Report of the INTSORMIL Review Committee

Our terms of reference are set out in the attached document "A".

Acknowledgements

1) We are greatly indebted to the Board of Directors, to Dr. Earl Leng, Director of INTSORMIL, to the Technical Co-ordinating Committee, and to all the Scientists who outlined their work to us, for their interest and helpfulness. Without their whole-hearted co-operation, our task would have been almost impossible. We were particularly impressed by the organization and management of the presentations.

2) It is inevitable that the report of a review panel should contain some adverse criticisms, since a part of their task is to seek out weaknesses and defects. We, therefore, wish to record at the outset our great admiration for the imaginative creation and development of this INTSORMIL CRSP. We believe that never before have the research capabilities and the concern for the peoples of the developing world held by staff and Scientists of the U.S. Agricultural Universities been so effectively organized into a co-operative activity bringing professional and technical knowledge to bear on the problems of ordinary sorghum and millet growers living in the LDC's. The implementation of this CRSP created a most favorable impression: the administrative machinery has devised a continuity of funding previously unknown in any donor agency activity in the developing world: and the Scientists have entered wholeheartedly and enthusiastically into the implementation of this CRSP. We hope that our admiration and favorable reaction to the way in which this CRSP has been implemented will be borne in mind throughout the reading of this report.

A. General

3) Two of our members from the developing world were unable to attend this review. This left only Dr. Brhane Gebrekidan from the developing world serving on the committee. Although the other three members of this panel have much developing world experience, we do not feel that we can speak with the same authority as can third world citizens.

4) We note with regret that no representative from ICRISAT headquarters in Hyderabad attended the review meetings. The activities of INTSORMIL are in a major area of the ICRISAT mandate, and the support for these programs totals some $14.5 million over a five year period. We appreciated the contribution to our review made by Dr. Vartan Guiragossian, ICRISAT scientist located with CIMMYT in Mexico.

5) At the time of this review, the CRSP had only been operational for nine months. The final form of its activities was not yet in place. This is particularly true of the activities in LDC's and with international institutes. Many of our comments must therefore of necessity relate to plans and intentions.

INTSORMIL ESTABLISHMENT AND LINKAGES

We have extracted the following information on the establishment and linkages of INTSORMIL -

6) Goals: The major goal of the INTSORMIL CRSP is to increase production of GS/PM in those countries where it is a principal crop. This is to be achieved by:
   (a) Developing and testing new, improved technologies;
   (b) Teaching local scientists to solve problems related to GS/PM production and use.

7) Purposes are to:
   (a) Organize and mobilize financial and human resources necessary for mounting a major, multi-institutional US-LDC collaborative effort.
   (b) Improve the capabilities of appropriate LDC institutions to generate, adopt, and apply improved knowledge to local conditions.

8) Implementation and Strategy
   (a) The program is to be composed of a set of integrated long-term research projects, together with related training and technical service capabilities.
   (b) Collaborative research relationships are to be developed between universities participating in the GS/PM CRSP, and:
      (i) appropriate LDC institutions;
      (ii) closely associated international centers and organizations such as STRC in Africa and CATIE in Latin America.
   (c) A substantial portion of the research will be done in the developing countries.
   (Attachment "A-1" of Collaborative Research Support Grant Document No. AID/DSAN/XII-G-0149 for Project No. 931-1254.11)

9) In the body of that document itself, the specific grant objective is defined as:
   (a) To link institutions having common interests in organized programs of research on this CRSP.
   (b) To mobilize and coordinate the research talent from the participating institutions to ameliorate world food, nutrition, and poverty problems specifically in the research priority areas of this CRSP.
   (c) To be responsible for the progress and fiscal management of this CRSP in accordance with the management plan set forth.
   (d) To achieve optimum collaboration and information exchange on the CRSP with AID missions, international research centers, U.S. and LDC institutions.

10) An interpretation of the documents by the Deputy Administrator of USAID records that AID sees CRSP's as instruments producing technology which will help developing nations directly. This primary purpose, technology production, is considered by the Deputy Administrator to be of over-riding importance. (The role of Title XII in International Development, by Joseph C. Wheeler, Attachment "B")

ORGANIZATION

11) (a) An Administrative Council of eight senior university administrators, one from each of the eight participating institutions, was established.
   (b) Five members from the Administrative Council were chosen to form the Board of Directors.
   (c) Dr. Earl R. Leng was selected as Program Director in December, 1978 and assumed full-time duties on August 1, 1979. He established his headquarters at Lincoln, Nebraska.
   (d) A Technical Committee of six members, one from each participating institution, was established.
   (e) Two AID/W Project Officers were nominated:
      (i) A Contract/Grants Officer (Mr. Ed Thomas)
      (ii) A Program Technical Officer (Dr. R. I. Jackson)

12) The Principles of CRSP Program and Interactions adopted are set out in paragraph II of the attached document "C", "Managing a CRSP" by the Program Director.

13) The principal initial activities of the Program Director towards the implementation of this CRSP are also set out in the attached document "C", as they relate to:
(a) Establishment of the headquarters office;
(b) Internal administrative arrangements;
(c) Subgrants to participating institutions;
(d) Relations with AID;
(e) Contact with participating personnel.

14) The views of the Program Director, abstracted from document "C" on Headquarters Organization, Relations with AID, and Communication with the CRSP group are as follows:

(a) Headquarters Organization

The headquarters staff should be as small as is consistent with meeting major requirements. Business transactions should be handled by the Management Entity institution through its normal procedures. Delays in processing administrative or fiscal documents must be kept at minimal levels if the program is to function.

(b) Relations with A.I.D.

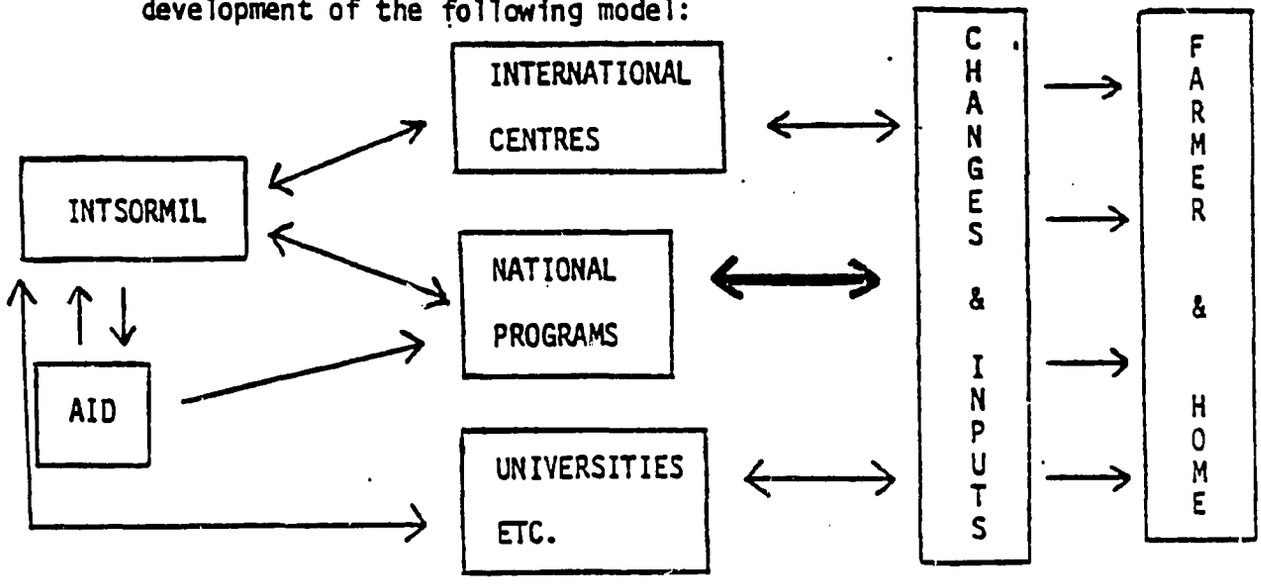
The closest possible working relations must be established with A.I.D. and maintained by constant communication. This has been quite easy in our case because of prior contacts and experience, but even had this not been so, the principle would remain the same.

(c) Communication within the CRSP Group

Every effort must be made to establish communication between the Program Director and all participants in program projects. This should include personal visits to the participating institutions, meetings and workshops - particularly of interdisciplinary focus, and frequent telephone contacts.

Above all, the Director needs to remember that academic research personnel have a strong tendency to be competitive and to focus on their own discipline and speciality; the strengths of these tendencies should be exploited but their drawbacks must be overcome if a coordinated program is to be successful.

15) Discussions at a workshop on the implementation of this CRSP led to the development of the following model:



FINANCIAL

16) The funds obligated under the grant document are $19,207,000 over a period of five years, from July 1, 1979 until June 30, 1984. This grant is made up as follows:
$14,500,000 - Estimated AID contribution
$ 4,707,000 - Estimated grantees' and subgrantees' non-federsl contribution

17) Continuity of funding is assured by the terms of this grant being extended annually to maintain a five-year advance program plan, subject only to the report of the annual review and the mutual agreement of the parties to that agreement.

18) Estimated total program costs for the five years of the grant are as follows:

Year	Total Program	Non-Federal Contribution	AID Contribution
1	$ 3,226,045	$ 1,026,045	$ 2,200,000
2	4,022,955	1,222,955	2,800,000
3	3,000,000	500,000	2,500,000
4	4,479,000	979,000	3,500,000
5	4,479,000	979,000	3,500,000
	$19,207,000	$ 4,707,000	$14,500,000

19) Participating institutions and funds allocated for the first two years (1979-81) are as follows:

University	No. of Projects	AID Contribution	Non-Federal Funds	Total
Arizona	2	121,000	36,000	157,000
Florida A&M	1	37,000	16,000	53,000
Kansas State	6	535,000	177,000	712,000
Kentucky	1	130,000	66,000	196,000
Mississippi State	4	575,000	191,000	766,000
Nebraska	9	908,000	720,000	1,628,000
Purdue	4	672,000	241,000	913,000
Texas	16	1,286,000	802,000	2,088,000

20) The Grant Document makes specific mention of funding for operations in the LDC's as follows:
"The grantees and subgrantees may make appropriate financial arrangements with LDC institutions as necessary to support a research project carried out under this grant. Such arrangements shall include the applicable terms and conditions of this grant."

OVERSEAS LINKAGES

21) The decision was made to work strictly through AID field missions in developing the early stages of LDC relations. This was the intent of the Grant Document, the management entity being required to "work with the regional bureaus, AID missions, and host country institutions to develop the priorities of the program to be done in the developing countries."

22) International linkages have three aspects:
(a) INTSORMIL internal, by discipline, inter-institutional, and intra-institutional.
(b) External
(i) formal links through AID Washington via DSB/RB to missions
(ii) to international centres such as ICRISAT, CIMMYT, IRRI & CIAT.
(iii) to developing countries.

23) The linkage organizations will be through
(a) Complex networks
(b) INTSORMIL ⇌ International Centres
(c) Program ⇌ Country
(d) Institution ⇌ Institution
(e) Individual to individual.
Ultimately, the personal relationship of (e) is the most effective, although it will take place through the medium of (a) through (d).

