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PNAAR-227

PROGRAM

INTSORMIL ANNUAL REVIEW
January 11-13, 1983
Sunburst Inn, Scottsdale, AZ

Monday, January 10, 1983
Participants travel to Phoenix, AZ, and travel to Sunburst Inn by limousine.

Tuesday, January 11, 1983
8:00 - Introduction (J.D. Axtell)

8:20 - An overview of Title XII and the role of CRSP's in LDC research and training programs (D.W. Thomas)

9:00 - Current status of INTSORMIL (E. Leng)

9:45 - Coffee Break

10:00 - Case history of the INTSORMIL/Sudan program (E. Reeves/B. DeWalt)

10:45 - Case history of the INTSORMIL/Honduras program (K. DeWalt/D. Meckenstock)

11:30 - Discussion

Noon - Lunch
RAPPORTEUR, COUNTRY PROGRAM - LAWRENCE BUSCH
1:00 - Country program reports (E. Reeves - coordinator)
(Country coordinators are responsible for the preparation of reports, which will last between 15 and 45 minutes each as indicated by the coordinator. The objective in each report is to give an overview of all INTSORMIL work in the country and to suggest where there is a need for future INTSORMIL involvement. A list of the country coordinators and the approximate length of their presentations is given below.)

Botswana - Glen Vollmar - 20 minutes

CIAT/South America - Dick Frederiksen - 15 minutes

Egypt - Jerry Eastin - 15 minutes

Honduras - Darrell Rosenow - 40 minutes

Mali - Art Onken - 30 minutes

Mexico/CIMMYT - Fred Miller - 20 minutes

India - Earl Leng - 15 minutes

Niger - John Axtell - 15 minutes

Sudan - Allen Kirleis - 45 minutes

Philippines - Chuck Francis - 15 minutes

5:00 - Discussion

5:45 - Dinner

7:30 - "INTSORMIL's Country Programs - Retrospect and Prospect"
(The objective is to achieve an overview and assessment of INTSORMIL's involvement in LDC's to date as well as to consider future options. Each panel member will speak for 5 minutes to sum up his views on the country programs. These comments will serve as a basis for starting the discussion.)

List of panel members: John Axtell
George Teetes
Jerry Eastin
Bill DeWalt
Darrell Rosenow
Ed Reeves (moderator)

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Wednesday, January 12, 1983

INTSORMIL Discipline Review
(Dick Frederiksen coordinator)
RAPPORTEUR, DISCIPLINE - RICHARD VANDERLIP

(Initially we plan to meet concurrently to review programs internally, discuss collaborative and out-reach projects. Following the brief concurrent session we plan 7 discipline sessions each with time for about a 45 min. to 1 hour formal presentation with the remainder for open discussions as needed.)

(Topics that are suggested for review by each discipline coordinator include:

1. What are the major disciplinary thrusts?
2. Summarize what is being done in LDC's?
3. Are we satisfying the objectives of the INTSORMIL program?
4. How will your work be relevent to scientists in developing countries?
5. What are our major constraints to realizing these goals?)

(Since there will be time for 1 long, or 2 or 3 short presentation, I suggest that you consult your colleagues and arrange to share the presentation. If by mutual consent, some disciplines believe they absolutely must have more time and other disciplines feel it riduculous to have such long presentations, I am sure adjustment can be made.)

8:00 - Concurrent sessions, Agronomy, Breeding & Genetics, Entomology, Pathology, Physiology, Socio-economic and Utilization

9:30 - Breeding & Genetics (D.T. Rosenow, Chr.)

10:45 - Pathology (R.A. Frederiksen)

Noon - Lunch

1:30 - Entomology (G. Teetes)

2:45 - Quality and Utilization (A. Kirleis)

4:30 - Socio-economic (L. Busch)

5:45 - Dinner

7:30 - Agronomy (R. Vanderlip)

8:45 - Physiology (A. Dobrenz)

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Thursday, January 13, 1983

Critical Issues & Special Topics

8:00 - "Improving Communications Between INTSORMIL and its Clients"

Communication with AID Missions & Bureaus (J. Yohe)

Communication with Host Governments and National Programs (J. Collum)

On Workshops, Conferences, and Short Courses (D. Frederiksen)

Research and Extension: An Alternative View (L. Busch)

10:00 - Western Hemisphere Germplasm Program (E. Leng)

10:45 - Coordination of INTSORMIL Striga Research (N. Zummo)

11:30 - Concluding remarks (P. Upchurch)

Noon - Adjourn

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COUNTRY REPORTS

BOTSWANA REPORT

Submitted by: Glen J. Vollmar

Report for the July 1, 1981 to November 30, 1982 Period

1. ACTIVITIES.

Dr. Glen Vollmar (ME) and Dr. Floyd Smith, Kansas State University, were in Botswana, December 12-19, 1982. The involvement of INTSORMIL researchers with the Government of Botswana research program and the MIAC Farming Systems Project, Kansas State University lead institution, were discussed. Research sites were visited and discussions were held with researchers and research administrators. Information was collected for an INTSORMIL Plan of work. It was decided that INTSORMIL should be involved in Botswana with joint staffing with a Cereal Agronomist and later on a Sorghum Breeder.

Because of a national economic slow down in Botswana during 1982, the INTSORMIL Cereal Agronomist was put "on hold." An effort is now being made (November, 1982) to work out an agreement and a plan of work which will lead to approval by the Government of Botswana to move ahead in filling the Cereal Agronomist position. A target date is July 1, 1983.

The KSU Farming System Project in Botswana has been partially staffed and is underway. Reports are that the Project is going well. Dr. David Norman is team leader. The Bean/Cowpea CRSP has stationed Dr. C. J. deMooy, Colorado State University, in Botswana.

2. INTSORMIL STAFF IN BOTSWANA.

INTSORMIL staff in Botswana:

*Dr. Floyd Smith, Kansas State University, December 12-19, 1982. (At the time of this trip, Dr. Smith was Chairman of the INTSORMIL Board of Directors.)

*Dr. Glen Vollmar, INTSORMIL, M.E., University of Nebraska, December 12-19, 1982.

*Dr. Max Clegg, INTSORMIL researcher, Department of Agronomy, University of Nebraska, October 15-29, 1982.

3. STUDENT TRAINEES.

Student trainees include:

*Mr. Louis Mazhani, M.S. program, Department of Agronomy, University of Nebraska. His adviser is Dr. Bill Ross.

