problems of pearl millet are not present in the U.S. A coordinated effort will allow studies on related pest species found in the U.S. that may have application in the LDC's. The following specific objectives would be proposed that would be included.

   A. Millet

      (1) Create widely adapted high yielding populations that have tolerance to environmental stress, photoperiod insensitivity, high nutrient content, or desirable physiological systems in resistance to diseases and insects.

(2) Develop millet lines and hybrids with improved grain yield potential, improved grain quality, efficient mineral uptake, and improved resitance to environmental stress including heat, cold, drought, and salinity.

B. Sorghum

(1) Develop agronomically desirable sorghum populations and lines with resistance to diseases and arthropod pests.

(2) Develop tetraploid grain sorghumes with improved fertility so that genetic variability of wild tetraploids could be exploited in improvement of cultivated grain sorghums.

2. Cultural practices (Vanderlip, Kanemasu)

Research needs in this area were identified primarily as those which would lead to yield stability. Many of the responses studied here would likely result in changes in the plant breeding program and would be best utilized through improved genetic material. The following specific objectives would be considered for both sorghum and millet.

(1) Identify yield-related physiological and developmental processes adversely affected by environmental stresses.

(2) Investigate environmental, morphologic and chemical factors controlling water loss from plants and evaluate the relationship between biological efficiency and water-use efficiency.

(3) Identify seed and seedling characteristics associated with field-establishment performance of sorghum and millet, and identify and evaluate germplasm with the capability of establishing normal stands under stress conditions, particularly temperature, moisture, and high salt conditions.

(4) Develop models which incorporate both the known genotypic responses and the range of physical and chemical environments in order to estimate the effects of changing environmental conditions or changing genotypes on individual yield responses.

3. Entomological research (Harvey, Mills, Pederson, Wilde, unidentified plant pathologist).

A. Field insects

A number of insect species have been recorded from the millet but their pest status is not well-known and needs study. The chinch bug is an a-propriate choice for initial work on plant resistance, since it is known to occur on sorghum in South Americ, Asis, Africa, and Kansas and is reported to be a pest of pearl millet in Asia.

B. Storage insects and microorganisms

Insects cause sizeable postharvest losses to millet and sorghum. In humid areas or in poor storage facilities, fungi may destroy grain and produce toxins harmful to consumers.

Areas needing investigation:

(1) Effects of environmental factors on biology and behavior of stored-grain insects in sorghum and millet.

(2) Susceptibility of various cultivars of sorghum and millet to stored-grain insects.

(3) Effects of storage conditions on microbial growth and toxin production in sorghum and millet.

(4) Relationship between the form in which millet is stored on farms (i.e., in heads or threshed), types of storage facilities, and its susceptibility to insects and microorganisms.

(5) Development of methods (applicable to LDC's) for controlling stored-grain insects in millet and sorghum.

(6) Effects of harvesting and handling methods on storability of sorghum and millet.

As production increases, studies may be needed on large-scale, long-term storage in LDC's.

4. Grain Quality (Hoseney, Marston, Pederson)

This area and (6) storage, was indicated as one of the important ones for research on pearl millet. In addition, it is the one area in which there is least expertise available in the international institutions. Specific objectives proposed here are:

(1) Determine how millet and sorghum are processed, prepared and consumed in traditional village foods and determine what constitutes high quality grain according to the villagers.

(2) Devise standardized laboratory procedures to prepare traditional village foods and use them to develop simple screening tests to predict end use quality that can be used in breeding programs.

(3) Identify, develop and evaluate millet and sorghum lines with improved nutritional quality using both chemical and biological methods.

(4) It is imperative that more fundamental knowledge on the properties of the various chemical components of millet and sorghum be developed. This would include characterizing the proteins, starch, lipids, pentosans, tannins and certain other components.

(5) Determine the factors that affect resistance to grain weathering and storage deterioration in millet and sorghum

(6) Determine the chemical components and physical characteristics of millet grain which reduces digestibility and availability of nutrients and interferes with end use quality of the grain in traditional foods.

5. Development of Improved Methods of Technology Communication (Prawl, Harris unidentified information specialist).

One of the key factors in increasing agricultural production in developing countries is that of informing and motivating small farmers to use existing and newly acquired technology information to stabilize or increase yields. Problems surrounding communication, motivation and leadership exist in virtually every country. One of the prime ingredients in a successful extension

program is the communication of valid and tested information to low-income farmers, particularly in remote areas. Paper communication of techniques needs to take into account the educational level of the population, as will utilize existing social networks and belief systems.

The ultimate objective of this activity is to increase agricultural production. This research project would examine the use of modern rural technology, such as audio cassette tape recorders and the existing social networks through volunteer leaders to disseminate agricultural information to farmers. Farmers served would be friends, neighbors and family members of the volunteer leaders. The use of oral communication techniques to transfer this information, in place of written information, is more in tune with values in most cultures. This is relevant for oral communication techniques may be the only means available for transmitting information in some areas of developing countries. Utilization of this method would support and supplement local extension activities. An experimental design to test the impact of traditional methods of extension versus the innovative techniques would be implemented.

The resources required for the implementation of this activity would be modest. Personnel required would be a project leader, an information specialist and a sociologist. Specialists from abroad could serve as consultants on a part-time basis. A complement of 50 tape recorders would probably be adequate for the first year of operation.

6. Trained manpower.

It is anticipated that Oklahoma State University will submit a proposal for a training program on millet and grain sorghum and that Kansas State University would cooperate on this program primarily through the millet research program which is available here.

7. The socio-cultural complex surrounding acceptance and use of grain sorghum and pearl millet as human food (Ottenheimer, Flora).

A change in food habits is one of the most difficult things to undertake when other aspects of society remain unchanged. Different foods have different social worth, which may or may not be related to nutritional value or local availability.

The research design would realize that food provision is primarily in the hands of women in the society, and focus on the group level norms surrounding food acceptance, particularly informal women's organizations. Through group based dated gathering techniques, the values and rationals surrounding the consumption of grain sorghum and pearl millet will be examined in the cultural context.

8. Farming Systems (Norman)

Kansas State University has interest in participating in the Farming Ssstems research program. However, at the present time it is not possible to be specific about the degree and type of involvement. The reason for this is the necessity of complementing and supplementing the work and/or possible work of agencies in the area (e. g. national agencies, ICRISAT, SAFGRAD, IDRC, etc.). Because Farming Systems research is specifically locational in nature, it will have to be primarily undertaken outside the U.S. Until more information is known concerning how the KSU component might fit into ongoing work in the area, it is impossible to formulate a realistic budget.

Proposed Budget:

Total Annual Budget - $605,000.

UNIVERSITY OF KENTUCKY

Preliminary Research Proposal

Socio-cultural Constraints in Agricultural Systems in the Production and Utilization of Grain Sorghum/Pearl Millet in Less Developed Countries

Submitted by C. M. Coughenour, L. Busch, W. B. Lacy, K. E. Pigg
Department of Sociology, University of Kentucky

I. Background

To date, little sociological research has been conducted that relates specifically to any crop. What little work has been done focuses on particular extension efforts. The research proposed here is an attempt to remedy that situation.

First, we propose to examine farming strategies in selected areas where sorghum/millet is or could be a major enterprise activity. Second, we propose to examine the research system's effectiveness in responding to farmers' needs. (These research tasks can be related to research needs identified in the Interim Report as paragraphs 7, 8, 11, and 14.)

II. Proposed Research Foci

A. Adaptive Farming Strategies - By farming strategy is meant the desired plans of combining crops and/or livestock enterprises in farming operations. In the farm management texts this is referred to as the "organization" of agricultural production and encompasses land, labor, and capital, commodity prices and locational factors. However, we regard a farming strategy in sociopsychological (and sociocultural) terms as reflecting a structured organization of attitudes toward various (alternative) farming enterprises. Farm enterprises consist of patterned activities resulting in the production of particular agricultural commodities. The structure of attitudinal orientations represent relative commitments (or behavioral intentions) to engage in interrelated farming enterprise activities. There are two key propositions: (1) a farmer adopts an adaptive strategy that provides "satisfying" net psychic and socioeconomic "profits" (reward over costs). (2) The chosen farming strategy represents a level of decision-making in farming above that of the particular techniques employed in carrying out farming enterprise activities, and below or subordinate to the more general goals and purposes of family living and social life in general. In this respect the farming strategy may function as a constraint to the adoption of farm technology, which is perceived as altering overall psychic and socioeconomic

profitability of the farming system of the family. Alternatively, it functions to enhance social motivation to adopt those techniques perceived as increasing overall profitability in sociopsychological and economic terms. Thus, relatively minor improvements in technique will be more readily adopted than relatively major (or more complex) ones that involve adjustments in farming strategy and, perhaps changes in family living, life style, and/or social (tribal) patterns. The latter involve changes in institutional arrangements and is developmental in nature. Moreover, other things equal, new technology that is perceived as increasing the benefits from the primary (most important) farm enterprises in the farming strategy will be more favorably regarded than those that might increase the social profitability of secondary farm enterprises as the farmer's commitment to the former is stronger, i.e., it represents the greatest existing socioeconomic investment in agricultural pursuits and provides the bulk of the social and economic profits.

A kind of agenda for exploring the implications of prospective new agricultural technology includes:

(1) What are the prevailing farming strategies - types of combinations of farming enterprises?

(2) What are the sociopsychological rewards for individual farmers and their families from engaging in a particular strategy, i.e., self-gratification of the operator and other family members, interpersonal rewards associated with the family and extra-familial relationships (e.g., status-role considerations) and the moral basis?

(3) What are the exchange rewards in monetary or in other commodities and/or items having symbolic significance?

(4) What are physical constraints to which an existing strategy represents an adaptive pattern?

(5) What are the requirements of the proposed new technology in labor and capital, and how would the presumed increase in productivity be used or disposed of?