24) The current status of development of the international linkages is as follows:

Country	Visit	Team Visit	Ongoing Activity
India*	10.79	-	-
Philippines**	-	-	-
Indonesia**	-	-	-
Sudan***(b)	10.79	10.80	10.80
Mali***	12.79	T/A	yes
Upper Volta***	12.79	T/A	yes
Tanzania*	10.79, 6.80	T/A	yes
Egypt(b)	10.79, 10.80	10.80	-
Yemen(b)	10.79	?	yes
Honduras*	10.80	10.80	-
Guatamala*	8.80	10.80	-
Mexico*	8-9.80	11.80	yes
Brazil*	-	-	-
Haiti	10.80	10.80	-

(b) with CID
* with ICRISAT
** with IRRI
*** with ICRISAT and SAFGRAD

B. Comment on the INTSORMIL establishment and linkages

25) Goals and Purposes
While we accept the basic interpretation of the Deputy Administrator of AID that the primary purpose of this CRSP is technology production, we feel that it was the intention of Congress to place great stress on:
(a) teaching local scientists to solve problems related to GS/PM production and use;
(b) improving the capabilities of appropriate LDC institutions to generate, adopt and apply improved knowledge to local conditions;
(c) organizing and mobilizing resources necessary for mounting a major, multi-institutional US-LDC collaborative effort. (our paras 6&7 above).

26) Implementation and Strategy

It was clearly the intention of Congress that "a substantial portion of the research will be done in the developing countries." At the time of this review, it had not proved possible to implement this intention, although active steps were being taken to do so. We believe this aspect of the CRSP activity to be of major importance, and we trust that the intention of Congress in this matter will be fulfilled to the letter. (our paras 8-10 abov

27) Organization

We approve of the organization established. We like the degree of decentralization developed, and particularly welcome the major input from the Technical Committee towards the development of appropriate administrative decisions. We believe that the involvement of the scientists in this area will be a source of strength in the implementation of the CRSP, and fully support the creation of the Technical Committee and the arrangements made for its continuous renewal.

28) We accept, in principle, that the staff of the directorate should not be large. However, as this CRSP program develops, there will be a heavy travel program for the director, both in the LDC's and within the U.S. We consider that additional assistance for the director to be essential, so that this travel burden may be shared.

29) We commend the director not only for the way in which he has developed an appropriate organization, but also for the speed with which it was implemented.

30) The proposed model for the operation of this CRSP has been discussed at a Workshop by Scientists and Administrators involved with its implementation. We see no reason or justification for proposing changes. However, we would wish to stress that the links with LDC universities may be of special value. They are often staffed by good scientists, with reasonable continuity of staffing. They are often in contact with small farmers in villages adjacent to the campus. Staff of other national institutions are often burdened with such a load of administrative and other diverse matters that their effectiveness and contacts with the local cultivators are lessened. (our paras 13 above).

C. Financial

31) We are favorably impressed by the long-term nature of the funding under this CRSP. We understand that the procedures outlined have been followed meticulously by AID. We trust that the universities will recognize the reality of the long and assured duration of this funding and will have no hesitation in employing all the staff members necessary for the activities required under this CRSP.

32) Only the broad outlines of expenditures and budgets were available to us, because of the short time which had elapsed since the initiation of activities under this CRSP. We feel that the Committee will require for their next review detailed budget and expenditure statements for each project, including the proportion of each staff member's time paid for under this CRSP. Only when such information is available can we attempt to assess the extent to which the universities are fulfilling the obligations laid upon them by Congress for implementing this CRSP. We have recommended that the director should have additional accounting support. (our paras 16-20 abov

D. Overseas Linkages

33) We have already indicated our view of the importance of these linkages. Having regard to the generally slow rate of decision - making in the developing world, we consider that good progress has been made in the developing of co-operative programs with LDC's. We are of the opinion that this CRSP could be implemented relatively speedily in Latin America. With an ICRISAT program based in Mexico, we believe that implementation could involve much of Latin America, without any political problems arising. We give more details for our judgement that Latin America would be the most appropriate area for the early implementation of this CRSP in the next part of our report. (our paras 19-24 above).
However, it does seem to us that there have been problems in obtaining full and enthusiastic co-operation from some of the AID missions over the organization of linkages with LDC's under this CRSP. We believe that the full purposes and desires of Congress in the creation of these Title XII CRSP's may have eluded some administrators working in isolated overseas locations.

E. The Projects

34) General

Funding is sufficient to maintain strong programs. In view of the long-term commitment of funds to this CRSP, it should not be necessary for projects to be operated entirely by Scientists on the basis of ten percent of their time paid by Title XII. More full time staff should be employed, with preference given to those willing to spend time overseas.

35) We are in no position to assess projects on the scientific excellence of the work, especially since many of the projects have only been operating for a few months. We can only express opinions on the applicability of each project to the situation in the LDC's. It is true that any piece of research on sorghum and millets will inevitably one day be of use in the developing world. We do not regard this as a sufficient justification for the existence of a research project. Nor do we consider that, for most projects, work done entirely in the U.S. can be justified on the grounds that trainees can come from the LDC's to be taught the technology. It is true that the production of technology has been considered to be the primary purpose of this CRSP: but Title XII is not a scholarship program, and the grant document clearly states that "a substantial protion of the work will be done in the developing world."

36) There has not yet been time to set up activities in the LDC's under this CRSP, but we feel that a strong orientation towards the needs of the LDC's is required of this program. Ways should be sought to help to solve important problems such as Striga, Quelea birds, Stem borers, long smut, and Sphacelia disease, which do not occur in the U.S., through research carried out in the LDC's. It should be possible to work out procedures in conjunction with the international centres whereby such activities may be carried out. We regret that there was no ICRISAT representative to participate in this aspect of our discussions.

37) Although this CRSP is not a training program, the need to train LDC scientists is implicit in the grant document charge to "Improve the capabilities of appropriate LDC institutions to generate, adopt, and

apply improved knowledge to local conditions." We would expect that some LDC scientists would conduct research in developing country institutions under this CRSP, and we would regard strong graduate programs in the U.S. for LDC trainees as an important component of most projects.

38) Certain of the projects started before this CRSP was implemented have established good patterns of co-operative work with the LDC's. Examples to be cited are the Texas disease resistance project (TAM 7), and the Texas food and nutritional quality of sorghum project (TAM 15). However, there is concern lest some other grant requests were made more on the need for funding of projects than from a strong desire to help LDC's to benefit through technology.

39) We think it no coincidence that the presenters of projects TAM 7 and TAM 15 spoke with evident concern of the needs and situation of the people in the LDC's. We believe that this has been a major factor in the development of these project activities, and that they represent the true fulfillment of the intentions of the men who designed the Title XII legislation. The true Title XII project is not just the transfer of a good piece of scientific research from the U.S. to an LDC. The authentic Title XII project is the one developed and led by strongly motivated scientists, those who have a glimpse of the misery and need in the developing world, and who see this CRSP as an opportunity to use their knowledge and skills to bring some relief to that misery and need.

40) One of the difficulties facing plant improvement projects, as well as some other projects, are the delays caused by quarantine regulations restricting seed movements into the U.S.A. from Africa or Asia. An intermediate stage might be useful to both the institutional and the private sector, and could do much towards speeding up the rapid introgression of germplasm. A committee of INTSORMIL scientists must also consider the strengths and weaknesses of the present world collection as to preservation and ready access.

41) Program priorities

We do not wish to attempt an assessment of which kind of project is the most useful. All are needed. However, we do specially welcome the projects dealing with human food and nutrition, since this has been a neglected area in past sorghum and millet research. We also welcome the development of projects which aim to learn about the small farmers' real social and economic situation, so helping to find technologies to meet his needs, and ways to implement them.

42) Implementation priorities

We think it probable that much of the technology and improved plant material developed in the U.S. could find immediate application in the Latin American region. The spectrum of pests and diseases is the same. Further, Latin America is readily accessible from the U.S. and would appear to be the obvious area in which to try out methodologies, such as surveys in farming systems research, before transferring them to the more difficult situations prevailing in the Old World.

43) More detailed assessment

We have already indicated that we are both reluctant and unqualified to give an assessment of the scientific merits and weaknesses of projects which have been in operation for but a few months, for which preparations

for the LDC components could not yet be made, through no fault of the project leaders or investigators. We, therefore, offer an opinion only on the potential value of these projects to the developing world, as we assess it.

Plant Breeding Projects

44) Project UA-1 is valuable but small. It is well planned, and could contribute towards the identification of potential drought tolerant types, which could then be tested in the LDC's in drought nurseries. We think that the area under sprinkler irrigation should be extended by further installations of irrigation equipment so that more germplasm may be screened. We are glad that the graduate student training program has begun to take students from the LDC's.

45) Project KSU1 We have serious doubts about the applicability of the pearl millet improvement work to the LDC's. The whole pattern of pests and diseases in the U.S. differs from those prevailing in Africa and the Indian sub-continent. It is not clear to us how this program supplements the excellent on-going pearl millet improvement programs being conducted by ICRISAT in India and West Africa. We believe that, ideally, the LDC component of the project should be moved overseas. The evaluation and screening work of the pearl millet program could be done in the extreme south U.S. with overseas supplemental evaluation.

46) Project UN7 Recurrent selection in random-mating populations is likely to become the most important system for sorghum improvement, especially suited to the developing world where population breeding has many advantages. However, we are astonished that only one generation is obtained each year, and believe that immediate steps should be taken to arrange for a second generation to be grown each year in lower latitudes or south of the equator. We believe that links with the recurrent selection programs of ICRISAT in Hyderabad should also be established immediately.

47) Project TAM 2 We believe that this disease-resistance work is of value to the LDC's, and that the screening component done in the developing world should be expanded, in so far as circumstances permit. Also techniques need to be made available to LDC's.

48) Project TAM 3 Breeding for insect resistance is of the greatest importance to LDC's. However, midge and aphis are not the most important pests. We would like to see a cooperative component developed with ICRISAT, dealing with stem-borers.

49) Project TAM 6 Apomictic sorghums could indeed be very valuable to the developing world. However, this project has been active for a number of years, and the level of apomixis available is still only 20%. We question whether this level of progress justified moving this project from its former support base on to Title XII funds. Emphasis should continue to be given to cytoplasmic differences.

50) Project TAM 5 This is essentially another drought resistance project. We believe this project to be of less value to LDC's than that in Arizona (UA-1), although the physiology component at Temple is good.

51) Project TAM 1 The development of sorghums with wide adaptation and stable yields is of great practical value to the LDC's. The determination of night temperature effects on sorghum growth is also of legitimate interest to the situation in LDC's. We cannot see that the involvement of phytohormones in the control of maturity, together with the determination of the relationship between yield and photosynthetic activity, are of any concern to the LDC's, and we are uncertain how they came to be regarded as legitimate charges to Title XII funds.

52) Project MSU-2 All aspects of this project are relevant to the more humid areas of the developing world. We hope that the next review panel will have figures available to allow them to compare costings with those of the equivalent Texas project. The magnitude of breeding, entomology, and pathology expressed by the investigators seemed less voluminous than the Texas counterpart projects. We feel the sweet sorghum program to be least applicable.

53) Project UN-3 The period of grain fill in sorghum seems only very remotely related to the needs of the LDC's.