*Ms. Dalena Solomon, M.S. program, Department of Agronomy, University of Nebraska. Her adviser is Dr. Ralph Clark.

*Mr. Lucas Gakale, Ph.D. program, Department of Agronomy, University of Nebraska. His adviser is Dr. Max Clegg. He is in Botswana doing his Ph.D. research. He was in the U.S. in August, 1981.

4. PLANS FOR 1983.

Plans for 1983 include:

a) Finalize an agreement with the Government of Botswana and USAID/Botswana and the Kansas State University Farming Systems Project for INTSORMIL Collaborative research in Botswana.

b) Have an INTSORMIL Cereal Agronomist on-site with the Kansas State University Farming Systems Project, July 1, 1983.

c) Attempt to bring additional Botswana students to U.S. Universities for training. Dr. Dick Frederiksen is working with a possible pathology student. Botswana is very short of trained scientists and technicians.

d) Dr. Vollmar or Dr. Leng will make a trip to Botswana to sign an agreement and get an update on sorghum/millet research plans.

e) Dr. Max Clegg has an interest in going to Botswana in 1983 for a follow-up with his Ph.D. student's sorghum research.

COUNTRY REPORT

CIAT - South America

Richard A. Frederiksen

1. Activities during the period July 1, 1981 - November 30, 1982:

Sorghum research conducted through CIAT by INTSORMIL will complement ongoing research by ICRISAT in both the highland areas (conducted at CIMMYT) and in the semi-arid tropics. It will thus provide a link between such international sorghum research and collaborating national research institutions in sorghum-producing countries in South America.

INTSORMIL, an AID-sponsored crop research project, headquartered at the University of Nebraska-Lincoln, is a commodity-oriented grouping that promotes the linkage of sorghum and millet research in the United States with that in the international and national centers in developing countries. The expectation is elimination of duplication of efforts to provide an effective mechanisms for solving pressing problems.

The Program will begin in November 1982, with the assignment of Lynn Gourley, sorghum breeder at Mississippi State University, as principal investigator, based at CIAT-Palmira. Field activities in Colombia will be located in both the Llanos and Cauca Valley. INTSORMIL and ICRISAT will provide genetic resources to maximize the amount and range of useful germplasm available for regional evaluation.

Expansion of sorghum production in Latin America is constrained by the lack of improved, high-yielding varieties with reasonable tolerance to the more acid soils, which predominate in the region.

On April 12-16, 1982, INTSORMIL hosted a Sorghum Quality Workshop attended by 65 participants from 11 Latin American countries, to initiate the sorghum network in the area. Future workshops will be held at CIAT, giving representatives the opportunity to present their plans and opinions on the best means of conducting the work, particularly in relation to the germplasm exchange network. A training component is also envisaged.

2. Dr. Lynn Gourley (Mississippi State University) at CIAT-Palmira for 1-2 years.

3. There were no visitors to INTSORMIL from South America

4. Students or trainees from South America:

Laura Giorda - Virology
Quentin Kubicek - Pathology

5. Brief outline of plans for 1983:

The assignment of Dr. Lynn Gourley to CIAT, as of November 1, 1982, will enable Mr. Jorge Cuarezma-Teran to conduct research at CIAT during June and July, 1983, in Colombia. The interactive effect of pathogens and major soil-related biotic constraints will be determined under controlled conditions and results from these experiments will be confirmed under field conditions.

In Colombia, Mr. Cuarezma's research will be directed toward the assay of soil mycoflora and nematode populations associated with sorghum in that country. Comparisons will be made to the primary species associated with sorghum in the Southeastern U.S. This work will be conducted with the final objective being to determine major pathogens and the interactive effect of pathogens on sorghum under controlled greenhouse conditions in Colombia.

Negotiations are underway to establish nurseries in Colombia, El Salvador, Honduras, and Mississippi in 1983 to determine the progression in which fungi invade preharvest sorghum grain and the frequency of their invasion with respect to the development of grain. Five to ten sorghum lines will be used and emphasis will be placed on invasion of grain at stages prior to physiological maturity of the grain.

In addition to the research program established by Dr. Gourley, winter sorghum nurseries from Purdue and Mississippi will grown at CIAT.

Egypt Country Report
July 1, 1981-Nov. 30, 1982

Activities

1. Nov., 1981. Dr. R. A. Frederiksen visited evaluating a PL 480 pathology program and consulted with EMCIP and ARC scientists.

2. Dr. Herman Warren participated in a plant pathology workshop.

3. Dr. Allen Kirleis visited field nurseries of Purdue material.

4. Dr. J. D. Eastin consulted with Egyptian ARC scientists and AID mission personnel primarily on "New Lands" development potential. The appropriate framework within which to consider such work was not in place.

5. Dr. D. T. Rosenow of Texas A&M supplied germplasm as did J. D. Eastin (NE). A report on Texas germplasm is not available. Dr. Ralph Finkner (N. Mexico State sorghum breeder) evaluated the 24 NE lines and rated 5 as amongst the best in the Egyptian program.

6. Dr. J. D. Eastin visited Egypt again October, 1982, at the request of Dr. John Yohe as a follow up to needs detailed in Strategies for Accelerating Agricultural Development.

INTSORMIL staff in Egypt

No one served more than a few days.

Egyptian visitors to INTSORMIL

1. Dr. Fakri Fayed, sorghum breeder

2. Dr. Adli Bishay, American University in Cairo

Names of students or trainees from this country

1. Mohamed A. Mostafa, Ph.D. candidate, University of Nebraska

2. Hosni Shafie, ARC production scientist, 6 months training at New Mexico State University and University of Nebraska.

Plans for 1983

The attached 1982 trip report outlines current INTSORMIL activities in Egypt. Exchange of germplasm is a major item along Plant Pathology cooperation. The main Egyptian agronomic interest is "New Land" or desert land development. Egyptians have expressed a renewed interest in help but so far a vehicle for implementing a research program is not apparent.

HONDURAS-INTSORMIL COUNTRY REPORT
July 1, 1981 - November 30, 1982

Dr. Dan Meckenstock, INTSORMIL sorghum breeder, moved to Choluteca (Southern Honduras) in early October, 1981. His first objective was to rejuvenate the Honduran sorghum improvement program which more specifically involved a rejuvenation of the La Lujosa station near Choluteca. This included land clearing, land leveling, building drainage and irrigation canals, as well as repairing and upgrading the equipment. This was largely accomplished by early 1982. Initial plantings of INTSORMIL, ICRISAT, Honduran locals (maicillo criollos), and breeding material were made in December, 1981.