(6) What are the implications of the latter requirements for the aspects enumerated under items 1 to 4?

(7) What is the aggregative impact of the presumed increase in productivity on the local society? That is, how

might it alter existing status, other social arrangements, and physical conditions, and thus, what would be the long-term consequences (cost and benefits) in demographic, sociocultural, and environmental terms?

While a number of sociological and anthropological studies have dealt directly with these issues and many others have done so tangentially, there is much not yet known especially, of course, with respect to the particular farming strategies in developing countries.

B. Systems of Agriculture - By this we are referring to the relationships among infrastructures, agricultural structures, and farming systems. There are many important aspects of these relationships. We are particularly concerned with the relationship between agricultural science and agricultural scientists, sponsors, and client groups who include types of producers (large and small, the producers of agricultural inputs, etc.), other agricultural scientists and students who will become farmers, technicians, or scientists, and the consumers of agricultural products. The main issue concerns the kinds of relationships between agricultural scientists on the one hand and various client groups on the other hand, and the influence exerted through these relationships on the decisions of research administrators to develop research programs of one kind or another, and of agricultural scientists to focus on particular kinds of problems in research projects. A related issue if the "negotiating" process through which institutions and structures of relationships are developed and influence exerted not only in the decisions of scientists but also subsequently in the relative effectiveness of transmitting and translating knowledge into practice on farms.

Studies of communication and diffusion, of course, have dealt extensively with the last part of this problem, but the other aspects have been almost totally ignored. As the experience in developing countries abundantly illustrates, this neglect frequently has contributed to disasters in agricultural planning and development. Moreover, as developing countries progress in the establishment of their own research institutes, failure to comprehend the nature of these relationships and processes seems likely to compound waste and primarily result in benefits to favored elites. How decisions are made to study sorghum/millet and who benefits thereby are relevant issues.

III. Methods to be used

Approximatley ten countries will be selected for research based upon (1) importance of sorghum/millet as a crop, (2) potential for increased production (increased acreage or productivity) (3) the percent of farmers engaged in subsistence production, (4) nutritional needs of the indigenous population, and (5) logistical considerations. After the initial selection is made, a thorough review of all sociological and anthropological research

relating to farming systems and research systems will be conducted. This will provide baseline data and permit the identification of (1) the most significant research gaps, and (2) the most effective field research strategies.

The second phase of the project will involve in-depth interviews with several key informants for each of the major farming systems identified as well as on-site interviews with scientists conducting agronomic research on sorghum and millet in those countries. These interviews will be focused upon generating (1) descriptions of farming systems and adaptative strategies therein as well as (2) descriptions of the agronomic research systems existent in those countries.

IV. Outputs

From this effort, the following outputs can be expected: (1) an evaluation of the appropriateness of agronomic research emphases and products to the farming systems they are intended to serve, (2) a delineation of existing linkages between farming systems and research institutions, (3) recommendations for improving those linkages, (4) an identification of the major sociocultural constraints to sorghum/millet production, (5) an evaluation of intervention strategies most likely to overcome those constraints, (6) identification of constraints to communication among researchers within and between institutions, and (7) recommendations for improving the effectiveness of communications among researchers. Particularistic concerns will be noted whenever relevant in the presentation of these outputs.

V. Qualifications of Project Leaders

Several of the project leaders have had substantial related experience. Dr. Coughenour has conducted considerable research on adaptive farming strategies in the U. S. and abroad. Dr. Busch has extensive field experience in LDCS including the evaluation of research and extension institutions. Dr. Pigg has conducted extensive studies of farming strategies in the Peoples' Republic of China. Dr. Lacy, in conjunction with Dr. Busch, is currently engaged in a study of problem formulation in the agricultural sciences in the United States.

BUDGET REQUESTED:

Total Budget $ 354,100

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Improvement of Palatability, Digestibility and Texture of Grain Sorghums and Pearl Millets For Human Foods

OBJECTIVE:

The objective of the proposed research is to improve palatability, digestibility and texture of grain sorghums and pearl millets with the ultimate aim of better utilization of these grains in human foods. This overall objective supports and is compatible to the principle constraints in the production, marketing and utilization of grain sorghums and pearl millets in less developed coutries as identified by the interim report (see pages 10, 12, 13, 19, 20, 23, 43-C, and 43-D of the report). The specific objective of this study is to modify the chemical and physical properties of the grain sorghums and pearl millets in order to utilize them in the manufacturing of foods which are acceptible organoleptically, nutritionally, culturally, socially and economically.

APPROACHES:

Simple food technology approaches to improve the bitter taste, poor protein quality and poor texture and to achieve an acceptability equivalent to other grains in grain sorghums and pearl millets will be investigated. The approach is to process the high yield variety of grain sorghums and pearl millets which can be easily cultivated for the manufacturing of human foods for effective utilization. Grain sorghums and pearl millets will be subjected to hydrolysis and extrusion to achieve better functionality, and palatability. Also extrusion technology will be developed to obtain solid structure matrix from grain sorghums and pearl millets. The resulted hydrolysis and extruded products will be characterized and evaluated for suitable use (i.e. infant formula, weaning foods, meat substitute or supplement, cereal substitute and supplement or as general food ingredients).

EXPERIMENTAL:

Physical Properties: Proteins, carbohydrates, oil and residue will be fractionated from grain sorghums and pearl millets. Each of these fractions, combinations of the fractions, and the contents of whole grain sorghums and pearl millets will be studied for their rheological, and thermal properties.

Rheological Properties. Shear stress, shear rate, and time of shear relationships will be studied using rotational and cappillary viscometers.

Thermal Properties. Enthalpy, temperature and rate of coagulation, gelatinization or denaturation under a range of conditions will be determined by the method developed by the principal investigator, Brabender Viscograph, and differential thermal analysis.

Hydrolysis: Grain sorghum mash and pearl millet mash will be hydrolyzed. Optimum substrate concentration, temperature, pH, time of hydrolysis to obtain food water suspendability and organoleptic quality will be established.

Enzyme Hydrolysis. Mixture of crude enzymes containing proteases and amylases will be used. Commercially available exzymes will be selected based on the activity, price and availability, and an optimum enzyme substrate ratio will be determined.

Chemical Hydrolysis. Hydrochloric acid will be used and an optimum concentration will be determined.

Extrusion Processes: Extrusion Cooking. Grain sorghums and pearl millets will be milled and subject to extrusion process. Extrusion conditions (shear rate, temperature, residence time) and raw material preparation (particle size, water content, surface active agents) for the maximum water dispersibility and palatability will be determined.

Extrusion Texturization. Grain sorghums and pearl millets flour and dehydrated powder of the solubilized products obtained from hydrolysis experiments will be texturized to yield both high density and low density products. Extrusion operating paramenters (shear rate, temperature, residence time, die geometry) and raw material preparation (degree of hydrolysis, water content, additives) affecting a desirable product texture will be established.

Characterization of the Products: Hydrolysis Products. Molecular weight distribution, release of the amine groups, and total nitrogen will be determined by gel filteration chromatography, flourescamine tests and kjeldahl methods respectively. Apparent viscosity will be also determined. Dispersibility will be determined by the sedimentation tests. Suitability for the use of hydrolyzate as a major ingredients in liquid formula, weaning foods, and other liquid and semi-solid foods will be evaluated.

Extrusion Products. Tensile or compressive strength, limit of the elasticity, storage and loss modulus of the exudates and hydrated products will be determined using an Instron Universal Testing Machine. Density and rehydration ratio will be determined. These results will be used to evaluate the suitability of the products use in porridge, gruel, weaning or baby foods, meat substitute or supplement, snack foods, or novel foods.

Personnel:

Principal Investigator, Dr. ChoKyun Rha is currently an Associate Professor of Food Process Engineering, at the Department of Nutrition and Food Science, Massachusetts Institute of Technology. She received a B.S. in Life Science, M.S. in Food Technology, M.S. in Chemical Engineering and D.Sc. in Food Science, all from the Massachusetts Institute of Technology. Professor Rha's laboratory, Food Material Science and Fabrication Laboratory, is currently carrying out research in the area of physical properties of food materials and fabrication technology related to food resource development and texturization processes. Professor Rha published more than 30 papers and three patents directly relating to these subjects, and she is also the editor of the series in Food Material Science. Professor Rha has an extensive international experience related to food raw material development and processing of under-utilized agricultural resources in developing countries including Thailand, Columbia, Chile, Korea, Pakistan and Thaiwan.

Dr. Nicholas Catsimpoolas, the co-principal investigator presently holds a position of Associate Professor of Food Biochemistry, also in the Department of Nutrition and Food Science, Massachusetts Institute of Technology. Professor Catsimpoolas received a Ph.D. in Biochemistry from the Department of Biochemistry, School of Biological Sciences, at the University of Tennesse, subsequently he worked extensively on biochemistry and biophysics of protein at the Central Soya Co., during which he also held a position of an Adjunct Associate Professor of Biochemistry and Biophysics at Loyola University Stritch School of Medicine. Professor Catsimpoolas was the organizer and general chairman of three international conferences and frequent invited lecturer at the international meetings. He is an inventor of the TRANSANALYZER, a new biophysical instrument for transport analysis of biomolecules and cells, editor of seven books and author of over 110 scientific articles.

OUT-PUT:

The significant result of this research will be the improved digestibility, palatability and texture of grain sorghums and pearl millets, leading to increased utilization of these crops in human foods. Basis for the process development, process development, products and characterization and use of the products will be obtained from this study.