54) Project UN-4 The usefulness and relevance of this project will be greatly enhanced when testing is extended to sites in the LDC's as planned.

Entomology Projects

55) Project TAM 11 This is the back-up project for TAM 3 and is thus of practical value to the LDC's.

56) Project TAM 12 This project would benefit from more activity in LDC's, and could do with a bigger component for graduate students drawn from the LDC's.

57) Project TAM 13 We think that the information gained in this project is likely to be too location specific to benefit the LDC's, but believe that the facts about this should be established by continuing the project for a further period.

58) Project TAM 14 Until the significance of sorghum virus diseases in the LDC's has been established under project TAM 9, we question whether project TAM 14 is a proper charge to Title XII funds.

59) Project KSU 4 Millet storage pests are of great importance to the LDC's. This project should be expanded to the developing world, so that the actual pest and storage situations prevailing there can be assessed and evaluated at LDC locations.

Plant Pathology

60) Project TAM 7 In many respects, this is a model INTSORMIL project, having good work in the U.S. linked to screening in the LDC's.

61) Project TAM 8 Greater emphasis on research in the LDC's will be required, but this is basically a relevant and useful project.

62) Project TAM 9 A valuable project. The anti-sera bank alone will be of real practical use to LDC's. The virus and mycoplasma incited diseases have not been well assessed in Asia and Africa, but certainly are of high potential importance.

63) Project TAM 10 This project is limited in scope to Downy Mildew and to Head Smut, about which quite a lot of information is already available. The benefit to the LDC's may be only slight.

64) Project UN-9 We believe that this project is too fundamental in nature to benefit the LDC's in the foreseeable future, and we question whether the project should be a charge to this CRSP funds.

65) Project PRF2 Since Periconia disease is important only in the U.S. and conidia of sorghum downy mildew are extremely fragile, we wonder why this project became a part of the activities supported under this CRSP.

Plant Physiology

66) Project KSU2 The value of the results from this project to the LDC's may be only slight, but its operations in the developing world could certainly help towards building local institutional capability by training staff in a research project.

67) Project UN-1 This project has been in progress for some years, and practical results, though useful, are unlikely to become available for some time yet. We believe that a research component in the developing world should be developed if this project is to combine to receive Title XII funds.

68) Project TAM 16 The activities of this project will be extended to the Sudan in the near future, and it appears suitable for continued Title XII support.

69) Project UN-2 This project will soon have ak LDC component, and should prove to be valuable.

70) Project UN-8 We are uncertain to what extent this project will be of practical use to the LDC's, but are pleased to note the involvement with international students.

71) Projects UN-5, UN-6, and TAM 4 The value of genetic differences in mineral nutrient uptake could be appreciable, but we question whether it justifies three projects. We suggest that the Nebraska projects may be the more valuable.

72) Project KSU6 This project is relevant only to the situation in the LDC's. Either the research work should be moved there so that local cultivars can be used in local situations, or the project should be closed down.

73) Project MSU-1 This is the only project dealing with seed technology, and it has an excellent record for training students from the LDC's. We believe that it should be continued.

Nutrition and Quality

74) All the projects under this heading are of great relevance to the LDC's. We, therefore, recommend that projects TAM 15, PRF 3, PRF 4, KSU 5, and FAM 1 should be continued and supported for several more years yet.

Socio-Economic Studies

75) Again, all the projects are of great relevance to the developing world, and much remains to be learnt about methodologies and analyses. We recommend that projects PRF 1, MSU 3, KY-1, and KSU 3 should continue to receive sustained support under this CRSP until sufficient results have been obtained for proper evaluations to be made. We have some doubts about the Kentucky program's relevance on the domestic scene, and we expect to look closely at relative performance of the four programs at the next review.

F. Summary of Project Assessments

76) Projects seeming less than appropriate for LDC interchange would be UN-3 on sorghum grain fill period; UN-9 on toxins in resistance screening; PRF 2 on mechanisms of sorghum disease resistance; and TAM 14 on insect vectors of virus diseases.

77) Partial projects of questionable relevance would include TAM 1 referring to hormonal work of Morgan; TAM 5 referring to drought screening of Clark; and MSU-2 referring to sweet sorghum disease studies.

78) The committee seriously questions the contribution possible from KSU 1 and KSU 6 on millet breeding and cultural practices as the programs are now designed. Extensive LDC work and nurseries to the south of Kansas seem essential for a continuance of these activities.

79) Projects needing close observation would be MSU-2 based on a rather large funding; UN-8 on climatology based on practical significance; and TAM 6 which seems only appropriate as it applies to cytoplasmic differences.

G. Recommendations

80) Consideration must be given to the introduction of plant collections to expedite a rapid flow of germplasm. Also, adequate storage and maintenance of this material will be vital to future progress.

81) To avoid needless delays and give more significance to the directors position, we feel the director needs more freedom of operation. A description of authority, however, must be agreed upon and understood by all parties involved.

82) Assistance in accounting or travel seems appropriate for the director.

83) A system to allow for limited funding outside the present projects at present participating or non-participating universities which would be administered by the director; but, with board approval, would generate more expertise for research and consultation.

84) Stronger attempts be made to involve ICRISAT at future reviews.

85) Provide review committee with expenditure per project and percentage involvement with Title XII by individual participant.

86) The review committee has been charged with making "appraisals annually or at strategic accomplishment target dates." We feel that the cost and time away from projects is not justified by benefits from too frequent a meeting schedule. Since funding only became available nine months prior to review one, we suggest the next review at the end of 24 months or December - January 1981-2.

87) A winter review should require no more than three days of participant time plus a minimum of one day for the committee to prepare their report. The significance of the Board to the success of INTSORMIL would suggest their participation throughout the session including field tours.

88) Update review committee with any changes in funding, projects, staff involved, etc.

89) An examination of ways to involve industry should be made especially as they could advise on matters of breeding and seed production and distribution.

90) Every effort should be made to emphasize to AID Field Missions the importance of prompt and effective implementation of these CRSP projects in developing countries.

Submitted by:

Hugh Doggett
Brhane Gebrekidan
Bruce Maunder
Bobby Renfro

Comments and Recommendations of INTSORMIL Technical Committee on External Review Panel Report, As Modified and Approved by Board of Directors, October 31, 1980

(Letter-number combinations refer to project numbers - see attached list. "Paragraph" numbers refer to External Review Report paragraphs)

KSU 1 & 6 - The Technical Committee and Board consider the pearl millet program at Kansas State as an opportunity to develop this portion of the CRSP with a significant expanded LDC field staff component. The Board strongly encourages Kansas to initiate planning for expansion of work to LDC sites at the earliest possible date. The liaison visit to the Sudan, November 9-25, 1980, is to be used to investigate the possibility of placing part of the work there.

MSU 2 - The comment by the Review Committee referring to research on sweet sorghum diseases (paragraph 77) under project MSU 2 is a misunderstanding of the work and goals of this project. No sweet sorghum research is being conducted under this project. In reference to the EEP comment that this project should be monitored because of substantial funding, the Board and TC noted that MSU 2 is a very comprehensive project with proportionately more of its money devoted to staff salaries than projects at other institutions. It was suggested that MSU should continue to develop discipline cooperation with other INTSORMIL institutions.

UN 3 - The Board and TC felt that the response submitted by the project leader does not adequately reflect an increased involvement in LDC's. The TC recommends that the project leader revise his response statement to accurately reflect LDC involvement. This is to be accomplished prior to the time of the next budget preparation effort (January 15, 1981), before additional funding is authorized.

UN 8 - The Technical Committee is convinced that project UN 8, as structured and operating, is of high practical value to developing countries and warrants continued funding. Work planned in Tanzania is already underway.

UN 9 - The Board authorized continuation of this project only until the funds now allocated are spent. Emphasis should be placed on tissue culture research. No additional funding for this project is recommended. The PI is requested to publish the techniques and results of plant growth from callus culture.

PRF 2 - The Board indicated that the project objective dealing with research on studies of mechanisms of disease resistance and susceptibility to Periconia should be phased out and that future emphasis be placed on studies on the mechanism of disease resistance and susceptibility and screening for improved resistance to fungal pathogens with emphasis on Colletotrichum graminicola. A revised budget and plan of work is to be submitted to reflect the redirection.

TAM 1 - The Technical Committee and Board accept the post-review decision of the Project Leader to discontinue the phytohormone research under this project. Also noted is the intent to redirect the emphasis from phytohormone research to effects of night temperature on yield under objective 3 of TAM 1 with funds already allocated to the project. The budgetary and work plan implications of this redirection will be considered prior to 3rd year funding approval.

TAM 4, UN 5 and UN 6 - The Technical Committee identified that two projects, not three as the Review Committee noted, deal with mineral nutrients. UN 6 deals primarily with nitrogen metabolism and does not overlap with UN 5 and TAM 4 which are on mineral nutrients. The emphasis in UN 5 is primarily on plant analysis of genotype response to differential nutrient element levels. TAM 4 is a soils project. The TC strongly encourages the development of an LDC component in TAM 4. The TC and Board do not consider that there is undesirable duplication in these two projects, but does encourage that strong cooperative efforts be developed between them.

TAM 5 - The drought screening program at Chilicothe conducted by Clark under this project largely represents a drought and temperature screening effort in a field environment quite different from those of Arizona, Lubbock, Western Kansas and Nebraska. Inasmuch as different sets of drought resistance mechanisms are probably operative in response to different environments, the choices of test locations are sound. The Chilicothe screening effort does not represent duplication of effort. The TC and Board are not concerned that there will be overemphasis on drought and associated temperature stresses in view of these limitations in LDC's.

TAM 6 - The Technical Committee and Board strongly endorse the apomixis research under this project and recommends that it be continued. The $7,000 level of funding for apomixis research is a relatively small investment in a system of high potential value to developing countries.

TAM 14 - The Technical Committee recommends that the project leader of this project submit evidence of a redirection of effort to focus on the problems of the LDC's. This research project should be continued through the 3rd year of funding (June 30, 1982), but by that time, evidence of the redirection must be apparent.

In response to paragraph 4 and 84 of the Review Report the Technical Committee and Board also regret that a representative from ICRISAT headquarters was not present for the review. However it is noted that Dr. L. E. House had just completed a cooperative trip to Mexico in consultation with INTSORMIL personnel and was thus unable to attend. INTSORMIL institutions have a long standing program of cooperative activities with ICRISAT, including the sharing of research projects and nurseries, exchange of germplasm, and development of joint conferences. The major conference "Sorghum in the 80's" will be a joint venture of ICRISAT and INTSORMIL. A majority of the key participants in the Conference at INTSORMIL staff scientists and three have served on the Planning Committee. This cooperation will continue in the future.

Paragraph 67 - The Technical Committee and Board agree that project UN 1 should develop an expanded research component in LDC's as soon as possible. Presently, Arizona and ICRISAT are using the methodology developed by Nebraska to screen for drought tolerant sorghums and millet. Nebraska is encouraged to continue expansion of the utilization of this methodology in LDC programs.

Paragraph 74 - The Technical Committee indicates that project MSU 3 is more appropriately included under nutrition and quality (Paragraph 74) rather than socio-economics (Paragraph 75).