Short, intermediate, and long range breeding goals have been established to increase grain sorghum production in Honduras. The short-run goal, to release an improved variety, has been achieved. Approximately 140 quintales of the variety Tortillero (a mass selection of CS3541) was released by Recursos Naturales in cooperation with INTSORMIL. Additional seed production of Tortillero (12 Ha) is scheduled for harvest in December. A brochure announcing its availability and use has been prepared and distributed to the Ministry's regional offices.

The intermediate range goal, to release a hybrid, has had a slight setback: One hundred pounds of ATx625 x 77Cs1 was produced for experimental purposes. Although this hybrid has outstanding yield, its production has been abandoned because of poor seed germination. The hybrid, ATx623 x Tortillero is being developed as an immediate alternative, with a 4 Ha production field scheduled for planting in December. This hybrid has been widely used in Guatemala where it is marketed as ICTAM 777. Several 2 dw hybrids from ICRISAT look promising, but their selection and production are at least one year away.

The long-range goal, to improve the native varieties (maicillos criollos), is proceeding with all due process. Seed was obtained from 125 maicillo x improved variety crosses in January. The F1's were planted in February and treated with short days, thus F2 seed was obtained for the regular planting season in May. Both F2 & F3 material are available for use in other Latin Programs. Crosses have been made to incorporate downy mildew and grey leaf spot resistance, and other desirable traits (tan plant and glume color, easy thresh) into the higher yielding maicillos criollos. A large number of F2's involving elite US breeding lines as well as disease and midge resistant breeding lines were planted in Sep. 1982 for selection and evaluation in Honduras.

Three Igenieros and two technicians are receiving plant breeding training. Ing. Francisco Gomez is studying under the direction of Dr. F.R. Miller for his doctorate at TAMU. Ing. Rigoberto Nolasco and Ing. Juan Guevara are working in Honduras with Meckenstock and are receiving on-the-job training. Nolasco has 6 years experience and Guevara has 6 months. Technicians Juan Salgado and Henri Fuentes are being trained in making crosses.

Three field days have been held at the La Lujosa experiment station. One was to announce the release of Tortillero and the other two to educate extension workers about sorghum. With the help of the extension agents and Billie DeWalt, more than 40 demonstration plots were planted with Tortillero in the postrera (August). Good rapport has been established with Drs. Vartan Giuragossian and Compton Paul (ICRISAT, Mexico), Dr. Margaret Smith (CATIE, Costa Rica), and members of the Comision Latinoamericana de Investigadores en Sorgo (CLAIS) which are the national sorghum breeders in Central America.

Drs. Billie and Kathleen DeWalt (University of Kentucky) began a study of cropping systems in pespire (Southern Honduras) in Summer, 1981 (June-August), from which a detailed report has been prepared. Their field research resumed on June 1, 1982. They did follow-up interviews with the farmers from the highlands around Pespire who were studied during the Summer of 1981. The purpose was to understand the role of sorghum in the farming and nutritional systems of highland farmers. Sorghum around Pespire is grown in association with corn. Major field work efforts that began in July and continue to the

present have focussed on the lowlands. Here, sorghum is sometimes grown in association with corn, but is also grown as a monocrop. Research since September has expanded into communities at higher elevations (about 900 meters) where sorghum is grown in association corn and beans (sometimes cowpeas) on the steeply sloping hillsides. Farming systems and nutritional strategies interviews have been carried out with about 40 farm families from the La Venta region. An additional aspect of this research involved distributing small quantities of seed of Tortillero, the improved sorghum variety released jointly by Recursos Naturales and INTSORMIL. The seed was given to farmers in all of the communities in which our socioeconomic research has been done. Results of these on-farm trials of Tortillero will be done in the future.

Sociological and nutritional field research by Mary Futrell and Eunice McCulloch (Miss. State) in southern Honduras during 1981 and 1982 has documented farming methods, social and economic factors and the nutritional condition of subsistence farmers in three localities where grain sorghum is a staple food. It has been found that a substantial amount of malnutrition exists in the areas studied. Preliminary findings indicate that, although farms are on the average very small (less than 1.5 ha) in the areas visited and the technology primitive, it is possible with the use of sorghum in the diet to grow enough maize, sorghum, and beans to meet energy and protein needs provided all produce is consumed and none is sold. The traditional diets of tortillas and beans, however, are sadly deficient in at least four essential nutrients and the requirements for these are not being met in most households.

On October 25, 1982, Billie DeWalt signed a new agreement (convenio) with the new Minister of Natural Resources, Miguel Angel Bonilla. This new agreement further specifies the kind of work that INTSORMIL and the National Program of Agricultural Investigations will carry out. The agreement also is more specific regarding the rights that INTSORMIL and investigators associated with it will have while working in Honduras. The new convenio clears up ambiguities of ownership of properly, import duties and taxes.

DeWalt also signed a new agreement on November 15, 1982 with Richardo Agurcia, the Head of the Honduras Institute of Anthropology and History. This agreement continues the cooperation between INTSORMIL and IHAH. It is more specific, however, in outlining a procedure for submission of reports and the publication of materials resulting from socioeconomic research in southern Honduras.

Robert Jones, an MS graduate student at TAMU, Dept. of Entomology (Frank Gilstrap), did his research in Honduras May - Dec. 1982, in cooperation with Dr. Keith Andrews and the Escuela Agricola Panamericana (EAP). He studied the effect of wasp parasites on the fall armyworm in corn and sorghum plantings.

Other INTSORMIL personnel visiting Honduras in 1982 included: (1) U. of Kentucky - Allyn Kritesel, Res. Asst., Aug. 15 - Nov. 15; Susan Duda, Res. Asst., Sep. 1 - present; Elizabeth Adelski, Res. Asst., June 1 - Aug. 20, (2) TAMU - G.L. Teetes, Frank Gilstrap, D.T. Rosenow - May 22-26., and (3) Miss. State - Robert Jones and Kelley Simpson, Graduate Students, travelled with Futrell in Honduras in 1981 and 1982. Honduran visitors to US included (1) Fernando Cruz, Head of Ethnology, IHAH in March, 1982 to U. of Kentucky. Cruz will probably pursue a PhD in Anthropology at U. of K. Francisco Gomez & Dan Mackenstock participated in the INTSORMIL External Review, Feb. 1-7, 1982, at Kansas City. Mackenstock traveled to the CLAIS meeting in Guatamela, Sep. 19 - 25, 1982.