It is recognized that the nutritional evaluation of these products and processes should be an essential and integral part of the proposed research. However, it was considered more practical to plan for the nutritional evaluation for a later stage at which time a detailed research plan based on the technical feasibility can be made and the collaboration of Dr. Nevin S. Scrimshaw, Dr. Vernon S. Young and as well as others in the Department of Nutrition and Food Science at the Massachusetts Institute of Technology who are actively engaged in nutrition research can be sought.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$85,053	$94,813	$87,163	$97,017	$469,031

UNIVERSITY OF MINNESOTA

Title: Nature and Prevention of Microbiological Spoilage of Sorghum and Pearl Millet in Less Developed Countries.

I. Problem:

Over the past decade we have received many samples of sorghum and earl millets from North African countries and India. All of them were from lots stored in homes or small villages. All of them were sent to us because they were suspected to have been involved in and possibly responsible for development of illnesses in those who consumed them, especially the "Ethiopian Liver Syndrome." All of them had been heavily invaded and partially spoiled by storage fungi, including Aspergillus flavus, some strains of which under some circumstances produce aflatoxin, said to be the most potent known hepatocarcinogenic agent. Unquestionably the problem of loss in quantity and quality of these food grains in the countries where they constitute a major dietary item is an important one. If production is increased, as is intended, the problem will become more severe. Research should be undertaken now to determine the conditions of storage that prevail in different areas. the conditions that make for high storage risk, and the conditions that should be maintained to reduce the risk of losses and to ensure that the harvested grains will maintain their quality until they are consumed. The general principles involved are well known, and specific practices applicable to many areas have been developed (Christensen and Kaufmann, 1969, 1977; Breth, 1976; Agrawal and Girish, 1977). Research on the nature, cause and prevention of microbiological deterioration of stored grains has been carried on in the Department of Plant Pathology, University of Minnesota, since 1945. Much of this has been done in collaboration with, and has been supported by, commerical grain merchandising firms, and so has had for its aim the practical solution of practical problems. Most of the work has been with farm and commercial storage of cereal grains and oil seeds in the United States, but some of it has been devoted to on-site study of problems in Mexico, Columbia, Puerto Rico, Thailand and Taiwan.

II. Plan of Work:

Different countries where sorghum and pearl millet are important food crops would be visited, and the storage practices inspected. Representative samples would be taken, and their condition and storability evaluated (this involves primarily inspection to determine damage, moisture content, and number and kinds of fungi present). This approach has proved to be of value whenever and wherever it has been used. If some adjustments had to be made to adapt them to different specific conditions encountered, they could be made easily.

Storage tests would be set up, using the low-cost, easily fabricated containers described by Breth and by Agrawal and Girish. Periodically samples would be removed from these and tested for condition and storability.

Proposed Budget:

Total	$26,000.

MISSISSIPPI STATE UNIVERSITY

Title: Title XII Collaborative Research Support Program for Grain Sorghum and Pearl Millet.

ABSTRACT

The objective of the research proposed is to determine or develop, through research activities in the LDC and the U.S., procedures and levels of technology to aid the people in the LDCs to develop the capacity to feed themselves. The overall approach is predicated on the fact that transfer of technology from the U.S. without considering the absorptive capacity, production inputs available, elements of the food chain, and institutional and social inhibitions of grain sorghum and pearl millet in the LDCs would probably fail.

PROPOSAL 1

I. Title: Crop Protection and Pest Management.

The Mississippi Agricultural and Forestry Experiment Station has on-going research projects in sorghum improvement with emphasis on quality, plant production, and host-plant resistance. Disease and insect nurseries have already been established in cooperation with sorghum researchers at Texas A & M to take advantage of environmental conditions favorable for the development and spread of certain sorghum diseases and insect infestations. The USDA Sugar Crops Field Station at Meridian, MS., which is scheduled to cooperate in the project, has an International Anthracnose Nursery for sorghum which was established in cooperation with Texas A & M.

MAFES in cooperation with USDA has developed considerable research strength in the areas of host-plant resistance and pest management (cotton, corn). This work is carried out by interdisciplinary teams of plant breeders, pathologists, entomologists, and agricultural economists. Two of the scientists involved in the Plant Protection and Pest Management Project have a total of 8 years research experience (corn, sorghum, millet) in Nigeria and other African countries.

PROPOSAL 2

I. Title: Seed Multiplication, Quality, and Usage.

MSU has a very strong and unique research, training and service program in seed science and technology. The Seed Technology Laboratory is a section of the Agronomy Department, and its program has been interdisciplinary (Agronomy, Agricultural and Biological Engineering, Agricultural Economics) for many years. The seed technology program has been involved in the seed program development, training and adaptive research in the LDCs for 20 years under various contractual arrangements with AID. Its staff has many years of long and short term experience in more than 30 countries.

Domestically, the seed technology program at MSU has strong research components in seed production, drying, storage, processing, quality evaluation and control, and stand establisment. It has also pioneered cooperative work with plant breeders to improve the quality and performance of seed.

PROPOSAL 3

I. Title: Human Nutrition.

The leader of this project has several years of international experience in Africa, India, Central and South America working with the nutrition of local population using sorghum as the main ingredient of the diet. This project must by necessity be conducted primarily in the target country due to consumer preferences. The nutritional potential for new genetic mutants of sorghum and millet will be tested by the use of laboratory animals and human subjects. The input by the Cereal Chemist-geneticist, with his experience with mutant corn genotypes and breeding, should speed the development of nutritionally superior cultivars.

PROPOSAL 4

I. Title: Production and Land Management Systems

MSU in collaboration with USDA has on-going interdisciplinary research on the effects of cultural management on yields of grain sorghum as well as the usual

variety trials of grain sorghum and pearl millet. This team made up of agronomists, weed scientists, agricultural economists, entomologists and agricultural engineers has looked at such practices as fall versus bedded systems, rotation with legumes such as soybeans versus continuous sorghum, etc. The economics and trade-offs of various practices have been evaluated as yield results have been summarized. There is also considerable experience at MSU on breeding for improved crop performance as an adaptation to local conditions. This has led to the availability of better performing germplasm. Thus the concept of interdisciplinary, interagency research is an existing way of life at MSU and is established in grain sorghum research.

Several of the personnel associated with this project have experience with research in foreign countries and all who have advised graduate students have had, or now have, several foreign students in their programs. Some of the personnel also have research experience in arid and semi-arid regions and have maintained contact with other scientists in those regions. Thus, this expertise and association can speed the research goals set forth in this project.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year	5th Year
$919,385.	$915,392.	$958,830.	$961,717	$1,027,435.

UNIVERSITY OF MISSOURI-COLUMBIA

Proposed Projects in Grain Sorghum and Pearl Millet Research Programs

I. Guiding Principles for Presentation of Proposal:

Four guiding principles were used in the preparation of the proposed projects. These were 1) problem foci, 2) target audience 3) utilization of University of Missouri-Columbia (UMC) strengths, and 4) UMC commitment to international agricultural programs. Each deserves elaboration.

Problem Foci. The four projects proposed herein focus on constraints and research areas identified in the Interim Report with one exception. The exception is a proposed research effort on the role of women in the production and utilization of these commodities. The other projects focus on problems associated with 1) the utilization of the commodities for their optimal nutritional value, 2) the role of the commodities in the total cultural system and 3) the dissemination of research information of each of the projects, their relationship to the identified constraints and research needs will be developed.

Small Farmer Focus. The target audience that permeates all of the proposals is that of small farmers among the poorest of the poor. Hence, the utilization research will be focused on techniques especially amenable to use in the homes of low-income farm families. Further, the research on the role of these commodities will concentrate on an in-depth analysis of their role in the production and utilization systems of small farmers. Likewise, the analysis of the role of women in connection with these commodities will concern not only the role of women in their utilization but also in the production of these grains--a characteristic of many low income agricultural regions. Finally, the information dissemination system will be structured in such a way that the research results from the total research program concerning sorghum and millet will be presented to change agents in a form that will facilitate its ready introduction to small farm agriculture.

II. Proposed Projects:

As suggested above, the four research projects proposed herein focus on utilization research, the role of sorghum in the culture of the rural poor, the role of women in the production and utilization of sorghum, and communication of sorghum-millet research findings. An overview of each of these follows.

Utilization Research. (In Response to Constraint No. 15 and Research Need No. 13). The utilization research focuses on improvements in the nutritive value of sorghum and millet by germination, fermentation or blending with legumes. In addition to improving their nutritive values, these techniques hold promise for improving the palatability and the digestibility of these commodities. In addition, toxicological and nutritional assessments of the functional properties of the developed foods will be made. Throughout, the research will focus on the utilization of these techniques by poor farm families as units and as members of kinship groups.

Collaborative research will be initiated on grain sorghum with investigators in Central America. Subsequently, the focus of the research will center on Africa and India as well as whichever crop is appropriate. Regardless of its location, both the biochemical and sociological dimensions of the investigation will be undertaken in a collaborative fashion to include the building of indigenous institutions capable of doing such research as well as establishing training programs to multiply their efforts. As a consequence of this research, there should be an upgrading of the nutrition of small farm families by virtue of the improvement in the utilization of these indigenous crops.

Role of Sorghum/Millet in Total Cultural System. (In Response to Constraint No. 18 and 19 and Research Needs No. 17). Both sorghum and millet are preceived to be "poor man's" crops in most of the developing countries This inferiority connotation does not bode well for their receiving the necessary attention either by indigenous institutions or small farm families. If insight is to be gained into why these are crops to be disregarded as soon as economic circumstances permit, a strategy can be devised so that these commodities can play a significant role in development, especially in areas where they have an agro-climatic advantage. hese insights can be gained only through an in-depth observation and analysis of the production utilization of these commodities in low income rural communities. Consequently, this type of in-depth analysis is proposed initially in Latin America and will subsequently be extended to both Africa and the Asian subcontinent. Pending obtaining such insights in this area, the most productive production research in the world can be inconsequential for improving the lot of the poorest of the poor.