INTSORMIL - INSTITUTION/PROJECT/ACCOUNT CODES
SEPTEMBER 1979

INSTITUTION	PROJECT NO.	SHORT TITLE
U. Arizona	XIIUA1	Sorghum Selection for Arid Conditions
Florida A & M	XIIFAM1	
Kansas St. U.	XIIKSU1	Pearl Millet Breeding
	XIIKSU2	Physiological and Developmental Processes
	XIIKSU3	Farming Systems Studies
	XIIKSU4	Storage and Preservation of Pearl Millet
	XIIKSU5	Nutritional Quality of Pearl Millet
	XIIKSU6	Seedling Vigor and Stand of Millet
U. Kentucky	XIIUK1	Sociological Constraints
Mississippi State U.	XIIMSU1	Seed Factors, Stands and Emergence
	XIIMSU2	Sorghum Crop Protection/Pest Management
	XIIMSU3	Human Nutritional Improvement
U. Nebraska	XIIUN1	Sorghum Drought Resistance
	XIIUN2	Temperature Stress in Sorghum and Millet
	XIIUN3	Sorghum Grain Fill Period
	XIIUN4	Adaptation and Yield Stability
	XIIUN5	Sorghum/Millet Mineral Efficiency
	XIIUN6	Nitrogen Uptake in Sorghum and Millet
	XIIUN7	Sorghum Recurrent Selection
	XIIUN8	Climatology of Grain Sorghum
	XIIUN9	Toxins in Resistance Screening
Purdue Research Foundation	XIIPRF1	Socio-Economic Constraints
	XIIPRF2	Mechanisms of Sorghum Disease Resistance
	XIIPRF3	Development of Superior Grain Sorghums
	XIIPRF4	Enhancement of High Tannin Utilization
Texas A&M U	XIITAM1	Sorghum Breeding for Productivity
	XIITAM2	Sorghum Breeding for Disease Resistance
	XIITAM3	Sorghum Breeding for Insect Resistance
	XIITAM4	Efficient Plant Nutrient Use
	XIITAM5	Resistance to Environmental Stresses
	XIITAM6	Improvement of Reproductive Systems
	XIITAM7	Host Plant Disease Resistance
	XIITAM8	Cultural Control of Plant Diseases
	XIITAM9	Diagnostic Systems for Plant Diseases
	XIITAM10	Nature of Resistance to Diseases
	XIITAM11	Insect Resistance by Host Plants
	XIITAM12	Biological Control of Insect Pests
	XIITAM13	Integrated Insect Control Systems
	XIITAM14	Insect Vectors of Virus Diseases
	XIITAM15	Food and Nutritional Quality
	XIITAM16	Adaptation to Suboptional Conditions

ATTACHMENT C

Review of the External Evaluation Panel's Report and the Technical Committee's Response to the EEP Recommendations

John D. Axtell

The first INTSORMIL-CRSP External Evaluation Review was held in Lubbock, Texas on September 15-19, 1980. A copy of the agenda for the review, abstracts of each INTSORMIL project report, and a list of members serving on the External Evaluation Panel was distributed. Copies of the report of the EEP Recommendations were also distributed. The Technical Committee met in Kansas City, Missouri on October 30-31, 1980 to respond to the recommendations made by the EEP. A detailed response of Technical Committee action is available in the minutes of the Kansas City meeting. In general, comments by the EEP were favorable but a few areas of research were questioned as to their relevance to the objectives of the INTSORMIL-CRSP. Each Principal Investigator whose project was questioned was asked to prepare a rebuttal for consideration by the Technical Committee. The Technical Committee carefully reviewed the statements made about each project by the review panel and carefully reviewed the response statements supplied by each project leader. In all cases, lengthy and objective discussions of each project were eventually formulated into a recommendation that was voted on by each Technical Committee member. It was suggested that three categories of responses be formulated in the consideration of each of these projects. They were: (A) disagree with the panel's statement (B) recommend project redirection or revision, and (C) recommend project termination at a specific time. Based upon extensive discussions, specific recommendations were made by the Technical Committee to the INTSORMIL Board of Directors. The Board accepted these recommendations with minor revisions. The Technical Committee recommendations were implemented at the December 5, 1980, Chicago meeting by informing each Institutional Representative and each Principal Investigator of their action.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Arizona Project No. XII UA 1

PROJECT TITLE: Evaluation and Development of Sorghum Germplasm for Arid Land Agriculture

PROJECT LEADER: Victoria Marcarian

PROJECT OBJECTIVES:

1. Identify drought tolerant grain sorghum genotypes through use of irrigation gradients in an arid climate.

2. Increase drought tolerance levels through controlled crossing, selection and recurrent selection, under low-moisture, high temperature conditions.

3. Study physiological attributes of sorghum types which can tolerate low available soil moisture.

4. Evaluate drought-tolerant lines for other desirable attributes.

RESEARCH APPROACHES AND WORK PLANS:

1. A sprinkler irrigation gradient system, to apply high, medium, low and zero levels of irrigation will be established at Yuma, Arizona. Soils are sandy and low in fertility; rainfall is about 5 inches annually with little or no rain during the sorghum growing season.

2. Genotypes obtained from various sources, including those already selected for drought resistance, will be tested. About 350 strains will be tested each year. Flowering dates, height measurements and grain production will be recorded for each genotype.

3. Strains performing best in the "low" and "zero" portions of the gradient system will be further selected and recombined for additional selection under moisture stress and high temperatures.

4. Physiological studies will be made on promising drought tolerant strains. These studies will include measurement of photosynthetic stability, and dark respiration rates.

5. Laboratory techniques will be developed to increase the efficiency and effectiveness of selection for drought tolerance.

LINKAGE RELATIONS EMPHASIZED: Domestically, plant breeding and physiology programs at University of Nebraska and Texas A&M. IN LDC's, Yemen.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Florida A&M University Project No. XII FAM 1

PROJECT TITLE: Development and Field Testing of Acceptable Sorghum/Millet Foods and Recipes

PROJECT LEADER: Hetty Deane Banatte

PROJECT OBJECTIVES:

1. Establish cooperation and linkages with other research institutes and with LDC agencies in selected countries of the Caribbean.

2. Design, pre-test, utilize and evaluate a survey system for identification of food habits and attitudes.

3. Develop and test low-cost, nutritious acceptable foods and recipes based on grain sorghum and pearl millet.

4. Assist in development of LDC foods research capabilities.

5. Design and execute non-formal education programs to improve food preparation skills and knowledge of nutrition.

RESEARCH APPROACHES AND WORK PLANS:

1. Visits will be made to other universities with related work and to Caribbean countries where sorghum and millet are potentially useful food crops.

2. Nutrition surveys will be designed and carried out in selected target countries. Full use will be made of surveys previously conducted by local and international agencies.

3. If needed, a food habit study will be carried out in target countries.

4. Recipes and food products will be developed and tested in the target population, in cooperation with local agencies.

LINKAGE RELATIONS EMPHASIZED:

Domestically, with Mississippi State University. In Caribbean, initially, with Haiti.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Kansas State University Project No. XII KSU 1

PROJECT TITLE: Pearl Millet Improvement Program

PROJECT LEADER: W. D. Stegmeier, F. L. Barnett, Tom L. Harvey

PROJECT OBJECTIVES:

1. To develop widely adapted pearl millet germ plasm, with special emphasis on early maturity, good seed size and seed setting, and high nutritional quality.

2. To study the inheritance of major grain quality characteristics, high establishment capacity and insect resistance.

3. To evaluate materials developed in this program under a wide range of environments, including those of developing countries.

RESEARCH APPROACHES AND WORK PLANS:

1. Population improvement will be conducted on several random-mating, mass selected populations and one special population undergoing selection for early maturity and dwarf stature.

2. Development of inbred lines and hybrids, from advanced populations, will be carried out. In the first year, about 200 F_1 hybrids have been performance tested, and a larger number will be tested in 1980.

3. Screening of selected materials for desirable nutritional, agronomic, and pest resistance traits will be conducted by interdepartmental cooperation.

4. Materials surveying advanced selection will be made available to ICRISAT and LDC research agencies, for coordinated testing in a wide range of environments.

LINKAGE RELATIONS EMPHASIZED:

Domestically, with Texas A&M University and other research institutions interested in pearl millet. In developing countries, with ICRISAT and with countries having significant pearl millet research programs.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Kansas State University Project No. XII KSU 2

PROJECT TITLE: Physiological and developmental processes adversely affected by environmental stresses.

PROJECT LEADER: Edward T. Kanemasu

PROJECT OBJECTIVES:

1. Determine microclimate of the crop canopy under various environmental stresses imposed by cultural and tillage practices (residue management, tillage, rotations, plant populations).

2. Determine the nature and quantification of changes in physiological and developmental processes occurring under different stressed conditions.

3. Correlate these changes with microclimatic effects and with variations in grain yield.

RESEARCH APPROACHES AND WORK PLANS:

1. In this first year of research, microclimate of the crop canopy will be monitored continuously and recorded in relation to various measures of crop development (growth stage, leaf area, tillers and yield components).

2. The above information will be analyzed and correlated to determine
   (a) the influence of environmental stress on expression of yield components;
   (b) the effective of microclimate on rate and expression of plant development, and
   (c) growth stages when expression of yield components are determined.

LINKAGE RELATIONS EMPHASIZED:

Domestically with other KSU projects and with University of Nebraska. In LDC's, with ICRISAT (linkages well established) and eventually with selected country cooperators.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Kansas State University Project No. XII KSU 3

PROJECT TITLE: A farming-systems approach to sorghum and millet production in India

PROJECT LEADER: Barry H. Michie, David Norman, Janet Benson, James Converse.

PROJECT OBJECTIVES:

1. Develop analysis of farming systems, linking social science dimensions with technical considerations.

2. Develop and modify technical strategy for sorghum/millet production.

3. Improve well-being of farmers through applied research at on-farm test sites.

4. Train domestic and foreign students and staff in farming systems research.

RESEARCH APPROACH AND WORK PLANS:

1. Descriptive analysis of actual sorghum/pearl millet farming systems (probably in Rajasthan, India) will be made.

2. A set of technologies considered appropriate to the actual farming conditions will be designed and pre-tested under research station conditions.

3. Evaluated technologies will be tested in detail in farmers' fields and under realistic conditions.

4. The best technologies emerging from farm-level tests will be further evaluated in broad-scale, extension trials.

5. The above studies will be combined with micro-level socioeconomic analysis of selected rural households in the test areas, and macro-level analysis of infrastructure, development programs and the economic and institutional environment.

LINKAGE RELATIONS EMPHASIZED:

Domestically, with other Kansas State technical projects and with Kentucky socio-economic studies. Overseas, with ICRISAT, and initially, with University of Udaipur, India.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Kansas State University Project No. XII KSU 4

PROJECT TITLE: Storage and Preservation of Pearl Millet

PROJECT LEADERS: Robert B. Mills, John R. Pedersen

PROJECT OBJECTIVES:

1. Determine the extent of insect and mold problems in stored millet grain, under actual LDC conditions.

2. Determine species, relative abundance and damage levels of stored-grain insects and molds.

3. Evaluate LDC storage facilities and techniques, and design improvements where appropriate.

4. Evaluate available local insect control methods for economy and effectiveness determine if different methods used in developed countries are practical in LDC's.