A dissertation based on 1981 Honduran field research, by Eunice McCulloch, is nearing completion. A paper by Eunice McCulloch "Interdisciplinary Research in Agricultural Development: The USAID Sorghum-Millet Project in Southern Honduras" was presented at the Mid-South Sociological Assn. meeting in October, 1982. Other papers on Honduras were presented at the Int. Workshop on Grain Quality and Sorghum in the 80's symposium (Oct. 28-Nov. 3,) 1981, ICRISAT, Hyderabad, India, and at the Int. Food Quality Workshop on Sorghum, April 12 - 14, 1982 at CIMMYT.

Future plans include continued sorghum breeding for developing improved sorghums headed by Mackenstock as well as continuation of the U. of K. and Miss. State programs. U. of K. field research will continue thru the summer of 1982 and early fall of 1982. Miss. State plans additional field research in Jan. - Feb., 1983.

REPORT OF INTSORMIL-MALI COLLABORATIVE RESEARCH PROGRAMS - NOVEMBER, 1982

The provisions for collaborative efforts agreed to between the Institute of Rural Economy (IER) of the Malian Ministry of Agriculture and INTSORMIL on April 8, 1981 have been completed. The IER appointed Dr. Oumar Niangado and Dr. Leng appointed Dr. A.B. Onken to be coordinators of collaborative research efforts between the two organizations. The first year's agreement contained joint research programs in cultural techniques, breeding, soils, agro-meteorology, and training. Linkages were also established with Dr. John Scheuring and Mr. Phil Serafeni, ICRISAT, Mali and Mr. Pierre Rosseau, IFDC, Mali.

Fifteen Malian sorghum lines, four sorghum hybrids, and three millet lines have been screened for nitrogen use efficiency at Lubbock. Currently, these same lines are being screened for phosphorus use efficiency. Profile soil samples from the Cinzana Experiment Station in Mali have been received in Texas for basic chemical and physical analyses. Literature searches have been made and copies of relevant research publications sent to Malian scientists.

A neutron probe and 30 heavy duty access probe tubes were constructed, purchased and shipped to Malian scientists for use in drought research. In addition, INTSORMIL furnished a training mission of 38 days by Mr. Michael O'Neill to Mali for the use of neutron probes and processing of data. As a result of contacts made by Mr. O'Neill while in Mali, he is currently employed by ICRISAT and will assist in construction of a line source sprinkler irrigation gradient system for drought screening at the Samé experiment station in Mali.

Mr. Moussa Traore, former Director of the Division of Agronomic Research, IER, began Ph.D. graduate studies in Agronomy, at the University of Nebraska, Lincoln in January 1982. His thesis research program has had a successful start and is concerned with drought resistance of sorghums with responses compared to pearl millet and maize. Seedling emergence and stand establishment are major problems in Mali. Initial experiments show some marked differences in sorghum responses to seedling drought. Drought avoidance and tolerance mechanisms of the three mentioned crops will be compared in further research. Particular comparisons will be made of the root systems and other physiological responses. It is planned that his research will also include studies of drought responses and nitrogen fertility interactions, since these crops are often grown in low fertility areas.

Grains of 14 sorghums grown in the West African Regional Nursery in Mali were evaluated for To quality in Dr. Rooney's lab and the results compared favorably with those of cooking trials conducted on the same samples in Mali. Research has included the biochemical, physical, and cooking characteristics of starch and flour of these samples. The in vitro starch and protein digestibility of sorghum To produced under three cooking conditions (acid, neutral, and alkaline pH) was similar. Samples of To prepared in Mali using traditional alkali and acid processing conditions did not differ in Per value in apparent D.M.D. when fed to rats. Some differences in mineral content were observed. Milling studies in Dr. Rooney's lab have confirmed Dr. Scheuring's village hand milling trials indicating that sorghums with thick starchy mesocarps are most easily milled by hand pounding. Assistance in acquiring equipment, i.e., spectrophotometer and chemicals to develop local lab procedures for quality measurements have been provided to Dr. Scheuring and co-workers.

A referred publication coauthored by personnel from ICRISAT and SRCVO in Bamako, Mali with personnel from the Cereal Quality Lab, Texas A&M University, College Station has been approved for publication in Cereal Chemistry. The joint authorship documents the interaction among Malian and U.S. University scientists. Madame Sidibe is a young Malian who is developing rapidly into a good scientist. This publication is:

Scheuring, J.F., Sidibe, Salimata, Rooney, L.W., and Earp, C.F. 1982. Sorghum Pericarp Thickness and Its Relation to Decortication in a Wooden Mortar and Pestle. Cereal Chemistry accepted.

Other publications in which collaborative work among Malian scientists and U.S. scientists include: two Ph.D. dissertations nearing completion by African students Mr. S. Da of Upper Volta and J. O. Akingbala of Nigeria. Both dissertations are on thick porridge quality and have benefited by using samples from Mali as well as Upper Volta. They are:

1) Akingbala, J.O. 1982. Effect of Physiochemical Properties of Sorghum Starch and Endosperm on the Quality of a Traditional African Food. Ph.D. Dissertation, Texas A&M University, College Station, Texas. 136 pp.

2) Da, S. 1982. The relationship of To Food Quality to Plant Color and Agronomic Characteristics in Sorghum bicolor (L.) Moench. Ph.D. Dissertation, Texas A&M University, College Station, Texas. 142 pp.

The research conducted in the U.S.A. on sorghum To quality has been in direct support of the efforts to breed for sorghum To quality in Mali and Upper Volta. Interchange of samples, backup support, and basic research on structure, composition, and physical properties has been mutually rewarding. This work continues.