The Role of Women in the Production and Utilization of Sorghum and Millet. (In Response to Constraint No. 24 and Research Need No. 8). In spite of the fact that women are involved worldwide in the utilization of these commodities and in vast areas of the world in their production as well, very little is known about their role, especially with regard to decison making. The research proposed in this area is highly personalized to the principal investigator. This is because Kusum Nair has unprocessed data concerning the role of women with regard to these commodities which she obtained at the farm and village level while doing research which has led to such books as Blossoms in the Dust and The Lonely Furrow. Analysis of these data would represent her initial thrust. Subsequently, data would be obtained for Africa and Latin America in order to facilitate the comparative analysis of the role of women with regard to these commodities in the three major sorghum and millet producing regions of the world.

Sorghum-Millet Research Dissemination System. (In Response to Constraint No. 16 and Research Need No. 7). Wide recognition has been given to the fact that one of the most inefficient aspects of agricultural research worldwide is the bottleneck encountered at the interface between the researcher and those charged with the responsibility of disseminating research results. The sorghum-millet research program would suboptimize its potential contribution if it repeated this oft made mistake. This proposed project is designed to see that does not happen. It focuses on the adaptation of an information dissemination system, the UMC Agricultural Guide, which has received international recognition as a useful information dissemination technique. The Guides represent a means of continuously updating research information as well as present research findings in a clearly understandable how-to-do-it fashion. Utilizing these time-tested advantages, the research information dissemination project will systematically translate both the presently available research results and after they become available subsequently, the results of this research program into useable form for change agents worldwide. In addition, the training dimension of the protect will facilitate the development of similar national systems, the demand for which can be anticipated as a by-product. Fianlly, continual evaluation can be expected to modify the information system to make it more useful over time.

Prposed Budget:

1st Year	2nd Year	3rd Year
$106,700.	$24,258.	$36,000.

UNIVERSITY OF NEBRASKA, LINCOLN

NEBRASKA PROGRAM OVERVIEW

Plant breeding and genetics at Nebraska are intimately coupled to basic and applied physiology research. These complimentary activities are designed to develop new breeder screening techniques. The first extensive U. S. sorghum physiology program of recent times was initiated at NU in 1964 by G. F. Sprague and D. G. Hanway. The program grew, with the help of Rockefeller Foundation grants for 10 years, to include 4 physiologists. The intent of the physiology program can be gleaned from the series of annual reports attached which are titled "The Physiology of Yield and Management of Sorghum in Relation to Genetic Improvement".

Shortly after the physiology program was initiated, the breeding program of long standing was expanded. Drs. P. Nordquist and C. O. Gardner in consultation with Dr. G. F. Sprague developed the first sorghum random mating populations using the MS_3 gene for genetic male sterility. Probably more than 95% of the random mating populations in the world today trace to that initial effort. Development of the population concept necessitated breeding methodology studies designed to determine which of several traditional selection procedures were the most efficient for raising yield levels in the U. S. and in developing countries. Dr. W. M. Ross, a world expert on sorghum with the USDA and in Nebraska since 1969, and Dr. C. O. Gardner are currently involved in those experiments.

Drs. Sullivan, Eastin and Clegg are conducting a comprehensive drought and temperature stress research program aimed at elucidating basic stress resistance mechanisms and developing breeder screening techniques. Several screening techniques are now being tested or used. Drs. Ralph Clark and Jerry Maranville and Professor R. A. Olson are conducting an extensive mineral uptake and utilization efficiency program on sorghum. A new $90,000 multiple element analysis system is being purchased to assist in their efforts. Dr. R. Klucas in biochemistry has extensive experience in associative nitrogen fixation in sorghum. Dr. R. Chollet was just hired to do basic photosynthesis research under environmental stress conditions.

Dr. C. A. Francis from C. I. A. T. joined the staff to add a new dimension to sorghum and millet adaptation research in terms of boths U. S. and international germplasm development.

Cultural practice research is aided greatly by Dr. R. Neild who has extensive international experience in climate typing for vegetable production and more recently with sorghum and corn. His climate typing and simulation efforts will be complemented by Dr. J. Norman, who brings to the staff experience in soil, physics, micrometeorology and crop water use efficiency.

Dr. Max Clegg specializes in legume contributions to nitrogen economy and multiple cropping systems, which tie closely to the fertility programs. Professor R. A. Olson has worked several times as a fertility expert for FAO in developing countries. His soil classification and fertility research are critical complements to the mineral use efficiency work.

Research on basic effects of toxins and their possible use in screening schemes for disease resistance is emphasized in pathology research. Entomologists are conducting a unique stem borer screening and breeding program. Methodology being developed probably has possibilities for wide acceptance and adoption.

Our quality research program is modest but has produced unique, rapid screening techniques for tannin (Maranville) and nutritional value (Satterlee). The nutritional value programs in poultry (Sullivan) and humand (Kies) also are excellent.

The total program emphasizes balance in pathology, entomology, quality screening, physiology and genetics as they complement out plant breeding effort. One may judge the degree of balance from the list of advanced students (Appendix II) graduated from the program over the years in a variety of disciplines. Emphasis is on the team approach to solving research problems. Complex problems require an interdisciplinary focus for their solution and this is the current strategy in Nebraska.

NEBRASKA TITLE XII PROPOSAL

The tenor of the Title XII law emphasizes equally the international interests of both US AID and participating states as well as the local interests of participating states and other entities. We are attempting to tailor program and personnel considerations to assure that the interests addressed here are mutual interests. Dr. C. A. Francis and Professor R. A. Olson representing the crops and soils areas, respectively, have the most extensive experience in developing countries. Others who have been involved in international travel and project reviews for several years are R. B. Clark, M. G. Clegg, C. O. Gardner, C. Y. Sullivan, W. M. Ross, P. J. Mattern, J. D. Eastin and W. D. Guthrie cooperating from Iowa State University on stem borer work. The international efforts of these individuals will be continued. However, it appears desirable to extend our overseas commitment with added staffing.

Two full time positions are requested to strengthen effectiveness of our foreign commitment. One position is a crops man, preferably a breeder-physiologist or breeder-production individual who would spend approximately half time working foreign nurseries, performance trials and other cooperative efforts. The other half of his time would be involved in the scattered breeding and physiology nurseries in the U. S. working cooperatively with the other scientist in order to keep close touch with breeding-screening programs in both the U. S. and abroad. While the breeders, geneticists, and physiologists named above will spend most of their time in the U. S. they will, nonetheless, spend considerable time analyzing foreign field problems and working towatd their solutions. Such as approach will make all team members keenly aware of both U. S. and tropical programs and permit us to make the most rapid progress in mutual help projects (i.e. project 11).

A second full time scientist for the soils effort is critical for tow reasons. FAO data indicate that modest and selective fertilizer imputs will probably afford the most immediate economic means of increasing food production in a number of developing countries. This judgment appears sound even where only very limited resources are available for fertilizer. A second reason for a solid soil fertility input into the program is clear. Application of the breeder screening techniques for any of the stress factors to be discussed below certainly will be more successful if the local soil enviroment is characterized well. This is true whether plants are being screened for temperature and water stress resistances or whether the search is for plants with greater capacities to extract minerals from the soil and utilize them more efficiently (Project 16).

The foreign effort commitment of existing Nebraska staff members will more than match the activity of commitments of the crops and soils scientists described above.

An additional full time equivalent position is requested to implement the proposal for training research leaders for developing countries. To be divided among five critical disciplines, this position will allow each scientist to dedicate 20% of his time to development and implementation of an integrated program which will guide students to view problems in the broad context of overall program priorities. The capacity to manage budgets, design relevant research programs, and set project priorities are among the first challenges which face young scientists who return to the developing tropics. We hope to better prepare them for this endeavor. The project also includes sufficient funding for travel so that involved staff can follow through with former students, select candidates for graduate study, and otherwise provide liaison between research projects in Nebraska and those in the tropics. Experiences of the proposed soil and crops specialists (projects 16 and 11, respectively) plus other team members with problems and people in developing countries should be invaluable in making the proposed training programs as effective as possible. This proposal may provide a model for other consortia and other universities (project 21).

The proposed program represents a balance of applied and basic research. The heavier applied element addresses practical plant breeding problems through traditional plant breeding approaches, through new breeding methodology being developed in an extensive population improvement program, and through basic research designed to develop new screening techniques for making breeding progress faster and more efficient in terms of both yield and nutritional value. Basic research is directed toward improving cultural systems to increaseor at least stabilize yields.

The world food problem is long term in nature, and will become more pressing in the decades ahead. This means we must increase our rate of progress in plant breeding and cultural practice improvement. There is no way to accelerate progress without incorporating a healthy level of basic research into strong plant breeding and genetics programs. More efficient genetic manipulation will depend heavily on understanding biological systems better and using this information to devise and implement improved screening techniques. The solutions to many research problems require this interdisciplinary and broad focus which can only be mobilized through a team research approach. This is one of the strong considerations Nebraska has to offer in implementation of Title XII objectives.

BUDGET REQUESTED:

Total Request $ 900,000

OKLAHOMA STATE UNIVERSITY
Proposal for Title XII
Sorghum and Millet Program

The Oklahoma State University proposes as a portion of the Sorghum and Millet Program to establish a center for the training of scientists, technicians, educators, and extension personnel of less developed countries (LDC). A well rounded breeding and teaching program exists to form the basis for the development of schedules for the training of scientists and technicians in the methods of breeding, selection, evaluation, production, and maintenance of sorghum and millet. Disease, insect and weed control capabilities are here for the establishment of in-depth training programs. Research underway in cultural methods, fertility practices, and conservation can also serve as a basis for the establishment of training in research and extension methods in these areas. A strong Agricultural Education Department such as the one at O.S.U. could give direction to a curriculum for the training of agricultural educators. Effective extension methods and facilities for modern agriculture will provide the basis for the development of outreach programs directed to the special needs in LDC. Training in marketing, prices, transportation, storage, grain handling and perhaps other areas could be developed upon mutually agreeable arrangements.