5. Conduct laboratory research on susceptibility of a wide range of millet types to insect damage.

6. Evaluate relationship of threshing and handling damage to storage losses.

7. Train LDC personnel in storage technology and research,

RESEARCH APPROACHES AND WORK PLANS:

1. Project personnel will visit selected millet-producing areas to study insect and mold prevalence and damage in actual storage situations.

2. Quality and potential for improvement of local storage structures will be evaluated.

3. Where appropriate, improved storage structures and methods will be demonstrated in cooperation with local personnel.

4. Local varieties of millet, along with improved types, will be evaluated in LDC's and the U.S. for reaction to different molds and insects.

5. Particular attention will be paid to the potential for mycotoxin formation (and its prevention) in stored millet grain.

6. Local short-course training in storage studies and methods will be conducted in LDC's.

7. Selected LDC personnel will be trained at KSU, through intensive short courses and degree work.

LINKAGE RELATIONS EMPHASIZED: ICRISAT and LDC country institutions as selected.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Kansas State University Project No. XII KSU 5

PROJECT TITLE: Nutritional Quality of Pearl Millet

PROJECT LEADERS: R. Carl Hoseney, E. Varriano-Marston

PROJECT OBJECTIVES:

1. Determine how pearl millet (and sorghum) are prepared and consumed in traditional foods; also determine local opinion as to characteristics of high quality grain.

2. Devise standardized laboratory procedures to prepare and test quality of traditional food products.

3. Evaluate and identify breeding lines of millet (and sorghum) with improved nutritional quality.

4. Determine chemical components and physical characteristics of pearl millet grain which may reduce digestibility or nutrient availability, or interfere with end-use food quality of the grain.

5. Develop fundamental knowledge of the properties of various quality-related chemical components of sorghum and millet grain.

RESEARCH APPROACHES AND WORK PLANS:

1. Traditional processing of millet and sorghum grain for human food will be studied on-site in selected, collaborating LDC's. Samples of "good" and "poor" quality grain will be obtained locally.

2. Samples thus obtained will be studied and characterized in the laboratory, defining those chemical and physical properties which determine functional quality. This information will be used to develop simple quality-screening tests.

3. Pearl millet grain will be characterized for variability in digestibility, and for genetic differences in proteins and amino acid distributions. Rat feeding studies will be conducted on traditional food products. Enzyme digestion techniques and scanning electron microscopy will be used to determine if barriers exist to enzymatic action.

4. Nutrient composition and availability will be determined by chemical and biological assay on whole grain and the various milled fractions of processed products. Animal studies designed to determine the effect of different grain types and their functions on nutritional status.

5. Carbohydrates will be characterized, particularly with regard to enzymatic hydrolysis. Staling of millet/sorghum chappaties and Kisra will be studied. Pentasans will be evaluated for amount and type.

LINKAGE RELATIONSHIPS EMPHASIZED: Domestically, with other participants studying food use and nutritional value. In LDC's, initially with ICRISAT and Sudan; later with other countries including Upper Volta and Senegal.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Kansas State University Project No. XII KSU 6

PROJECT TITLE: Seedling vigor, stand establishment, and developmental physiology of pearl millet.

PROJECT LEADERS: Richard L. Vanderlip and Edward T. Kanemasu

PROJECT OBJECTIVES:

1. Identify seed and seedling characters associated with differential seedling vigor and field stand establishment.

2. Identify and evaluate germplasm with capacity to establish good stands under stress conditions - particularly temperature, moisture and high salt.

3. Identify factors closely related to plant growth, development and grain yield.

4. Identify and evaluate physiological and developmental processes adversely affected by environmental stresses.

5. Evaluate herbicides available for weed control in summer cereals, to determine which herbicides are potentially useful in pearl millet cultivation.

RESEARCH APPROACHES AND WORK PLANS:

1. Utilize established laboratory techniques and procedures for stress prior to germination, to determine the correlation of test results with field establishment and seedling vigor.

2. Determine if seed size and density are related to seedling vigor, stand establishment, plant development and grain yield.

3. Identify environmental stress responses of pearl millet resulting from particular cultural practices.

4. Quantify effects of environmental stresses, particularly those imposed by different cultural practices, on yield-related processes and characteristics.

5. Conduct field, greenhouse and laboratory studies to determine if herbicides used for other crops can be effectively used in pearl millet; determine optimum application rates for herbicides found suitable.

LINKAGE RELATIONS EMPHASIZED: Domestically, no other INTSORMIL participant has a program on pearl millet. Professional contact will be maintained with researchers on related work with sorghum, particularly at Nebraska and Texas A&M. Overseas, contacts have been established with ICRISAT, and close coordination is expected with pearl millet improvement programs in India, Sudan, and several West African countries.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Kentucky Project No. XII UK 1

PROJECT TITLE: Sociocultural Constraints in the Production and Composition of Grain Sorghum and Pearl Millet

PRINCIPAL INVESTIGATOR: C. Milton Coughenour

PROJECT OBJECTIVES:

1. To define the sociocultural complex in major production and consuming areas, including farming strategies, distribution and marketing patterns, and consumption variables.

2. To identify the processes and limitations in communications between scientists dealing with sorghum and pearl millet.

3. To identify educational linkages between scientists and farmers to evaluate programs for dissemination of scientific knowledge and information, and to develop more effective dissemination programs.

RESEARCH APPROACHES AND WORK PLANS:

1. Literature survey. This survey will utilize cross-cultural methods to look at sociocultural correlates of sorghum/millet production in societies around the world. This study is expected to enable researchers to make a preliminary identification of the most important sociocultural factors associated with sorghum and millet production. Specific regional differences also are likely to be identified.

2. Micro-level anthropological studies. These studies will be conducted in at least two differing regions of the sorghum/millet production belt in Africa, and possibly elsewhere (India?). Information on farming and consumption systems will be obtained by direct field work with farmers, family members and other relevant groups.

3. Study of research structures and operations. Research will be conducted by interviews with agricultural researchers and administrators at ICRISAT and in selected research institutions in countries participating in coordinated international GS/PM research. Data will be gathered on backgrounds of the researchers, their perceptions of cultivator's needs, their definitions and organization of research, their research goals, and their relations with other institutions and scientists. Data obtained in this study will then be correlated with data from other phases of the research and with other information, to assess a) the research workers' awareness of cultivators' needs and problems, and b) the appropriateness of research products to needs of the rural population.

4. Field studies of dissemination/knowledge utilization mechanisms. In selected areas, data will be obtained on sources and channels of information, value perceptions, and expectations of change agents and their clients. Preliminary work will be done to prepare for field investigations on decision processes, educational programs and learning styles. The latter studies are to be further developed later in the project.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Mississippi State University Project No. XII MSU 1

PROJECT TITLE: Seed Factors Influencing Germination, Emergence and Stand Establishment of Grain Sorghum and Pearl Millet.

PROJECT LEADER: J. C. Delouche

PROJECT OBJECTIVES:

1. Analysis of emergence and stand establishment problems in actual production areas, to determine causes of problems and relative importance of seed and environmental factors.

2. Characterization of germination and emgence responses to temperature, soil moisture, mechanical emergence and salinity.

3. Identification and characterization of heritable seed characters associated with superior seed quality and crop performance.

4. Development of useful screening techniques for superior seed properties.

5. Training of selected LCD personnel in seed research and technology.

RESEARCH APPROACHES AND WORK PLANS:

1. Direct contact visits will be made to cooperating LDC institutions, to observe and record data on emergence and stand establishment under actual field conditions.

2. Multiply superior seed quality lines in Texas or Arizona for heritability studies. Incorporate desirable traits into plant breeding programs where possible.

3. Implement LDC personnel training.

LINKAGE RELATIONS EMPHASIZED: LDC personnel to be selected. Arizona, Texas A&M, Kansas State University, Puerto Rico domestically.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Mississippi State University Project No. XII MSU 2

PROJECT TITLE: Crop Protection and Pest Management

PROJECT LEADER: Lynn M. Gourley

PROJECT OBJECTIVES:

1. Identify sorghum genotypes with resistance to midge and fall armyworm and identify mechanisms of resistance.

2. Determine the etiologies of the sorghum F. moniliforme disease complex and sorghum grain molds.

3. Incorporate factors for resistance to midge fall armyworm, Fusarium, grain mold and leaf disease pathogens into elite U.S. and LDC lines.

4. Conduct inheritance studies on multiple sources of resistance to sorghum insect and disease pests endemic to Mississippi.

RESEARCH APPROACHES AND WORK PLANS:

1. Develop techniques for innoculating developing sorghum grain with fungi. Evaluate seed borne pathogen effects on seed viability and stand establishment.

2. Obtain 65 grain mold resistant sorghums from ICRISAT plus segragating populations and test with domestic genotypes. Select and further evaluate in LDC's and the U.S.

3. Initiate inheritance studies on etiology and epidemiology of diseases and on mechanisms of insect resistances.

LINKAGE RELATIONS EMPHASIZED: Internationally, INCRISAT and selected sites. Domestically, Texas A&M, Georgia.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Mississippi State University Project No. XII MSU 3

PROJECT TITLE: An Interdisciplinary Approach to Nutrition Improvement of People Consuming Grain Sorghum and Pearl Millet as the Staple Food.

PROJECT LEADER: Mary Futrell

PROJECT OBJECTIVES:

1. Determine social, economic and local dietary factors affecting food consumption patterns in LDC's and delinate values and norms associated with GS and PM Consumption.

2. Determine participation by women in decision-making household, agricultural and economic activities relating to planting, harvesting and processing, storage marketing and consumption of GS and PM.

3. Assess the nutritional status (specific nutrient deficiencies) of low income GS/PM consumer to be used as a yardstick for assessing agricultural development progress.

RESEARCH APPROACHES AND WORK PLANS:

1. Arrange a nutritionist-sociologist-agronomist team to visit LDC's and prepare descriptive ethnogeographies including family structure, farming practices, marketing arrangements, communication and institutional structures and village social organization. Identify problems, potential local research associates and trainers for collaborative effort.

2. Select an ODC village where community development is minimal and cooperation is desired. The sociologist will place a graduate student there to compile data on consumer preferences and nutritional status by body measurements, animal level, infant mortality, etc. to be correlated with household nutrient intake measurements. Where malnutrition exists intervention programs will be recommended.

3. Deficiency exposure data will be used to initiate a remedial plant breeding program when applicable.

LINKAGE RELATIONS EMPHASIZED: Domestically, Purdue, Kansas State University, Texas A&M. Internationally, Honduras, Guatamala, selected African nations.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Nebraska-Lincoln Project No. XII UN 1

PROJECT TITLE: Evaluation and Development of Sorghum Germplasm for Arid Land Agriculture.

PROJECT LEADER: C. Y. Sullivan

PROJECT OBJECTIVES:

1. To define physiological characteristics which are affected most by drought stress, and identify both tolerance and avoidance mechanisms which may be selected to improve drought resistance.

2. To develop and implement practical techniques of screening and selecting for plant genotypes with desirable physiological responses for use in breeding for yield stability in moisture stress situations.