Dr. D. T. Rosenow traveled to Mali and with Dr. Oumar Niangado visited the sorghum breeding nurseries at Sotuba (Bamako), Massantola, Cinzana, and Baramandougou. Elite tropically adapted U.S. Developed sorghums and ICRISAT/India sorghums looked very good from the grain yield standpoint. However, all of these materials were damaged severely by head bugs (several species) resulting in poorly developed grain, floury endosperm, and extensive grain mold under high rainfall at Sotuba. Only the loose-headed Guinea type locals escaped head bug damage. U.S. Germplasm can make a significant contribution in yield, but it appears that the Guinea head type is essential to the higher rainfall areas of West Africa. Grain hardness is also important, and U.S. and ICRISAT sorghums appear to have floury endosperms when the grain is developing under severe moisture stress. The head bug complex may be contributing to this. Anthracnose was found at several sites, and killed some U.S. and ICRISAT materials at Baramandougou. It was also quite prevalent but not causing damage to locals in farmers' fields. Sooty stripe was quite prevalent at all locations. The U.S. drought tolerant germplasm was planted only at Sotuba under high rainfall. Seedling drought tolerance and post-flowering drought tolerance appear to be major concerns.

U.S. sorghums can contribute high yield potential, nutrient use efficiency, disease resistance, and post-flowering drought tolerance, but major breeding efforts will be required in Mali. Future collaborative research plans include starch deposition in the grain as related to hardness, weathering resistance, relationship of head type to head bug and grain mold, anthracnose evaluation, drought screening utilizing line source and field screening in Mali and germplasm exchange of new, high yielding early generation germplasm.

Dr. A. B. Onken and Dr. C. W. Wendt traveled to Mali in March, 1982 and evaluated the soils lab at the Sotuba Experiment Station. Dr. Wendt also traveled to FAO in Rome to Wageningen to obtain information concerning lab procedures relative to tropical soils. The evaluation report has been completed and submitted to the IER through the Program Director's office.

A trip to the U.S.A. for Dr. Niangado, Malian coordinator, and Mr. Mamadou Keita, Director, Sotuba soils lab was arranged and completed in May, 1982. During this trip, these Malian scientists visited with U.S.A. scientists at the IFDC, Texas A&M University, Texas Agricultural Experiment Station at Lubbock, Kansas Agricultural Experiment Station at Hays, and the University of Nebraska at Lincoln. During their visit in Lincoln, some needed lab supplies and equipment were purchased for the Sotuba soils lab. As a result of discussions held in Mali between Dr. Onken and Dr. Niangado in March, 1982. Dr. Niangado brought collaborative research proposals from Malian scientists with him during his trip to the U.S. These proposals were discussed in detail between Dr. Niangado and Dr. Onken, English translations have been obtained and submitted to INTSORMIL scientists who have expressed an interest in collaborating in these research efforts. The research areas included were: breeding, agroclimatology and plant physiology. In order for these projects to be implemented, a convention covering administrative details must be signed between the IER and INTSORMIL. The Program Director has indicated that this will be done in the near future.

In order to make maximum use of available resources, INTSORMIL, TROPSOIL, and IFDC have agreed to cooperative activities when their programs overlap in DC's.

From the standpoint of enthusiasm of Malian and INTSORMIL scientists, support of the IER, the USAID Mission in Mali, and ICRISAT, Mali, the potential for highly significant collaborative research in Mali is very great. All the necessary components are present and this program represents one of the best opportunities to meet our mandate under the Title XII program.

Note: All travel to Mali must be announced to the IER through the Program Director's office.

MEXICO

Country Report
INTSORMIL

1982

I. Activities for period July 1, 1981 to November 30, 1982

During this period negotiations on a draft of a memorandum to cooperate was discussed with both INIA (Mexico) and INTSORMIL staff. Because of the complex nature of the memo in Mexico, members of the team were advised to proceed pending approval.

Because of limited space and the large amount of work accomplished in Mexico only a few highlights will be given here. A sorghum food quality workshop for Central American workers was sponsored by INIA, ICRISAT/CIMMYT and INTSORMIL at CIMMYT April 11-18, 1982. Approximately 65 people from 11 Latin American countries participated. The workshop was a resounding success. Both breeders and cereal quality personnel were represented as well as Mexican administrative and commercial individuals. Lectures, laboratory demonstrations and field studies all meshed together to provide a unique teaching opportunity. A large number of field selections were made at Poza Rica plus some 15 sets of the Latin American Sorghum Observation Nursery were distributed.

Seven tropical adaptation tests were seeded at critical locations throughout the sorghum producing regions of Mexico. Fifteen experimental hybrid trials were sent into the South of Mexico to help evaluate the potential of sorghum following rice or maize. Four international virus nurseries, four all disease and insect nurseries, 65 F_2 populations, two twin-seeded hybrid trials were sent into various areas for evaluation and to be blended into the National Program.

Disease survey and recording trips were made to evaluate virus, rust, downy mildew and leaf diseases. Equipment to monitor the environment was provided to INIA to help understand disease buildup. Several University and industry related seminars and training sessions were held to expand sorghum utilization.

Sorghum materials developed in Texas appear to be immediately transferable into Mexico, both into the Bajeo and into the lowland tropics. There is a substantial increase in the production of white food quality sorghums to help

reduce dependence on maize which is in short supply. Mexico is exploring the possibility of jointly releasing materials tested in the TAT program.

Researchable problems identified in Mexico in the areas of germplasm expansion, cereal quality and utilization diseases and physiological problems have been incorporated into INTSORMIL activities at several institutions.

II. INTSORMIL staff serving in Mexico for some time

1. Dr. Fred Miller - Breeding
2. Dr. L.W. Rooney - Cereal Quality
3. Dr. R.A. Frederiksen - Pathology
4. Representatives of Dr. R.W. Toler - Virology
5. Dr. J.D. Eastin - Physiology
6. Dr. Lynn Gourley - Agronomy/Breeding
7. Dr. C. Francis - Agronomy/Breeding
8. Dr. Ralph Niels - Agronomy

III. List of Students from Mexico

Armando Valdes G.	Ph.D.	Miller
Pedro Jasa	Ph.D.	Miller
Santiago Bedella	Ph.D	Rooney
Helbert Almeida-Dominguez	M.S.	Rooney
Sergio Saldivar	Ph.D.	Rooney
Nancy Vivas	M.S.	Rooney
Jorge Rojas	Ph.D.	Teetes
Jose Sifuentes	M.S.	Frederiksen
Jose Gomez	M.S.	Eastin
Victor Gonzales	M.S.	Eastin
Manual Lizera-Murnez	Ph.D.	Eastin
Leopoldo Mendoza	Ph.D.	Eastin
Roberto Maures	Ph.D.	Sullivan