Nationals would be given a combination of methods of training and actual on-the-job experience including existing university instructional courses, specially developed instructional programs, work experience training, and visits to other U. S. or foreign

institutions for training in special methods or for exposure to other training and/or socio-cultural conditions. The extablishment of the training curricula and schedules for the several catagories of trainees will be developed after consulting with on-site knowledgable nationals in agricultural institutions or research and training centers, and also after visiting and consulting with personnel at International Research Centers such as ICRISAT. Studies into the question of how best to contribute to the development of manpower and facilities to help LDC's help themselves will be conducted. For example, is it better to train personnel in the U. S. and provide on-site experience, or to both train and give experience on the site?

The overall objective of the training center will be to provide trained scientists for staffing research institutions in the LDC to do cooperative research and to utilize the continuing adaptive research growing out of U. S. and other countries, to provide trained personnel for the dissemination of research results in outreach programs. Scientists, educators, and extension trainees will be expected to complete two-year programs. Technicians will complete one-year programs. A concerted effort will be given to instill a philosophy of self-help, and to create a desire in the trained personnel to establish their own training facilities in order to become self-sustaining. Kansas State University has been contacted about joining OSU in the overall training program.

BUDGET REQUESTED:

1st year	2nd Year	3rd Year	4th Year	5th Year
548,000	591,840	639,187	690,321	745,545

PURDUE UNIVERSITY

Title: Increasing the Contribution of Sorghum/Millet to an Improved Nutritional Status for Poorer Peoples in LDCs.

I. **Problem** Focus:

Much of the world's poverty is concentrated in the semi-arid tropics where soils are poor; rainfall is limited in quantity, concentrated into a short rainy season, and highly variable in timing and volume; and crop pests are numerous and varied. Grain sorghum and millet, because of their ability to produce under high stress conditions, are the best adapted of the food grains to these harsh conditions and thus constitute a major component in the production and consumption patterns of the poor people of many semi-arid less developed countries.

There are several factors which constrain the contribution that sorghum and millet currently make to the economic and nutritional well-being of the poorest of the poor. First, the nutritional quality, especially protein, of the grain is inferior to rice and wheat resulting in nutritional deficiencies where sorghum/millet are very large proportion of the total diet. Other grain quality characteristics such as taste, texture and cooking quality cause it to be considered inferior to wheat and rice by many consumers. One valuable characteristic of sorghum which makes it somewhat resistant to attack by birds and insects is its high tannin content. However, this further reduces the nutritional and food quality of sorghum. Improvement of these quality characteristics, without sacrificing bird and insect resistance and other stress-tolerant characteristics, would greatly increase the economic and nutritional role of sorghum and millet. Much more needs to be known about nutritional quality, consumer perception of quality, and the role of sorghum/millet in the total diet and its interaction with other components. The potential contribution of improved varieties in regular diets, as well as in renutrition of malnourished people, needs to be further explored.

Traditionally, breeding programs and natural selection by producers have emphasized stress-tolerance (drought, insect and disease) at the expense of other performance characteristics such as yield and grain and forage quality. While the ability to produce under adverse conditions is important, more yield potential and better quality in varieties adapted to less developed country resource conditions is an important key to increasing the contribution of sorghum/millet to human welfare.

Post-harvest losses of sorghum and millet greatly reduce the available supply and increase cost to the consumer. The resources required to reduce losses in storage. handling and processing are minimal compared to the resources required to offset these losses with additional output. Research is needed to develop improved storage and handling facilities, and processes which are consistent with the economic realities of the less developed countries.

Sorghum and millet are important sources of farmer income as well as important components of diets of both farmers and urban dwellers. They are, however, only one component of a production system which involves a variety of goals and constraints associated with the economic, nutritional and social needs of the farm family. This production-consumption decision system needs to be better understood in order to set appropriate policy, research and educational priorities. In the past, many development initiatives have failed because of insufficient understanding of the farmer decision environment. It is especially important that farmer attitudes toward risk and the risk exposure of proposed new sorghum/millet varieties and production technologies be better understood if a broad sorghum/millet research program is to have a beneficial impact on the poor farmer.

Efforts to increase sorghum and millet supply may create a surplus of grain in producer hands, result in unacceptable prices and farm income levels and, therefore, be successful only in the short-run unless there exists a demand and a marketing system adequate to handle the increased supply. The structural and performance characteristics of the marketing system for food grain are poorly understood in most less developed countries. The nature of consumer demand for sorghum and millet has not been quantified and is poorly understood. The social, economic and nutritional roles of sorghum in determining consumption patterns of various groups of people are not well defined. Characteristics associated with perceived quality are not known. This body of ignorance may well constitute one of the most serious constraints to increasing the contribution of sorghum and millet in alleviating hunger and malnutrition.

II. Objectives:

1. Develop agronomically superior sorghum germplasm with improved nutritional value and grain quality which is highly acceptable for predominant forms of utilization in developing countries.

2. Develop and evaluate breeding techniques empahsizing selection procedures in sorghum populations from artifically induced random matings applying these techniques to development of elite populations and varieties with increased yield, broad adaptation to the semi-arid tropics and desirable levels of disease, insect and lodging resistance.

3. Study the chemistry and biological effects of tannins and other phenolic compounds in sorghum, emphasizing development of practical processing and dietary supplementation methods which will minimize the negative nutritional effect of high tannin content.

4. Analyze the constraints to adoption of new sorghum/millet technology by low income-risk averse farmers, identifying the types of technology most appropriate for such farmers and the likely effects of policy decisions on technology adoption and farmer supply response.

5. Improve resistance to fungal disease (especially anthracnose) in sorghum lines having high potential for LDC use through incorporation of resistance identified in the world sorghum collection, and determine the relationship between level of fungal disease and nutritional and mineral composition of stover and grain.

6. Develop handling and storage procedures for sorghum/millet grain which are effective in reducing post-harvest losses caused by fungi and insects and which are technologically and economically appropriate for LDC conditions.

7. Establish the inherent properties and processing effects which determine food quality characteristics important to sorghum/millet consumers and develop more efficient food processing and energy production systems which are responsive to LDC consumer preferences and needs.

8. Analyze and describe for one or two LDC's the demand for sorghum/millet; structure and performance of the marketing system; marketing policies currently in use; and the impact of changes in technology on consumption decisions.

9. Evaluate the nutritional contribution made by sorghum/millet in combination with other components in representative LDC diets and determine the effects on health and nutritional status of introducing improved varieties, or of modifying processing techniques.

III. Approach:

This section provides a brief overview of the general approach to be employed in pursuing the several objectives presented above. Actually, each objective may best be thought of as a component of a broad integrated research program designed to increase the contribution of sorghum/millet to improved nutritional and economic status for poor people in the LDC's of the semi-arid tropics. The principle unifying focus of the components is improved quality in the broad sense of a more desirable food grain from the viewpoint of both producers and consumers while enhancing yield potential.

Purdue University has established a strong research and outreach base in the area of sorghum/millet grain quality improvement through the AID sponsored research program under the direction of Dr. John Axtell. Previous work has focused primarily on improved protein quality of sorghum but more recently has expanded to include other quality characteristics. This research has involved geneticists, plant breeders, production agronomists, biochemists, nutritionists, animal scientists and agricultural engineers. It was partially responsible for initiatives which led to another AID sponsored research project focusing on socio-economic constraints to sorghum/millet production in Sahelian Africa.

The existing research on grain quality and overall sorghum improvement has led to the establishment of one of the most complete germplasm collections in the world. Numerous linkages with institutions and scientists in the sorghum/millet consuming LDC's have been established. This experience has led to the interest expressed in this proposal for an expanded research effort. Many of the components of this program depend on this basic grain quality research for input and support. It is critical to this entire program that this basic work continue. Other components must be considered additions to and not alternatives for the program of Dr. Axtell and his associates.

As the research approach for each objective or program component is presented below, an attempt will be made to show the linkages and interdependencies among them. A more detailed and complete discussion of each component is presented in the appendices referenced below.

1. Field observation will identify use for sorghum/millet in various forms and determine characteristics of grain and food products associated with high quality. This field work will be closely coordinated with the demand and marketing component. Tests will be developed to characterize sorghum/millet grain relative to perceived quality as well as nutritional quality.

Selection from the Purdue collection and breeding efforts will be directed toward development of superior germplasm for LDC use in terms of nutritional and perceived grain quality, and adaptation to farm production conditions.

2. The results of applying selection procedures over ten years to the diverse germplasm present at Purdue, including the world collection, provide the basis for this continuing effort. Material will be evaluated at Purdue and in Puerto Rico, and after further selection, included in International Yield Trials grown at 40-50 locations in 20-25 countries. Elite cultivars will be evaluated for yield, tropical adaptability, resistance to stalk rot, anthracnose, and stalk borers, lodging, weathering, and grain quality. Material selected will be crossed into random mating populations. Further evaluation should lead to superior yielding desirable varieties which are widely adapted. These will be tested and distributed to LDC breeders. Inbred parental lines important to hybrid production in the semi-arid tropics will be maintained, tested and distributed. Studies of combining ability of elite lines will be conducted. Selection will continue from Purdue synthetic and random mating populations. A variation of a simple recurrent selection system will be used to develop a broad-based sorghum population for highland tropics. Data generated will be analyzed across a number of experiments to provide for comparison of relative efficiency of appropriate breeding methodologies under developing country conditions.

3. Biological effects of tannin will be investigated by extraction and fractionation of tannin from high tannin sorghum and feeding fractions of rats and and chicks. Laboratory experiments with various chemical processes and diet supplementations as means of detoxification of high tannin sorghum will be conducted. Detoxified materials will be further evaluated for effect on nutrient bioavailability in the nutrition project. Economic viability of detoxification processes will be evaluated as part of the demand-marketing study. Efforts will continue to develop more sensitive and reliable analytical methods of tannin.