RESEARCH APPROACH AND WORK PLANS:

1. Utilize line sprinkler irrigation and low pressure travelling sprinkler systems to create continuous water gradients for testing genotype and population reaction in terms of yield and yield components.

2. Monitor growth and development patterns, which relate to yield components in the same gradient system.

3. Evaluate essential physiological processes which dictate yield with emphasis on stomatal control as it relates to transportation and CO_2 exchange. Try to identify the most limiting essential processes.

4. Related physiological measurements will include leaf water osmotic and turgor potentials stomatal diffusive resistance, heat and dessiccation tolerance, cuticular waxes, air and leaf temperatures.

5. Water loss via evapotranspirational by different genotypes will be checked to see if improved water use efficiency can be selected for.

6. Development of breeder screening techniques will be attempted.

LINKAGE RELATIONS EMPHASIZED: Domestically, Arizona, Kansas, Texas. Internationally, India (ICRISAT), probably Sudan, Kenya, Nigeria.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Nebraska Project No.XII UN 2

PROJECT TITLE: Grain Sorghum and Millet Response to Temperature Stress.

PROJECT LEADER: Jerry D. Eastin

PROJECT OBJECTIVES:

1. Characterize the effects of temperature on developmental processes in sorghum and millet which dictate limitations to seed size and seed number, and simultaneously monitor and describe key physiological processes which control development.

2. Attempt to develop screening techniques for temperature typing sorghum and millet to improve adaptation in existing zones and exploit potential of new areas. Breeders will try to use the techniques to develop cool tolerant and heat tolerant sorghum populations.

3. Test selected materials and newly synthesized populations in key U.S. and LDC locations where temperature extremes and drought currently limit production.

4. Attempt to evaluate temperature effects on plant metabolic efficiency.

5. Initiate experiments to quantitate temperature and drought interactions for yield and yield components.

RESEARCH APPROACH AND WORK PLANS:

1. Compare shifts in sorghum and millet developmental periods as influenced by temperature or water stress at Garden City, Kansas, and Lincoln, Nebraska. Both field and growth rooms will be used.

2. Evaluate L. Mendoza's cool temperature screening techniques for synthesizing cool tolerant germplasm in sorghum and millet.

3. Population development will start immediately but at least 3 cycles will be necessary before testing begins in very many locations.

4. Metabolic efficiency testing as influenced by temperature and water status will be done on seedlings and living grain fill in selected genotypes. Explanation of observed differences may require molecular level investigations.

5. While some temperature studies can be conducted pretty much in the absence of water studies, drought studies usually cannot be considered apart from elevated temperature effects. Therefore studies in Nebraska and Kansas will be initiated to quantitate temperature and drought interaction effects on yield. Gradient irrigation systems will be used.

LINKAGE RELATIONS EMPHASIZED: Domestically, plant breeding and physiology programs at Arizona, Kansas State University and Texas A&M. Internationally, ICRISAT, the Sudan and selected LDC's in time.

INTSORMIL COORDINATED RESEARCH
SUPPORT PROGRAM -- GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Nebraska Project No. XII UN 3

PROJECT TITLE: Grain fill period in sorghum

PROJECT LEADER: Charles A. Francis

COLLABORATORS: Jerry D. Eastin

Max D. Clegg

William M. Ross

PROJECT OBJECTIVES:

1. Explore the existing variability in grain fill period under a range of conditions and relate this to other morphological and physiological characters.

2. Develop new lines and source populations with extended grain fill period. and

3. Test these new hybrids and populations in a wide range of conditions in temperate and tropical zones.

RESEARCH APPROACHES:

1. Known genotypes with extremes in length of filling period will be compared to a wide range of additional lines and hybrids to explore the existing variability; from variable source populations, individual plants will be evaluated and selected to form the basis for new breeding materials in population form which will represent extremes in the trait for later comparison in yield trials.

2. Selection of new lines and continued development of new populations will lead to new combinations which are different from existing populations and hybrids. Comparisons will evaluate the usefulness of this trait.

3. New materials will be evaluated in the U.S. and in cooperating programs

LINKAGE RELATIONS:

This project will relate directly to the NE projects in adaptation and yield stability and in recurrent selection. The effects of temperature and moisture stress on grain fill period also will be evaluated (NE, TX and KS projects). Linkage with programs in the tropics will be critical to success, and there are possibilities in Tanzania, Botswana, Sudan and in Brazil.

INSTITUTION: University of Nebraska Project No. XII UN 4

PROJECT TITLE: Adaptation and yield stability in grain sorghum

PROJECT LEADER: Charles A. Francis

COLLABORATORS: William M. Ross

Jerry D. Eastin

PROJECT OBJECTIVES:

1. Study the adaptation and yield stability of a range of grain sorghum lines and hybrids under varied conditions.

2. Determine which morphological or physiological traits are associated with yield stability.

3. Develop widely adapted populations for use as varieties and as a genetic source for extracting lines. and

4. Test widely adapted lines, hybrids and populations in a range of conditions in the temperate and tropical zones.

RESEARCH APPROACHES:

1. A standard set of lines and hybrids will be grown in 6 locations in the U.S., locations which differ in temperature, rainfall, and photoperiod; different cultural conditions will be imposed such as density, planiing date, irrigation level, and type of land preparation. Data will be collected on plant growth and development, as well as final yield and yield components.

2. Correlations with yield and dry matter distribution will provide understanding of adaptation, and how best to select for this trait.

3. Broad based populations will be planted in these same locations and recombined to produce new combinations which are adapted across sites.

4. Testing sites will be used in the U.S. and in the tropics.

LINKAGE RELATIONS:

This project relates closely to the NE projects in temperature and drought tolerance, grain fill, nitrogen use efficiency and recurrent selection. There is potential linkage with TX, KS and Mississippi State projects listed. The testing and implementation in the tropics is critical, and no specific sites have been selected yet.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Nebraska Project No. XII UN 5

PROJECT TITLE: Mineral element efficiencies and tolerances in sorghum and millet.

PROJECT LEADER: R. B. Clark

PROJECT OBJECTIVES:

1. Evaluate genotypic responses for efficiency and tolerance to uptake, translocation, accumulation, balance and use of mineral elements of plants grown in high, normal, deficient, and toxic root envrionments.

2. Determine the adaptability and stability of genotypes grown on soils with varied mineral stresses.

3. Determine effects of environmental, production, and management conditions on uptake, and use of mineral elements.

4. Determine the inheritance of mineral element efficiency and toxicity tolerance traits.

RESEARCH APPROACHES AND WORK PLANS:

1. Genotypes of diverse gentic backgrounds will be screened in nutrient solutions and/or soils for differences in their ability to absorb, translocate, accumulate, and use mineral elements using high, normal, deficient, and toxic levels of particular mineral elements. Differences in growth rates, dry-matter yields, mineral element concentrations of plant parts, degree of visual stress symptoms, time for stress symptoms to appear, type of root systems, top:root ratios of dry weights and mineral element contents, dry-matter produced per unit of element, distribution of mineral elements in various plant parts, and interactions with other elements will be determined.

2. Plants will be evaluated for their adaptability and stability when grown under varied mineral stresses in field and greenhouse experiments. These will be conducted in cooperation with scientists in Nebraska, and other states and countries to evaluate genotypes under a variety of mineral stress conditions.

3. Sorghum and millet will be grown at different moisture and temperature conditions, and plants grown under various production and management practices to determine mineral element concentrations, contents balances, and distribution of mineral elements.

4. Genotypes with high and low mineral element efficiencies and toxicity tolerances will be crossed in different combinations to determine the inheritance of mineral element accumulations and usage and the ability of these traits to be manipulated genetically.

LINKAGE RELATIONS EMPHASIZED: Physiology, soil fertility and plant breeding in states (Texas, Arizona, Mississippi, Georgia, etc.) and countries (India, East African countries, Algeria, Brazil, Colombia, Central America, Egypt, etc) where mineral stresses exist.

INTSORMIL COORDINATED RESEARCH
SUPPORT PROGRAM -- GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Nebraska Project No. XII UN 6

PROJECT TITLE: Nitrogen uptake in sorghum and millet

PROJECT LEADER: Jerry W. Maranville

PROJECT OBJECTIVES:

1. Identify sorghum and millet genotypes which are capable of producing high rates of growth and good quality grain under limited N fertility.

2. Determine the physiological mechanisms which allow genotypes to be N efficient.

3. Measure the interactions which occur between N metabolism and environmental parameters such as light, temperature, and water.

RESEARCH APPROACHES AND WORK PLANS:

1. Initial screenings for N efficiency will be made on several sorghum populations and advanced breeding materials under low and high soil N levels using both field and nutrient solutions.

2. Physiological processes such as root activity, translocation, and photosynthesis - respiration -- N metabolism interactions will be compared on N efficient versus N inefficient types.

3. Morphological comparisons of root systems will be made.

4. Environmetal parameters such as water, temperature, and light regimes will be altered by variation in field locations as well as use of greenhouse and growth chambers.

5. Genotypes will be closely evaluated for their performance under wide ranges of environmental variability with emphasis on yield and protein content.

INSTITUTION: University of Nebraska Project No. XII UN 7

PROJECT TITLE: Recurrent Selection

PROJECT LEADERS: W. M. Ross, C. O. Gardner, and C. A. Francis

PROJECT OBJECTIVES:

1. Identify plant breeding methods concerned with recurrent selection and population improvement that will be useful and effective in developing countries.

2. Develop random-mating populations that possess attributes of high yield, desirable agronomic characteristics, pest resistance, and/or grain quality.

3. Identify superior germplasm in these populations.

RESEARCH APPROACHES AND WORK PLANS:

1. Yield test base populations in the U.S. and overseas and identify those useful for breeding work.

2. Initiate family selection schemes, particularly S_1 progeny testing, as a means of population improvement. , Initiate multi-trait as well as single trait selection.

3. Evaluate other recurrent selection methodology such as topcrosses, test crosses of S_1's to lines, and possibly reciprocal recurrent selection.

4. Select in improved cycles of populations and develop inbred lines. Evaluate these lines alone or in hybrid combinations as appropriate.

5. Cooperate with disciplines in the development of screening techniques for environmental stress, plant nutrition, pest resistance, and grain quality.

LINKAGE RELATIONS EMPHASIZED:

Domestically with Arizona, Texas, and Kansas; internationally with ICRISAT and India; contacts exist in Thailand, Philippines, Cameroons, Sudan, and Brazil.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: University of Nebraska-Lincoln Project No. XII UN 8

PROJECT TITLE: Agricultural Climatology of Sorghum/Millets

PROJECT LEADER: R. E. Neild

PROJECT OBJECTIVES:

1. To describe the growing cycle of grain sorghum in terms of climatic requirements. Critical stages of plant development and critical levels of significant elements would be identified and discussed.

2. To complete a comparative climatological analyses of sorghum, growing seasons and regions in the United States and other developed countries.

3. To characterize and categorize the climatic conditions in seasons and regions growing sorghum in developing countries throughout the world. Emphasis would be placed on identifying areas where sorghum is gorwn beyond the limits normally considered as suitable for strains adapted to the developed growing regions.