IV. List of visitors from Mexico to INTSORMIL

Jesus Vargas	Dr. Alberto Betancourt
Jose Luis de La Garza	Prof. Guadalupe Razo Vazquez
Ing. Apolinar Aquillon	Ernesto Vazquez

Jaime Barker (a farmer)
Angel Jimenez
S. Medina
M. Hernandez
J. Narro
Patricia Reyes-Solis
MC Manuel Sanchez-Lucero
MC Yoja Gallellando
Ing. Jorge A. Franoke
Lic. Juan I. Cisnecos A.
Alfonso de la Torre

Saul Trejo Reyes
Lic. Gustavo Rebora Gonzalez
Dr. Ramon Fernandez Gonzalez
Ing. Erik Larsen
Ing. Samuel Gomez Jr.
Luvella Cantu
Carlos Cardenas
Antonio Mouret Polo
Dr. Octavio Paredes Lopez
4 staff and graduate students-University of Saltillo

V. Brief outline of plans for 1983

A. Continue sending Tropical Adaptation Tests to 6 to 8 locations.

B. Continue and expand the exchange of F_2 and F_3 early generation crosses which infuse the National Program, to expand the diversity within the Breeding Program of Mexico.

C. Assist in establishing feasibility of sorghum production in the South of Mexico rice and maize.

D. Continue disease control work in rust, virus and downy mildew.

E. Assist in the evaluation procedures of tortilla quality.

F. Conduct a workshop on sorghum breeding at CIMMYT, April 10-16, 1983.

INDIA COUNTRY REPORT

Submitted by Earl R. Leng

Period - July 1, 1981 to November 30, 1982

1. IN-COUNTRY ACTIVITIES:

Project KSU-3 (Farming Systems in Millet Production) began field work in India late in 1981, and developed a full-scale program in the Kharif (rainy season) of 1982. This study was conducted in 9 villages of Sikar District, Rajasthan State. It was planned as a four-year baseline study, but (see below) will be terminated in early 1983.

Cooperation with Mohan Lal Sukhadia University and ICRISAT was well developed SKN College of Agriculture, Jobner (affiliated with MLS University) also was involved.

Findings in the 1982 season were difficult to interpret clearly. Weather conditions were unusual, even for this area which is noted for variation in rainfall. Unusually heavy and early rains were followed by a weak and erratic monsoon in July, then by drought, then by a heavy cyclonic storm after the normal growing season was over. Otherwise promising improved millet varieties did not show any special advantage under the 1982 conditions.

Other important observations were:

a. Farmers planted on the early rains, even recognizing that they were unseasonal. They would not plant after the 3rd week in July, even though the monsoon was clearly erratic.

b. Farmers are concerned with total dry matter production (for animal feed) as well as with grain yield.

c. The improved hybrids now available are not liked for food, and tend to be grown for sale. Local varieties continue to be used for home consumption.

d. Stand establishment is a major constraint.

e. Mixed cropping, particularly millet/grain legumes, is the normal practice under rainfed conditions.

2. PERSONNEL.

Dr. Barry Michie, KSU, was in residence in India from mid-1981, and led the work. Brief visits to USAID/Delhi were made by Drs. Glen Vollmar and Earl Leng of INTSORMIL headquarters.

3. OVERALL STATUS OF COUNTRY PROGRAM.

a. India was chosen as a major "target" location for an INTSORMIL program in 1979, and early attempts were made to establish linkages at the governmental level.

b. The general policy of the Indian Government is that collaborative programs must be cleared by the Indian Council of Agricultural Research (ICAR). INTSORMIL has not yet succeeded in even having substantive discussions or replies to correspondence on the part of ICAR.

c. In addition to the KSU-3 project described above, INTSORMIL has had definite proposals from its members for collaborative work at Hissar (evapotranspiration studies) and Hyderabad (food quality of sorghum and millet). Unfortunately, none of these has been considered by ICAR.

d. As a result of the clearance situation, USAID/Delhi and INTSORMIL have agreed that:

(1) The field work of KSU-3 will be terminated by early 1983.

(2) INTSORMIL will make no further direct approaches to ICAR or Indian institutions, regarding possible collaboration.

(3) At an appropriate time, USAID/Delhi will explore with ICAR the prospects for future collaborative work.

e. The INTSORMIL Technical Committee and Board of Directors concur in the points listed above in d. Therefore, INTSORMIL work in India will not be conducted in Year 5 or in the foreseeable future.

4. ICRISAT.

We do not regard our extensive cooperation with ICRISAT as basically being related to an India country program. Suffice it to say that our cooperative work with ICRISAT was greatly expanded during 1981-82, and can be expected to grow further in future years.

COUNTRY REPORT

Niger

Preliminary plans were made for an INTSORMIL team visit to Niger in January-February 1983, to discuss cooperation between INTSORMIL and the Government of Niger. The Purdue bilateral contract was signed in November 1982 and Dr. John Clark began duties as sorghum breeder in Niger in December 1982.

Visitors

Planners for the Niger Cereals Research Projet were:

Representing the Government of Niger: Mr. Moussa Oumourou
Mr. Mahamane Salifou
Mr. Silliman Ganoun

Also . . . .

Dr. Quincey Benbow and Mr. Mike Huffman, AID Washington
Dr. D. Woods Thomas, IPIA, Purdue University
Dr. Bernie Liska, Dean of Agriculture, Purdue University
Dr. Wilbur Thomas, AID Agriculture Officer, Niamey, Niger

Attached is a summary of the contract.

Section II. This Is A Summary Of The Contract

SUMMARY - PURDUE/ALABAMA A & M/INRAN PROJECT - NIGER

I. Project Objectives

Long-Term - Growth and development of Niger's Institute for Agricultural Research - (INRAN) as an effective, well-staffed and well-supported national research institution which is well linked to extension and which meets farmers' needs.

Intermediate - Rapid development of research program for major food crops producing technology and germplasm which will stimulate productivity growth in sorghum, millet and cowpeas.