4. The analysis of constraints to adoption of sorghum/millet technology, including new varieties, will involve intensive study of low income farmers and their farming systems. Field data collection will be conducted by native interviewers under direction of a team of economists, sociologists/anthropologists and agronomists in cooperation with indigenous institutions. Risk averse attitudes and the role of risk in decision making will be a primary emphasis

of sociologists and anthropologists. Weather induced risk of alternative technological packages will be quantified using techniques developed by Purdue and Brazilian agricultural scientists. Models of production decision making under risk will be developed and used to evaluate technologies, policies and market conditions.

5. Entries in the world sorghum collection maintained at Purdue will be further evaluated for resistance to anthracnose. Results of the resistance selection process will be fed into breeding programs under projects described in further detail later. Analyses will also be conducted to determine the effect of anthracnose on the nutritional and mineral composition of sorghum grain. This will be coordinated with the nutrition project.

6. Field studies in collaboration with LDC institutions will describe existing storage and handling procedures and the level of post-harvest loss due to fungi and insects. Germplasm from the Purdue world collection will be evaluated for resistance to fungi and insects with the results being utilized in breeding programs. Human health implications of fungi contamination will be evaluated. Alternative processes and structures for storage and handling will be developed and evaluated for technical and economic efficiency under LDC conditions.

7. Based on quality characteristics identified in the sorghum quality improvement project, alternative grain processing systems will be proposed and tested to determine their effect on nutritional value and food quality. The more promising processes will then be field tested in pilot plant operations in a selected LDC using locally available materials and labor. New processes developed at Purdue for production of alcohol from grain and crop residue will be evaluated using sorghum/millet.

8. In cooperation with LDC scientists, data will be obtained and used to derive quantative estimates of sorthum/millet demand relationships. A household consumption survey will be conducted and sociologists anthropologists and economists will identify the role of sorghum/millet in traditional diets and the acceptability of new types and forms of sorghum/millet. The structure of marketing systems will be determined and the efficiency of their performance analyzed. Marketing policies will be described and analyzed. The economics of detoxification of high tannin sorghum and the potential demand for the processed product will be evaluated. Two countries will be selected to provide for cross-country comparisons.

9. In vitro and in vivo evaluation techniques will be used to determine the bioavailability of micronutrients from various types of sorghum/millet and the effect of constituents of sorghum/millet on nutrient availability from other foods in the diet. Samples of typical meals will be evaluated. This will be followed by intensive study of diet composition in sorghum/millet consuming households, possibly in conjunction with the demand study. The use of high-protein sorghum in renutrition of malnourished children and re-establishment of immune systems will be integrated into a continuing study in Columbia.

As programs develop, the overall accomplishments will be evaluated and balance between individual components modified. Cooperation between other major U.S. sorghum research institutions will be maintained. Emphasis will be given to maintaining ties with breeding efforts at Texas A & M, physiology studies at Nebraska, and the broader millet program at Kansas State. Sociologists anticipate cooperation with colleagues at the University of Missouri, providing for comparison of studies conducted in Latin America and Africa.

IV. Joint Research, Outreach and Training in the Sorghum Program

Rapid and widespread payoff from research depend upon an effective outreach program. A substantial, carefully programmed outreach effort will make research results available to users in the LDC's and will provide feedback from LDC's to ensure that research continues to be relevant in both objective and approach. Outreach efforts will include substantial individualized assistance to LDC scientists, workshops, carefully organized germplasm exchanges, and international trials. Purdue proposes to conduct joint research with scientists in LDC and graduate countries, including Kenya, Colombia, Brazil, Tanzania, and in Sahelian Africa.

Training programs, academic and non-academic, are a part of outreach and will be coordinated with research. Graduate students from LDC's will be involved in each major component. We will involve U.S. graduate students in campus-based and overseas cooperative research, and outreach programs.

Equivalent of two full-time staff will conduct outreach activities in and with LDC institutions. While

all portions of our program will result in outreach activity over time, initial efforts will be concentrated in germplasm trials and distribution, and in extending research methodology in breeding and protein quality, utilization of high tannin sorghum, and in risk and other constraints.

Proposed Budget:

Total for five years ..... $785,957.

TEXAS A AND M UNIVERSITY

I. INTRODUCTION

The Texas Agricultural Experiment Station of Texas A and M University welcomes the opportunity of being named the lead institution for the collaborative research support program on grain sorghum and millet under Title XII.

TAES has led the nation in sorghum research since it began in the United States (attachment A-1). Sorghum for grain has been grown in Texas since 1886. For the past half century, Texas has produced over 45% of the sorghum in the United States (attachment A-2).

Sorghum research and improvement is a major thrust of the TAES. The major achievements for improving sorghums were products of these endeavors, including development of dwarf combine sorghums, the discovery of a practical system of producing hybrid varieties, the conversion of tropical sorghums to dwarf early-maturing types and the development of disease and insect resistant sorghums with improved quality and nutrition. These achievements have been major factors in increasing sorghum production in the U. S. by 250% since 1950 (attachment B).

Many sorghum cultivars developed in Texas are the basis for the rapidly expanding sorghum acreage in Argentina, Brazil, Venezuela and Australia. Similarly, the sorghums most productive in Israel, Korea, Lebanon, Thailand, Vietnam, Yemen and other areas are directly from the Texas Sorghum program. The first hybrid in India, SCHI, used parents selected directly from lines developed by TAES. This hybrid produced 60 to 80% more grain than the Indian local varieties and in 1976, CSHI was grown on about 50% of the sorghum acreage in the Indian state of Maharashtra. The Indian variety 'Swarna' was selected directly from lines developed by TAES. This variety has tolerance to shoot fly and shows promise not only for India but for Upper Volta, Phillippines and Pakistan as well. Currently, superior sorghum lines from the Texas program are being evaluated in national programs or cooperatively with ICRISAT in Mexico, Guatemala, Venezuela, Brazil, Upper Volta, Mali, Senegal, Sudan, Niger, Nigeria, Ethiopia, Kenya, Tanzania, Egypt, Botswana, India and other countries.

The enviroments in Texas for growing sorghum and millet are varied and parallel those of the major arid, semi-arid and semi-tropical sorghum and millet growing regions of the world. Production hazards in Texas are the same as in many DC's. Fully staffed research centers are located in the major sorghum producing areas.

Twenty staff members of the TAES devote a major portion of their research to sorghum and millet improvement. Included are large and productive programs in genetics and breeding, pathology,

entomology, quality and nutrition, physiology and cultural management (attachment C). Many of the sorghum research workers in Texas are recognized authorities in their areas of interest but without exception they are committed to productive interdisciplinary approaches. Staff members with joint appointments at Texas Tech University and Cooperative USDA, ARS staff are important members of this research team. Joint academic and research appointments of participating staff provide broad-based graduate training relating to sorghum and millet. Unique opportunities for the application of TAES research comes through the private workers since the bulk of the sorghum seed industry is located in Texas. A recent survey showed that over 75% of the breeding material used by private sorghum breeders contains germplasm derived from the Texas programs.

TAES staff have worked cooperatively in international programs for decades. In 1974, Texas workers initiated a formal program with USAID on "Development of high yielding sorghum cultivars with disease and insect resistance." This program has fostered an expansion of the type of sorghum research that has application throughout the world (attachment D).

A catalyst and key to the success of sorghum research in Texas is the source of new and diverse gerplasm from the USDA-TAES sorghum conversion program. These new sorghums have contributed to essentially all sorghum improvement programs nationally and internationally (attachment E).

II. OBJECTIVES

A. Breeding - Develop productive, stable-yielding, efficient, nutritionally superior sorghum and millet cultivars with resistance to diseases, insects, other pests, environmental stresses and wide ranges in adaptation.

B. Cultural Practices - 1) Develop agronomically elite sorghums and millets with superior capabilities for nitrogen fixation, efficient use of soil nutrients and tolerance to low soil moisture. 2) Develop general methods to predict optimum time of planting for GS/PM using local meteorological data and determine seedling responses to environmental stresses.

C. Pathology - Identify, evaluate systems for controlling insect pests of sorghum by integration of resistant varieties, cultural manipulation and biological control.

D. Entomology - Develop and evaluate systems for controlling insect pests of sorghum by integration of resistant varieties, cultural manipulation and biological control.

E. Quality and Nutrition - 1) Determine how sorghums and millets are processed and consumed in traditional foods and determine the grain characteristics affecting the

organoleptic (taste, texture, etc.) properties of the food products. 2) Develop methods to assess the important grain quality characteristics and use these in cooperation with the breeding program to develop sorghums with improved food properties approaching those of rice and wheat. 3) Determine the factors that affect the nutritional value of sorghum and millet and interfere with end use quality of the grain in traditional foods.

F. Data Base and Germplasm Introduction - 1) Develop an international data base and unified data management system. 2) Develop a system to efficiently introduce germplasm through a quarantine system in collaboration with USDA.

III. RESEARCH APPROACHES

A. Breeding

1. The broad-based breeding program will use identified sources with desirable traits. Major emphasis will be on developing widely adapted sorghums with improved stable yields and resistance to adversities such as insects, diseases, grain weathering and environmental stresses including drought and nutrient deficiency. Standard breeding methods will be used including crossing, back-crossing, pedigree line selection and random mating populations. The wide range of environmental conditions existing within Texas and the large number of internationally important disease and insect pests present in the state offer a unique opportunity to breed for world-wide adaptation, insect and disease resistance, and improved grain quality. Early generation breeding and regional evaluation research will be conducted at selected locations under tropical, sub-tropical and temperate conditions to develop sorghums which maximize all yield characteristics across a broad range of climatic conditions. We have shown that sorghum selected by this method have excellent adaptation for yield in many tropical areas of the world. Screening for sources with desirable traits in introduced lines and breeding materials will be in cooperation with scientists in several disciplines. Screening and breeding nurseries already in existence include those for diseases, insects, grain quality, lodging, drought stress and adaptation. Additional breeding and evaluation nurseries will be grown under natural and artificial conditions through cooperation with other disciplines. Superior materials from the breeding program will be distributed to interested workers in national and international programs such as at ICRISAT and entered into various domestic and international uniform nurseries such as the International Disease and Insect Nursery (IDIN), All Disease and Insect Nursery (ADIN), grain Weathering Test (grain mold), midge and adaptation yield tests.