4. Construct weather-crop models to predict the development and yield of grain sorghum.

RESEARCH APPROACHES AND WORK PLANS:

An agroclimatic interpretation and integration of information in sorghum/millet literature and analyses of phenological, production and climatic data from growing regions in the United States and other developed countries will be used to describe the growing cycle and construct weather-crop models. Agroclimatic procedures will be developed to characterize, compare, categorize, list, map and otherwise delineate by computer information relative to climate and grain sorghum/millet for different regions of the world.

Project No. XII TAM 1

INSTITUTION: Texas A&M University

PROJECT TITLE: Plant Breeding and Genetics - Productivity

PROJECT LEADER: F. R. Miller

PROJECT OBJECTIVES:

1. Develop sorghums with wide adaptation and stable yields.

2. Determine the involvement of phytohormones in the control of maturity, sex expression, height, root development, tillering, and other growth responses related to yield.

3. Determine the effects of night temperatures on sorghum growth.

4. Determine the relationship between yield and photosynthetic activity.

RESEARCH APPROACHES AND WORK PLANS:

1. Materials from the integrated sorghum improvement program will be evaluated for adaptation at key international and domestic locations. Relationships of maturity, height, grain yield and components of yield will be established. Base temperature differences will be correlated with agronomic traits.

2. The twelve sorghum maturity genotypes will be grown under non-synchronous photo and thermoperiods to determine the interactions of daylength and temperature on growth and development and hormone levels. These and other genotypes will be used to isolate and purify sufficient quantities of ABA and IAA to allow identification by gas chromotography-mass spectrometry.

3. Physiological studies will be made on sorghums known to respond to temperate and tropical conditions to determine the effects of night temperature on growth parameters through night-time temperatures control chambers.

4. Sorghums which have different components of yield will be used to determine the association between yield and photosynthetic activity. Non-senescencing sorghums with different panicle characteristics will be evaluated for the interaction of seed size and seed number and which responds to population pressure most severely.

LINKAGE RELATIONS EMPHASIZED: Plant breeding, physiology and pest control programs in Texas and similar programs at University of Nebraska, Kansas, Arizona and Georgia, as well as testing and evaluations in Mexico, Guatemala, India, Sudan Tanzania, Ethiopia, Egypt and Upper Volta will be used as collaborators.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAM 3

PROJECT TITLE: Breeding for Insect Resistance

PROJECT LEADER: Jerry W. Johnson

PROJECT OBJECTIVES:

1. Obtain germplasm to be evaluated for resistance to the sorghum midge, greenbug, corn leaf aphid, and Banks grass mite.

2. Determine the inheritance of insect resistance.

3. Develop and release high yielding, agronomically improved sorghum resistant to selected insects.

RESEARCH APPROACHES AND WORK PLANS:

1. Grow replicated tests of sorghums that have been identified by the entomology component of INTSORMIL as possessing resistance to the target arthropod pests and evaluate for agronomic potential.

2. Select entries with the most desirable combination of resistance and agronomic potential for crossing to agronomically elite lines, and for intercrossing.

3. Use standard breeding techniques to incorporate resistance into improved types and to improve resistance levels.

4. Inheritance studies will be conducted using F_1, F_2, and F_3 generations.

LINKAGE RELATIONS EMPHASIZED: Domestically, USDA in Georgia and Oklahoma and Mississippi State University. International, R. A. Borgonovi and J. M. Waquil (EMBRAPA - Brazil); Vartan Guirogossian (ICRISAT - Mexico); Albert Plant (ICTA - Guatemala); Don Kidman (CID - Bolivia); J. C. Davis and Lee House (ICRISAT - India); and J. A. Frawd (ICRISAT - Upper Volta).

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas Agricultural Experiment Station, Texas A&M University

PROJECT TITLE: Efficient Nutrient Use Project No. XII TAM 4

PROJECT LEADER: Arthur B. Onken

PROJECT OBJECTIVES:

1. Identify and define potential sources of more efficient plant nutrient extraction and/or utilization in sorghum.

2. Develop agronomically elite sorghums with improved nutrient use efficiencies.

3. Develop new methods for determining nutrient use efficiencies and to study responsible mechanisms when appropriate.

RESEARCH APPROACHES AND WORK PLANS:

1. Diverse genotypes of grain sorghum will be obtained from the breeding programs at Lubbock, Texas and grown in nutrient and soil culture in greenhouse studies for N, P, and Fe use efficiencies along with susceptibility to Al toxicity.

2. Genotypes to be screened first will be those that have been shown to have promise in LDC's from research conducted under AID Contract No. AID/ta-c-1384 as well as selected converted lines of diverse genetic backgrounds.

3. Crosses will be made among lines to make a preliminary assessment of heritability. Evaluation and selection of improved types will be made in soil and solution culture. Verification of selections will be made in the progeny of improved lines under field and solution culture.

4. Standard breeding techniques (including random mated populations) will be utilized in improving nutrient use efficient materials.

5. Mechanisms of nutrient use efficiency (e.g. reductant release, root configuration) will be studied as necessary for screening procedure modifications and/or inheritance studies.

LINKAGE RELATIONS EMPHASIZED:

Domestically, plant breeding and soil fertility programs of the Texas Agricultural Experiment Station, Texas A&M University and the University of Nebraska. In LDC's, Upper Volta and Mali. Also in Venezuela.

INSTITUTION: Texas A&M University Project No. XII TAM 5

PROJECT TITLE: Other Environmental Stresses

PROJECT LEADER: Page W. Morgan

PROJECT OBJECTIVES:

1. Determine the range of genotypic variability for characteristics which contribute to heat and drought resistance.
2. Define environmental conditions where these characteristics may contribute to superior performances.
3. Screen cultivars for adaptation to low soil moisture, high tolerance to temperature and moisture stress during panicle development, flowering, and grain development.
4. Develop superior agronomic types with tolerances to these stresses.

RESEARCH APPROACHES AND WORK PLANS:

1. Greenhouse and controlled environment studies will be conducted to define effects of high temperature and drought stress with laboratory estimate of heat and desiccation tolerance.
2. Field experiments will be conducted to evaluate heat tolerance, desiccation tolerance and leaf wax content.
3. Root growth rates among genotypes will be measured to identify genetic capacity for rapid root growth.
4. Hormone analysis of xylem exudate will be conducted as a first step in studies on effects of drought stress on performance of sorghum.
5. Field nurseries will be planted at Temple, Chillicothe, Big Spring, Lubbock, and Halfway to screen germplasm under field stress conditions to identify lines with various types of stress tolerance.
6. Plant breeding nurseries and tests for stress tolerance evaluation and selection.
7. Select superior plants in nurseries and take notes on stress traits.

LINKAGE RELATIONS EMPHASIZED:

All work the first year will be within the Texas Agricultural Experiment Station. Linkages will be established with Nebraska, Arizona, and ICRISAT physiologists for future work.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAM 6

PROJECT TITLE: Reproductive Systems

PROJECT LEADER: K. F. Schertz.

PROJECT OBJECTIVES:

1. Identify lines with superior reproductive characteristics including obligate apomixis and new cytoplasmic sterility systems.

2. Achieve anther culture and obtain haploid and homozygous diploid plants.

RESEARCH APPROACHES AND WORK PLANS:

1. Identify lines with superior reproductive characteristics among newly introduced and current germplasm by observations of morphological and cytological characteristics.

2. Identify stages of in vitro sorghum microspore development in order to clarify in vitro responses of microspores to culture conditions which could lead to androgenesis and whole plant formation.

LINKAGE RELATIONS EMPHASIZED:

Collaborative research will be developed with personnel at the Univeristy of Florida to identify differences among lines in mitochondrial DNA. Collaboration will be established with the University of Nebraska and with Puerto Rico to determine field response of lines with different cytoplasms. ICRISAT personnel will cooperate in locating and collecting grassy types. Collaboration with personnel involved with the sorghum conversion program will identify genotypes to be used in anther culture.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAM 7

PROJECT TITLE: Identification, evaluation, and implementation of effective systems for controlling diseases or pathogens in sorghum and millet. (Host Plant Resistance)

PROJECT LEADER: Richard A. Frederiksen

PROJECT OBJECTIVES:

1. Identify, catalogue, and evaluate sources of disease resistance in sorghum and millet.

2. Develop effective screening techniques for detection and incorporation by breeding of superior plant resistance levels.

3. Study disease etiology.

RESEARCH APPROACHES AND WORK PLANS:

Sorghum entries will be evaluated under field and controlled conditions for their reaction to major diseases, particularly downy mildew, head smut, maize dwarf mosaic, stalk rot and anthracnose. Lines with high levels of resistance will be advanced to the "All Disease and Insect Nursery" (ADIN) for evaluation under a wide range of hostile environments.

Sources of host resistance will be used as screens for the evaluation of pathogens and variability. For example, the Uniform Head Smut Nursery, the Internation Sorghum Downy Mildew Nursery, and the International Sorghum Anthracnose Virulence Nursery all have demonstrated the importance of pathogen variations. Steps will be taken to improve efficiency in evaluation of host resistance.

LINKAGE RELATIONS EMPHASIZED:

Domestically with Texas workers, Mississippi State Improvement Program; internationally with ICRISAT and by cooperative development of the monitoring and screening nurseries in locations where a) they are requested, b) they can effectively evaluate host resistance levels, and c) be used to monitor pathogen variability.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAM 8

PROJECT TITLE: Identification, evaluation, and implementation of effective systems for controlling diseases or pathogens in sorghum and millet. (Cultural Control)

PROJECT LEADER: Gary Odvody

PROJECT OBJECTIVES:

1. Explore the use of cultural, chemical, and biological control measures as an adjunct to control by disease resistance.

RESEARCH APPROACHES AND WORK PLANS:

Studies will be conducted to determine the ecology of major pathogens of sorghum and millet including those presently causing endemic and epidemic diseases in the U.S. and exotic pathogens of potential quarantine significance. Emphasis will be placed on studies of major soil-borne pathogens investigating host and environmental factors related to disease incidence and development. Results of these studies will be utilized to develop indicated biological, cultural, and chemical controls. The involvement of key LDC scientists in cooperative studies will enhance the development of disease controls and facilitate their acceptance and implementation in cooperating countries.

LINKAGE RELATIONS EMPHASIZED:

Collaboration among plant pathologists, agronomists, and entomologists developing integrated control approaches, particularly in Texas and Mexico. Selected aspects of the work will need to be done by LDC scientists to evaluate differences among models, i.e. similar experiments for control of charcoal rot or downy mildew could be carried out in Mali, India, and Texas.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM - GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAM 9

PROJECT TITLE: Identification, evaluation, and implementation of effective systems for controlling diseases or pathogens in sorghum and millet. (Diagnostic Systems)

PROJECT LEADER: Robert W. Toler

PROJECT OBJECTIVES:

1. Develop critical disease diagnostic systems.

RESEARCH APPROACHES AND WORK PLANS:

1. Make a collection of sorghum germplasm that shows differential reactions to different viruses and to strains of viruses that attack sorghum. To determine specific reactions and develop a collection to aid in sorghum virus and strain diagnosis.

2. Build an anti-serum bank for sorghum viruses to use with serologically specific electron microscopy for sorghum virus disease diagnosis.