II. Project Focus

During the initial five years of the project, activity will focus on three major areas:

1. Growth and development of INRAN's capacity to administer and manage its research program, its resources and its linkages to other institutions.
2. Growth and development of INRAN's capacity to support its researchers' efforts through services in the areas of library and information, soil and plant analysis, food quality of grain analysis, in-service training, statistical consulting and data processing, farm machinery availability, etc.
3. Growth and development of research programs underway concentrating on three principal research programs each of which is substantially interrelated with the other including:

A. An Interdisciplinary Team Research Program for the major food crop, millet, sorghum, and cowpeas with emphasis on cereal production. The team will include plant breeders, plant protection specialists, agronomists, and cereal quality specialists which will identify the major constraints to expanding productivity in each crop and develop methods to minimize the constraints. These efforts will be concentrated at the Tarna station near Maradi and at the Kolo station near Niamey (see map attached).

Kolo is the agricultural research station 30 miles from Niamey. Tarna is the agricultural research station 3 miles from Maradi. All are on good paved roads. The distance from Niamey to Maradi is 420 miles on good roads and there is a bi-weekly plane service.

B. A Farming Systems Research Program which will comprise initially farmer surveys designed to more clearly characterize the farm enterprise, including its resources and their use, the practices employed, and the constraints to expanding production. Subsequently, this research will include on-farm testing of specific interventions and technologies to determine their acceptability and impact upon the farm. This research will include trials carried out in several villages in several different ecological zones with the first studies being within the administrative regions of Niamey and Maradi.

C. A Production Systems Research Program which will develop systems of cultural practices appropriate for production of cereals in

the various ecological regions and by the various kinds of farm enterprises. Work will include focus on understanding and development of recommendations on rotation, intercropping, fertilizer use, time of planting, density and spacing, weeding and pest control and economic concerns including cost/return and related management analysis. Work, including both research and demonstration efforts, will be originated at the Tarna and Kolo stations, but will also be conducted at a number of sites in several ecological zones in the administrative regions of Niamey and Maradi.

III. Project Inputs

1. Long Term Staff - 24 man years in the first five years.

All long-term staff will participate in and contribute to specific segments of project effort to develop INRAN's capacity to provide support services and facilities and to administer its programs. Overall development of INRAN's staff is a primary function of all project members. Members of the long-term staff will be:

A. Team Leader - Primary responsibility for overall project direction, leadership, and administration. Will take primary responsibility for project efforts related to development of INRAN's administrative and management capability. Will coordinate project effort to develop INRAN's ability to provide support facilities and services to researchers. Will live in Niamey, work in Niamey.

B. Plant Breeder - Primary responsibility to guide the development of the Interdisciplinary Team Research Program (see II-3-A above) for millet, sorghum and cowpeas. Secondary research

responsibility to assist with the development of the Production System Research Program at Kolo and within the Niamey administrative region. Will live in Niamey, work out of Kolo.

C. Senior Agricultural Economist - Primary responsibility to guide the overall development of the Farming Systems Research Program (see II-3-B above). Will provide direct supervision for Farming Systems Research effort developed within the Niamey region. Secondary responsibilities include assisting with Production System Research Program in the Niamey region. Also responsible for the development of the Agricultural Economics Department of INRAN and development of policy-oriented research. Will live in Niamey, work out of Niamey.

D. Production Agronomist - Primary responsibility to guide the development of the Production System Research Program (see II-3-C above). Secondary responsibility to assist with the development of the Interdisciplinary Team Research in millet, sorghum and cowpeas at Tarna. Will live in Maradi, work out of Tarna.

E. Junior Agricultural Economist - Primary responsibility to supervise directly the Farming systems Research effort developed in the Maradi region. Secondary responsibility to assist the Production System Research effort in the Maradi region. Will live in Maradi, work out of Tarna.

2. Research Associates - 12 man years in the first five years.

Six positions of two year duration to be filled with Purdue or Alabama A & M graduate students who will serve as researchers, working on INRAN/project research, one-half of their effort applicable to thesis research development. Preference will be given

INTSORMIL SUDAN COUNTRY REPORT
July 1, 1981 - November 30, 1982

COUNTRY COORDINATOR: ALLEN W. KIRLEIS
ACTIVITIES:

Farming and Marketing Systems

July 1, 1981 - August 15, 1982, two economic antropologists (Edward B. Reeves and Timothy Frankenberger) carried out a study of farming and marketing systems in 15 villages located within 50 km of el-Obeid, Sudan; this research was designed to provide a data baseline for the Western Sudan Agriculture Research Project, the Kordofan Regional Ministry of Agriculture, and the ICRISAT sorghum and millet breeding programs. Computer analysis of the data collected is presently being carried out at the University of Kentucky.

Research Systems

In March 1982, 60 scientists and 15 research administrators associated with the Sudan Agriculture Research Corporation (ARC) were interviewed and documentary data on research plans were collected by Larry Bush and William Lacy. Date analysis and a report on the Sudanese agricultural research system will be completed in 1983.

Breeding and Genetic Evaluation of Sorghum

INTSORMIL (U.S developed) germplasm was evaluated at Wad Medani, el-Obeid, Gadambalia and Kadugli during the 1981 and 1982 crop years. At Wad Medani, much of the INTSORMIL developed tropically adapted lines and their hybrids performed very well. Three hybrids, developed by Gebisa Ejeta (ICRISAT - Sudan cooperative program), using the INTSORMIL line ATx623, as the female are being considered for release by the Sudan government. Several of the INTSORMIL developed drought tolerant lines (including P-898012) performed very well at Gadambalia and el- Obeid under severe drought stress in both 1981 and 1982 crop years. It appears that certain U.S. germplasm can be used directly in these rainfed areas.

In 1981/82 over forty Sudan sorghum varieties were collected (including some black seeded types) in the Kadugli and el-Obeid areas and introduced in the U.S. for conversion and breeding lines. In addition a few elite Sudanese breeding lines have been selected and transported to the U.S. for the same purpose.

Cooperators on the breeding and genetic evaluation of sorghum project are Abel Latif Nour (ARC), Gebisa Ejeta (ICRISAT - Sudan cooperative program) and Darrell T. Rosenow (INTSORMIL).

Physiological Work

Work plans were developed for the 1983 crop year with the Sudan Agriculture Research Corporation on development and use of low-cost physiological screening techniques for studying sorghum stress resistance. Jerry Eastin (INTSORMIL) and S. M. Farah (ARC) are the cooperators responsible for this work.