Breeding for resistance to major international pests such as striga, shootfly and ergot, which are not present in the United States, will be done primarily by national programs and/or

international workers. However, we will utilize sources of resistance as they become available and provide germplasm containing resistance for evaluation and further selection.

2. Reproductive characteristics useful in seed production will be identified. New cytoplasmic-genic sterility systems will be identified among progenies from reciprocal crosses and by mitochondrial DNA fragmentation to provide opportunities for cytoplasmic diversity and breeding flexibility. Apomictic lines will be determined by cytological and progeny testing and their potential for hybrid seed production in LDC's evaluated. Crossing enhancement and outcrossing-restricting traits will be evaluated for hybrid seed production and their inheritance determined.

3. Physiological research to improve yield stability in both sorghum and pearl millet will characterize sources of genetic variability in light energy utilization, water use, drought resistance, assimilate transport and systems controlling photosensitivity, grain filling and root development will be characterized and compared among genotypes. The characteristics of tropical adaptation and those which impart improved disease and insect resistance will be identified and tissue culture of anthers will be employed to produce haploid and doubled haploid plants from desirable breeding lines.

4. Pearl Millet improvement will be accomplished to a large extent by cooperation with the Kansas Agriculture Experiment Station (KAES). The KAES millet program will be supported and strengthened by the use of facilities, environments and expertise within Texas and the TAES international cooperative locations not available to KAES.

B. Cultural Practices

1. Three approaches will be used to develop agronomically meaningful symbiosis between sorghum and millet roots and nitrogen fixing bacteria. A screening program will be conducted with converted and partially converted sorghum and millet lines involving a) determination of those that transfer large quantities of photosynthate to their roots for support of associative nitrogen fixing bacteria, b) inoculation with nitrogen fixing bacteria isolated from c_4 photosynthetic tropical grasses in Texas and c) inoculation with bacteria isolates obtained from soils of LDC's.

Mineral nutrition efficiencies will be investigated from the standpoint of more efficient nutrient extracion and/or utilization through screening of sorghum and millet lines under graduated levels of plant nutrients in greenhouse and field studies. Particular emphasis will be placed on nitrogen, phosphorus and iron with tolerance to aluminum in acid soil environments.

Screening for low moisture tolerance will be conducted on three soil types and under rainfall shelters to assure plant stress each growing season. Physical measurements of soil water extraction and the ability to withstand stresses will be made at various stages of growth. Chemical measurements will be made to develop screening techniques.

2. Germination and seedling emergence in relation to soil moisture, soil temperature and seeding depth will be determined to establish gneral responses to a wide range of environments. Established seedling responses to soil and aerial environments in controlled studies will be coupled with weather data to develop the capability to predict stands.

Lines with superior characteristics will be made available to plant breeders for incorporation into their breeding programs. Desirable characteristics will be combined with characteristics such as insect and disease resistance and improved grain quality. Soil scientists will continue to cooperate by screening newly derived breeding materials for the superior characteristics desired. It is intended that research with millets will be in cooperative effort with the KAES. Materials from all phases of this program that are deemed acceptable will be screened in the cooperative international nurseries in LDC's.

C. Pathology

Established techniques will be used to identify and catalog sources of sorghum and millet resistance to pathogens. Complementary studies will be made to ascertain the extent and degree of pathogen variability and the genetic interaction of hosts with their environments. Significant effort will be directed to determine factors affecting pathogen survival, spread and infection. This approach will incorporate appropriate integrated cultural and chemical controls with host resistance. Sorghum pathology research will continue to be coordinated with other international institutions, national programs such as those in Senegal and Nigeria and particularly with ICRISAT. Joint planning, study and interpretation leads to more efficient and effective research. Pathologists will work with breeders on improving techniques for incorporating host resistance, with physiologists on the nature of host resistance and with entomologists on the interactions of insect and disease development as well as insects as vectors of plant pathogens. Sorghum diseases now studied and to be included are anthracnose, bacterial stripe, Cercospora leaf spot, downy mildew, grain mold, head blight, head smut, leaf blight, maize dwarf mosaic, Pythium root rot, stalk rots, zonate leaf spot and minor disease problems.

D. Entomology

The approach to dealing with insect pests as a major constraint to sorghum production will be to identify and evaluate the direct

insect-pest suppression tactics most applicable to the management of sorghum insect pests and to gather essential ancillary information regarding pest biologies and economic injury levels. Those control components most applicable to dealing with insect-pest problems in LDC's will receive major consideration. This approach will involve cooperative efforts between entomologists, plant breeders pathologists and physiologists. Also a coordinated effort among entomologists located in different geographic areas is required. Direct research cooperation is underway in Latin America and it can be expanded in Africa and Asia. The cooperative effort will allow for direct dissemination of research information, insect resistant germplasm and biotic control agents. An established plant breeding-entomology program for identifying, evaluating and improving insect resistant sorghums currently exists in Texas. This program is involved in host plant resistance research with the sorghum midge, greenbug, corn leaf aphid, spidermites and several panicle-pest species. An active germplasm exchange program provides resistant sources to scientists within the USA and several developing nations. An equally active program in both classical and natural biological control also exists in the state. Crop-culture manipulation, likewise, is an active research area. Since any one control component is seldom totally effective alone, the integration of these multiple approaches will be the goal of this proposed research.

E. Quality and Nutrition

Sorghum food quality is not understood. Currently, quality of sorghum is assessed primarily by visable or evident kernel characteristics of the grain such as kernel size, shape, plumpness, color and luster. Unfortunately, not all grains which possess these evident quality characteristics possess good cooking properties. The approaches will be:

1. Survey and compile existing information on the methods commonly used to prepare sorghum and millets for food by conferring and cooperating with existing research centers in Asia and Africa. These traditional cooking methods will be classified into groups based on similarities of the foods and/or processes and the ideal grain quality characteristics for each category will be summarized.

2. Standarized laboratory procedures will be developed to produce the major kinds of foods made from sorghum or millet. these procedures will provide a means to identify the factors that determine the food quality of sorghum or millets and provide useful criteria to select sorghum with desirable food properties. Simple, practical techniques will be devised to select for food quality properties in a breeding program.

3. Grains with resistance to molds and deterioration will be studied to determine the physical, chemical or structural factors that contribute to their resistance. Efforts to identify

mold resistant lines with desirable grain quality will be expanded. New techniques for efficiently screening for resistance will be developed in cooperation with the pathologists and plant breeders.

4. Look for varieties of sorghum and millets that are grown for special purposes by the natives and attempt to determine what makes them unique.

5. The relation of grain composition and kernel structure to the cooking properties and nutritional value of sorghum and millet genotypes will be determined. New lines of sorghum emerging from our research on single-seed selection techniques using SSM will be evaluated for differences in cooking properties and digestibility. Present efforts to determine why sorghum and millets are considered coarse grains will be expanded. The nutritional value will be determined by using a combination of animal feeding trials and in vitro assays. A major goal will be to determine whether genetic differences in availability of carbohydrates exist.

F. Data Base and Germplasm Introduction

1. Designate descriptors and parameters for efficient classification of data and develop a data bank from current research in the consortium as well as from compilations of previously collected data. Organize and put data management systems into use to facilitate collecting, handling and communicating data to the data base both within and among the states of the consortium.

TAES, in cooperation with USDA, has developed a file of sorghum data from the conversion program and other research. The data from consortium research will be communicated to the USDA-funded Boulder, Colorado program and, cooperatively with that program and ICRISAT, an international data base of use to sorghum scientists will be developed. TAES is also developing data management systems and will make these available to cooperating scientists.

2. Quarantined introduction of newly collected germplasm will be continued in designated greenhouses but with increased efficiency by the addition of support personnel. Plans will be made jointly by USDA-TAES to establish facilities for introducing greater numbers of lines and populations of plants. An island or other isolated location will be identified and germplasm entering via this system will go into sonsortium research programs either directly or through the USDA-TAES conversion program. This field quarantine location will permit the cycling of breeding populations from the USA to LDC's and back to the USA again. This facility will be planned to accommodate germplasm of other consortia, e.g. corn, as these consortia identify needs and assign funds for this purpose. It is proposed that the USDA will accept the long-term funding of this quarantine facility.

IV. EXPECTED RESULTS

Remarkable increases in yield, quality and the efficiency of utilization of sorghum as a direct result of TAES research program have occurred in developed nations in the last 20 years. These successes form the basis for our confidence that significant improvements can be made in the LDC's. TAES has an abundance of germplasm and technology, a comprehensive research program and momentum. The additional funding and organization available through Title XII will facilitate an increase in the rate of transfer of the components of crop improvement to the LDC's. While the difficulties in effecting changes in cultural/agricultural systems in LDC's are known to us by experience, recent successes, trends and findings from our program make us confident that improvements in the food supply at the village level will result from the research proposed here. Information on the likely effects of significant increases in grain production on the socio-economic situation in the LDC's will be developed with workers from other cooperating institutions. For instance, modifications in grain handling storage and marketing will be designed to avoid or minimize these problems.