3. Determine if pinwheel inclusions can be used as a diagnosistic tool in identification of maize dwarf mosaic virus and sugarcane mosaic virus strains.

LINKAGE RELATIONS EMPHASIZED:

With LDC virologists and pathologists by joint participation in developing the International Sorghum Virus Nursery.

INSTITUTION: Texas A&M University Project No. XII TAM 10

PROJECT TITLE: Identification, evaluation, and implementation of effective systems for controlling diseases or pathogens in sorghum and millet. (Modes of Resistance)

PROJECT LEADER: Jeweus Craig

PROJECT OBJECTIVES:

1. Determine mode of disease resistance and inheritance of resistance.

2. Evaluate genetic variability in plant pathogens.

RESEARCH APPROACHES AND WORK PLANS:

1. Sorghum cultivars homogenous or nearly homogenous for resistance and susceptibility to important pathogens will be identified, inoculated, and observed for host-parasite interactions to determine how, when, and where disease resistance is expressed.

   The sorghum cultivars will be used as parental lines for the F_1, F_2, F_3, and backcross populations needed to determine the mode of inheritance of disease resistance.

2. The genetic variability for virulence in sorghum pathogens will be evaluated in field nurseries containing collections of the known resistant genotypes. The nurseries will be sited over a range of environments and will be monitored for abnormal reactions to pathogens. In addition, samples of pathogens will be collected from various locations and tested for virulence to resistant sorghum lines under controlled conditions in the greenhouse.

LINKAGE RELATIONS EMPHASIZED:

In cooperation with Dr. Gary Odvody, Texas A&M Agricultural Experiment Station, Corpus Christi, Texas.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM- GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAMU 11

PROJECT TITLE: Development and evaluation of systems for controlling insect pests of sorghum by integration of resistant varieties, cultural manipulation and biological control.

PROJECT LEADER: George L. Teetes

PROJECT OBJECTIVES:

1. To identify and evaluate sorghums resistant to the sorghum midge, greenbug, corn leaf aphid, sorghum webworm, corn earworm and Banks grass mite; determine resistance mechanisms; investigate plant-pest ecological responses, and determine economic injury levels.

RESEARCH APPROACHES AND WORK PLANS:

1. Selected sorghum introductions as they become available, and appropriate converted and partially converted exotic lines from the sorghum breeding program will be screened for insect and mite resistance.

2. Greenhouse screening trials will be used to screen for resistance if dependable techniques are available or can be developed.

3. Field screening trials will be made at multiple geographic areas for testing under natural conditions and insect infestation.

4. Resistance will be evaluated on the basis of pest densities that develop on plants and/or the response of plants to pest feeding and response of pests to plants.

5. Ecological effects of insect resistance sorghums on pest and natural enemy population dynamics will be studied.

6. Pest population densities will be compared to plant damage and subsequent yield to determine economic injury levels of susceptible and resistant sorghums.

LINKAGE RELATIONS EMPHASIZED: Domestically, Mississippi State U., Oklahoma State U., USDA, SEA, FR, Tifton, Georgia. In LDC's, ICRISAT, and country programs in Africa, Asia, Central and South America.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM-GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University Project No. XII TAM 12

PROJECT TITLE: Development and evaluation of systems for controlling insect pests of sorghum by integration of resistant varieties, cultural manipulation and biological control. (Bio Control)

PROJECT LEADER: Frank E. Gilstrap

PROJECT OBJECTIVES:

1. To identify and evaluate indigenous and/or exotic natural enemies of sorghum midge, greenbug, Banks grass mite, and several lepidopterous pest species as potential control agents.

RESEARCH APPROACHES AND WORK PLANS:

1. By field studies, survey, identify and determine host, host plant, and temporal phenologies of existing natural enemies of aphids and sorghum midge attacking sorghum in ecologically unique sorghum producing areas of Texas.
2. By literature search, determine the diversity, geographic distribution, and host plant affinities of natural enemies of sorghum-infesting aphid species and sorghum midge from other sorghum producing regions of the world.
3. Introduce, study, release, establish, and evaluate exotic natural enemies of aphid species attacking sorghum.
4. Initiate working relationships and informational exchanges with investigators in key sorghum producing countries of the world.

LINKAGE RELATIONS EMPHASIZED: Domestically- Oklahoma State University, University of Missouri, USDA-AR at Newark, Delaware. In LDC's -country programs in Africa, Asia, and Central and South America.

INSTITUTION: Texas A&M University Project No. XII TAM 13

PROJECT TITLE: Development and evaluation of systems for controlling insect pests of sorghum by integration of resistant varieties, cultural manipulation and biological control. (Bio Systems)

PROJECT LEADER: George L. Teetes

PROJECT OBJECTIVES:

1. To determine the biology, systematics, behavior and seasonal abundance prof of sorghum insect pests and associated predators and parasites as support tactics in pest control schemes.

RESEARCH APPROACHES AND WORK PLANS:

1. Classical techniques for studying the biology of sorghum pests and their associated parasites will be used, including laboratory, greenhouse, and/or field studies.

2. Efforts will be made to determine effects of various environmental factors on natality and mortality of arthropods associated with sorghum.

3. The distribution both temporal and spatial and abundance of insects in relation to crop growing season will be studied in the field.

4. Factors influencing the inception, duration and termination of diapause will be studied in field and laboratory experiments.

5. The knowledge gathered on the biological attributes of sorghum insect pests will then be applied to take advantage of various crop-cultural manipulation tactics that would tend to suppress pest density and damage.

LINKAGE RELATIONS EMPHASIZED: Domestically, Oklahoma State U., Mississippi State U. and USDA, SEA, FR at Tifton, Georgia. In LDC's, ICRISAT, Brazil and Central America.

Institution: Texas A&M University Project No. XII TAM 14

Project Title: Development and evaluation of systems for controlling insect pests of sorghum by integration of resistant varieties, cultural manipulation and biological control. (Insect Vectors)

Project Leader: Kerry F. Harris

Project Objectives: To better define the insect-pathogen-host plant interactions of insect-borne pathogens of sorghum.

RESEARCH APPROACHES AND WORK PLANS:

1. Alate aphid species will be sampled and monitored using yellow pan and suction traps.

2. Basic transmission experiments will be used to identify vectors (particularly aphids and leafhoppers) and to describe transmission mechanisms as either circulative or noncirculative.

3. The fate of maize chlorotic dwarf virus (MCDV) and other viruses in their aphid or leafhopper vectors will be studied by electron microscopy, ELISA and SSEM techniques.

4. The role of ingestion-egestion behavior in virus transmission will be studi using artificial and natural feeding techniques.

5. The ultrastructures of the feeding apparatuses of aphid and leafhopper vectors will be studied using conventional scanning and transmission electron microscopical procedures.

LINKAGE RELATIONS EMPHASIZED: Domestically, Rutgers University, USDA, SEA, FR, Tucson, AZ and Wooster, OH. In LDC's, ICRISAT, country programs in Africa, and Central and South America.

Project No. XII TAM 15

INSTITUTION: Texas A&M University PROJECT LEADER: Lloyd W. Rooney

PROJECT TITLE: Quality - Productivity

PROJECT OBJECTIVES:

1) Determine how sorghums are processed, prepared and consumed in traditional village foods and determine the grain characteristics that affect the organoleptic properties of the traditional food products.
2) Develop simple, practical laboratory methods for use in breeding programs to assess important grain quality characteristics.
3) Determine the basic physical and chemical factors that affect the nutritional value and food quality of sorghum and that interferes with end use quality of the grain in traditional foods.
4) Determine the factors that affect resistance to grain molds and field deterioration in sorghum and devise laboratory procedures to detect genotypes with resistance.

RESEARCH APPROACHES AND WORK PLANS:

1) Visit selected countries to determine how sorghums are processed, cooked and consumed by conferring and cooperating with existing research centers in Latin America, Africa and India. For example, "To" production in West Africa will be the first product evaluated.

2a) Standardized lab procedures for "to" production with and without alkali will be developed. The procedure(s) will be utilized to confirm that certain sorghums produce good and-poor quality "to". Then, experiments will be initiated to determine why certain sorghums have poor "to" properties. The relation of starch content, amylose content, gelatinization temperature and other properties to "to" making quality will be determined.

b) Determine the factors that affect the milling properties of sorghum by developing and evaluating small scale laboratory dry milling procedures that can be used on samples in a breeding program.

c) Determine the tortilla making properties among sorghum varieties from Central America and selected varieties and lines in breeding programs and the conversion program.

d) Determine the affect of pericarp color, glume color and other genetically controlled factors on the quality of foods made from sorghum.

e) The relation between food properties and certain chemical constituents such as amylose content of the starch will be determined. Measurements that will be taken on the grain includes kernel hardness, composition, texture, starch properties and others.

3a) Initiate studies to determine the relation of grain composition and kernel structure to the cooking properties and nutritional value of sorghum genotypes.

b) The availability of the nutrients in sorghum genotypes and sorghum foods will be determined by using in vitro procedures.

c) Studies will be initiated to determine why sorghum and millets are considered coarse grains.

d) New lines of sorghum emerging from the breeding programs will be monitored for differences in cooking properties, in vitro digestibility and structure.

e) An attempt to measure the interaction between the major traditional processing methods and availability of the nutrients in sorghum genotypes will be initiated.

4a) Grain of resistant and susceptible lines will be characterized to detect differences in kernel structure, rate of water uptake and mode of entry of molds with light and electron microscopy.

b) The physical and chemical properties of the grain will be determined.

c) Food quality properties of grain of mold resistant, agronomically superior lines as they become available will be examined to insure that food quality is not impaired.

INTSORMIL-COORDINATED RESEARCH
SUPPORT PROGRAM-GRAIN SORGHUM/PEARL MILLET

INSTITUTION: Texas A&M University PROJECT NO. XII TAM 16

PROJECT LEADER: Charles W. Wendt

PROJECT TITLE: Meterological Adaptation - Suboptimal Soil Moisture

PROJECT OBJECTIVES:

1. Identify and define grain sorghum cultivars which have the potential to be tolerant to sub-optimal moisture conditions in different soil types.

2. Determine the usefulness of soil moisture depletion patterns and plant sugars as methods for screening for sub-optimal moisture conditions.

3. Development of agronomically elite grain sorghum with improved tolerance to sub-optimal moisture conditions.

RESEARCH APPROACHES AND WORK PLANS:

1. Sites with clay loam, loam, and loamy fine sand or fine sandy loam soils will be selected and characterized as to their physical and chemical properties.

2. A rainout shelter will be constructed at the loam soil site. The shelter will be used to assure conditions to evaluate the influence of early stress on a group of diverse genotypes.

3. Advanced breeding materials from the existing Texas A&M University plant breeding program will be evaluated in the early research efforts. Additional cultivars will be incorporated for evaluation as they become available from the program.

4. Soil water depletion and plant sugars will be evaluated as to their potential for screening cultivars under sub-optimal conditions.

5. Plants will be harvested and analyzed periodically to determine the responses of the different cultivars to soil and climate conditions.

6. Climate measurements will be used to estimate potential evapotranspiration.

LINKAGE RELATIONS EMPHASIZED:

Domestically, plant breeding and physiology programs at Texas A&M University. In LDC's, the primary interest is Africa, more specifically, the Sudan.