Major outputs of the proposed research will be improved cultivars and new technology related to the production of sorghums in both the developing and developed countries. The proposed program will also characterize the major constraints to increased production. Through the cooperation in existence and that proposed between sorghum and millet workers within the several developing countries programs, ICRISAT and other international research centers the following results can be expected within five years:

A. Cultivars with improved environmentally stable yeild potentials including increased levels of disease and insect resistance, and with acceptable grain quality will be distributed to LDC's. Some farmer use of these cultivars is expected. The anticipated superiority of hybrids will be established and technology of hybrid seed production will be transferred and refined. We expect limited hybrid seed production will occur. In addition, technical information generated in support of the breeding program will continue to be useful in subsequent years.

B. Some genotypes with improved nitrogen fixing capability, greater nutrient utilization at low soil levels and more efficient utilization of suboptimal amounts of soil moisture will have been identified.

C. Losses will be reduced and production made more stable by deploying host resistant genotypes in concert with other biological and cultural control programs. Additional technical information on which deployment of these control strategies can be implemented through on-going country programs will be provided.

D. Significant outputs in the grain quality and nutrition area will be:

1. Knowledge of the major ways sorghums and millets are used in traditional foods.

2. A better understanding of the grain characteristics that determine whether a sorghum or millet genotype has acceptable quality.

3. Standardized laboratory procedures to evaluate grain quality factors.

4. Screening tests that can be used in a breeding program to select for grain quality.

5. A better understanding of the anti-nutritional components of sorghum and millet and how to eliminate them if possible through genetic modifications.

6. A better understanding of the availability of carbohydrates and proteins in sorghum and millets.

E. An international data base and a unified data management system will be developed and implemented. This approach will provide information with results that have immediate applicability, but much will depend on the development of the country development programs. Through the transfer and establishment of existing and new technology, the cooperative program will build systems for improved sorghum production.

BUDGET REQUESTED:

1st year	2nd Year	3rd Year	4th Year	5th Year
1,770,843	1,060,712	1,883,274	2,005,812	2,139,502

TEXAS TECH UNIVERSITY

Devlopment of stress Tolerant, High Yielding Sorghum and Millet Genotypes Utilizing Superior Physiological, Morphological and Nutritional Characteristics

Plant and Soils Science Department
Texas Tech University

The project described is this proposal will be a part of the total research efforts designed to improve yield and yield stabil- of sorghum and millet to increase food production in L.D.C's. The basic output of this will be improved gerplasm possessing characteristics found or known to be related to production capacity and yield stability under less than optimum production conditions such as inadequate available water and nutrients.

Basically our objectives will be:

1. To define the relationship between morphological, developmental and physiological characteristics and drought stress tolerance, nutrient utilization and yield of sorghum and millet.
2. To define the degree of genetic variability existing in the desirable characteristics related to yield and enviromental stress tolerance.
3. To genetically manipulate the germplasm to incorporate as many desirable yield and stress tolerant characteristics as possible and determine the heritability characteristics of each.
4. To develop techniques to rapidly identify the desirable yield and stress tolerance characteristics and interface these techniques with viable, productive plant breeding programs.

Approach:

In order to achieve our goals in a reasonable period of time, the following approaches will be used.

Considerable effort will be expended in determining the relationship between photosynthetic activity as related to plant morphology, yield capacity and enviromnental stress tolerance. Photosynthetic activity is directly related to productivity of most plants. Genetic differences between species and within species are known to exist with respect to photosynthetic rates, leaf area, utilization of photosynthate (yield) and tolerance of environmental stresses. Photosynthetic activity (photosynthetic rate times functional leaf area) is very highly related to total dry matter production rates of most green plants although it is not always directly related to harvestable economic yield.

Under semi-arid conditions the evaporative demand results in very high transpiration rates, and thus large volumes of water being used by the plant. Water consumption under a given set of environmental conditions can be reduced only by stomatal regulation or reductions in transpiring leaf area, both resulting in potential recuctions in photosynthetic activity. Under moderate to high evaporative demand conditions (10-12 mm/day) we have found no evidence of stomatal regulation of water loss in sorghum. We believe at this time that due to the high heat load imposed upon these plants, if transpirational water loss were reduced, leaf temperatures would become lethat. Therefore water conservation is minimal and water stresses due to depletion of available soil water result fairly rapidly.

In order to extend the availability of water two approaches will be used. The first approach to be evaluated is to reduce the transpiring leaf area of the plants. In order to maintain or increase productivity with less leaf area, net photosynthetic rates must be increased. We have ample data to know that in sorghum, genetic differences in net photosynthetic rates exist both with respect to whole leaf CO_2 fixation rates and in the carboxylation enzymes involved. We have no definite information on pearl millet at this time.

Selection of genotypes possessing superior photosynthetic systems will include both whole leaf photosynthetic rates and an estimation of enzyme activity using "in vitro" techniques. Enzyme activities will include both PEP carboxylase and RUBP carboxylase since at this time we believe that in sorghum, a C_4 plant, RUBP carboxylase is probably the rate limiting enzyme system just as it is in C_3 plants. The response of the photosynthetic system to enviromental stress such as drought and heat must be determined. The tolerance of each system to stress must be considered in the development process.

The second approach to extending the available water supply to the plant population involves improving the type of root system present. Preliminary evidence (W. Jordan, TAES, Temple, Texas) indicates that genotypic differences exist in the depth of root systems found in sorghum. In pearl millet we have no indications of the variability in root systems, although large differences exist in top growth.

Studies utilizing the known differences in sorghum root systems will be conducted to determine the water extraction capabilities under a wide range of soils ranging from coarse sands to heavy clays under semi-arid conditions. A very real possibility is that the genotype x enviroment (soil texture) interaction will be large indicating that selections of desirable root systems must be made for each soil type encountered. These determinations will be tentatively made utilizing the technique of monitoring the water extracion capabilities of each genotype. Additionally varieties of sorghum and millet with known rooting patterns will be sampled at various physiological stages of growth. Sampling in different soil textures will give an indication of textural modifications of root growth.

Since the root systems play a major role not only in water extraction but also in nutrient extraction, the plant nutritional aspects of various genotypes will also be determined as related to yield and water stress tolerance. In most developing countries the soils are low in native fertility and the possibility of soil amendments (in the short term) is remote. Our research will evaluate the nutrient accumulation capabilities of sorghum and millet root systems as related to the yield potential of the tops.

The ability to maximize the use, or efficiency, of accumulated plant nutrients is also of critical importance. Experiments will be conducted to determine productivity differences per unit accumulated nutrient. The nutrients to be emphasized will be N, P, K, Ca, Mg, Fe, and Zn and their interrelationships as affecting the uptake of specific nutrients. Recent observations in the sandy soils of West Africa indicate the possibility of significant

differences between sorghum and millet as to the nutrient accumulation or utilization efficiency. The nutrient deficiencies of sorghum resembled those associated with Fe and Zn. However, the millet was very green and actively growing on these same soils. The differences between species and among genotypes within each specie for the effective utilization of native soil nutrients will be determined and incorporated with other desirable traits.

The desirable morphological developmental and physiological characteristics related to yield and stress tolerance must be genetically manipulated to result in genotypes possessing the highest degree of all possible desirable characteristics. The heritability of each characteristic must be determined for future use.

The result of these efforts should be a clear definition of the yield and stress tolerance related plant characteristics and the degree of their inheritance and interaction with other desirable characteristics.

In order to fruitfully utilize this information, techniques must be developed to rapidly identify the desirable characteristics in a large source of germplasm. The development of techniques will of course have to wait for the identification of the most highly desirable characteristics.

The germplasm developed from this project will be incorporated through further breeding efforts by others associated with the total project, with disease resistance, insect resistance, improved

grain quality, etc., to improve the food production capabilities of developing countries. Since many of the problems facing L. D. C's are similar to production in the U. S., it is believed that the output of these efforts will also be of significant benefit to U. S. Agriculture

BUDGET REQUESTED: $ 148,910 Per Year

TUSKEGEE INSTITUTE

Intercropping grain sorghum and millet with soybeans

Principal Investigators: James R. Allen

One of the limiting factors in maximizing the yield of crops such as sorghum and millet is the unavailability of nitrogen fertilizer. There is no indication that this fertilizer will become available in the future and if it does become available it will become so expensive that most of the farmers in the developing countries will not be able to afford it. Therefore, it is apparent that to improve grain yeild in these countries, the procedure must be through improved cultural practices or through breeding varieties that will produce under low fertility.

To participate in this program, Tuskegee Institute proposes a project to study an intercropping system of grain sorghum and millet with soybeans. This study will be conducted on the Tuskegee Institute farm and a target country designated by the program leader. If desired, this study could be done in collaboration with another participating university. Objectives of the study are the following: (A) To devise an intercropping system of grain sorghum and millet with soybean, to obtain adequate grain yield without adding nitrogen fertilizer; (B) To determine the combination of varieties of grain sorghum and millet that will be most compatible and therefore maximize this yield in such a cropping system.

PROCEDURE

Varieties of sorghum and millet to be used in the proposed study will be those designated by the leader of the consortium.

Intercropping combinations to be tried will be the following:

A. Controls:

1. Millet alone -
2. Sorghum alone -
   Millet + sorghum -

   Plots to be fertilized according to soil test recommendation.

B. Millet + sorghum

C. Sorghum + soybean — Fertilize with P and K only

C. Sorghum + millet + soybean

Row spacing will vary so that the distance between each row of sorghum or soybean will be 6", 12, 24".

All planting and harvesting will be done by hand to simulate the technique used by developing countries.

Data to be taken will include the following:

a. Grain yield
b. Dry matter yield
c. Tillers/plant

The above data will be correlated to:

a. Row spacing
b. Cropping combination
c. The presence or absence of soybean
d. Plant population

The study is expected to be conducted over a period of four years. The study is expected to be done a tuskegee institute and then a developing country targeted by the leader of the collaborative research.

Proposed Budget:

1st Year	2nd Year	3rd Year	4th Year
63,164	60,253	61,376	64,816