Evaluation of Sorghum Food Quality

ARC/INTSORMIL/ICRISAT collaborative Sorghum Food Quality project, which began in November 1980, was continued in 1981/82. The objectives of this project are to defined the parameters which control the food quality characteristics of sorghum for making kisra. Gebisa Ejeta (ICRISAT - Sudan cooperative program sorghum breeder) has developed a sorghum food grain nursery. Entries from the nursery are evaluated for milling and kisra quality by Sitt Badi (Head Cereal Technology Department, Food Research Centre, Khartoum, Sudan) and chemical, physical and physiochemical properties are compared to milling and/or kisra quality evaluation results in order to define the grain parameters which influence its end-use quality.

To date only the entries from the 1980 crop year have been analyzed. When comparative analysis of all quality and analytical factors were examined no strong relationships were found. This may have, in part have resulted from the fact that when the grain samples arrived in the U.S. from Sudan, they were badly infested with insects. Evaluation and analysis of the 1981 crop presently being carried out by the project participants.

Striga

Active cooperation on *Striga hermonthica* research began in August 1982. Dr. Lytton Musselman (Fulbright Fellow) and F.F. Bebawi (University of Khartoum) made a collection of *Striga* biotypes in Sudan during September-October 1982. Plans are presently being developed for collaborative *Striga* research with ARC weed researchers at Wad Medani and the University group for 1983.

A *Striga* tolerant line from the Purdue breeding program has been identified by Dr. Gebisa Ejeta (ICRISAT) in Sudan. The line (P-9679083) appeared *Striga* free in 3-row plots in both reps of a uniformly *Striga* infested field in Kadugli, sudan in 1981.

Agronomic Work

From June - October 1982 Tareke Berke carried out agronomic research in the el-Obeid area of Sudan. The 1982 agronomic research activities in sudan included: millet demonstration plots at seven villages; chickpea adaptation trials; plant spacing and plant population survey; pest and disease problem assessment; a study of seed size and density in relation to stand establishment; and a millet germplasm collection. These activities will be continued and/or completed during the 1983 crop year.

INTSORMIL STAFF SERVING IN SUDAN

Short Term

Richard A. Frederikson November 9-22, 1981
Administrative work on ARC/INTSORMIL and Faculty of Agriculture University of Khartoum/INTSORMIL Memorandum of Agreement for Cooperative Work.

Darrell T. Rosenow November 9-22, 1981
Evaluation of sorghum and millet nurseries as outlined in the ARC/INTSORMIL Memorandum of Agreement.

Billie R. Dewalt December 29, 1981 - January 12, 1982
Evaluation of el-Obeid farming systems project and develop plans for future work.

Philip C. Abbott April 12-27, 1982
Establish contact and develop work plans for cooperative Economic work in Sudan with the Department of Rural Economy Faculty of Agriculture University of Khartoum .

Jousif E. Seifelnasr June 10 - July 21, 1982
Identify grain storage problems in Sudan.

Earl R. Leng, Allen W. Kirleis, and Richard L. Vanderlip August 7-19, 1982
Update ARC/INTSORMIL Memorandum of Agreement for Cooperative Work and establish a means for INTSORMIL to provide funding for ARC/INTSORMIL cooperative sorghum and millet research. Also review current INTSORMIL/ARC cooperative work in Sudan.

Jerry D. Eastin October 4-8, 1982
Develop cooperative ARC/INTSORMIL 1983 work plans for physiological screening of sorhgum drouth stress resistance.

Darrell T. Rosenow and L.E. Clark October 27 - November 11,1982
Evaluation of sorghum and millet nurseries as outlined in ARC/INTSORMIL Memorandum of Agreement.

Long Term

Edward B. Reeves and Timothy Frankenberger July 1, 1981 - August 15, 1982
Carried out a farming and marketing systems study in North Kordofan, Sudan.

Tareke Berke June 17 - October 28 , 1982
Conducted agronomic research in North Kordofan, Sudan. Research work plans were developed from problem areas identified by the farming systems study.

SUDANESE TRAVELING TO U.S. INTSORMIL INSTITUTIONS

Mohamed Bakheit Said, Director General ARC and Dafalla Ahmed Dafalla, Project director WSAPP July - August 1982

STUDENTS AND TRAINEES FROM SUDAN

NAME	INSTITUTION	FUNDS
Ahmed Aziz	Mississippi State University	FAO
Yousif Seifelnasr	Kansas State University	INT. & AFGRAD
Abdel Rahman	Kansas State University	Sorghum Commission State of Kansas
Abdelilah Mohamed	Univ. of Nebraska	Sudanese Govermnent
Abdelrahman Mohamed	Univ. of Nebraska	Sudanese Government
Osman Ibrahim	Purdue University	Sudanese Government
Laila Monawar	Purdue University	Partial Support from INTSORMIL
A.A. Abdalla	Texas	Rockfeller Foundation

INTSORMIL supported two Graduate Assistants from the University of Khartoum. These students assisted the University of Kentucky farming and marketing systems team in Sudan with their data collection.

1983 PLANS

Breeding and Genetic Evaluation of Sorghum

1. Evaluation of sorghum will continue at Wad Medani (tropically adapted-high yielding germplasm), el-Obeid and Gadambalia (drought resistant germplasm) and Kadugli (disease resistant germplasm).
2. Germplasm exchange between INTSORMIL and ARC/ICRISAT will continue with increase emphasis on sending early generation breeding material to Sudan for evaluation and selection.
3. INTSORMIL will provide ARC with equipment for harvesting threshing and seed handling.

Physiological Work

1. Water management studies (ARC/INTSORMIL) will be conducted on sorghum at Wad Medani and Gadambalia. Plants from these plots will be used to obtain measurements which will provide a better understanding of the physiological factors limiting plant processes when under drought stress.
2. Agronomy-rotation-intercropping experiments will be conducted to optimize production from the standpoint of optimizing the use of available nitrogen, other mineral resources and water resources.
3. INTSORMIL will provide ARC with some equipment for the physilogical studies outlined above.

Agronomic Work

1. Agronomic work in the el-Obeid area will continue by Tareke Berhe during the 1983 crop year.
   a. Agronomic performance trails in farmer's fields with pearl millet will continued.
   b. Intercropping association of chickpea in pearl millet and sorghum will be continued.
   c. Pearl millet fertilizer and sowing method trials will be initiated

Evaluation of Sorghum Food Quality

1. Evaluation of sorghum food quality (ARC/INTSORMIL) will continue with emphasis on developing a set of specific criteria for defining kisra quality.
2. INTSORMIL will provide the Food Research Centre (ARC) with some of the laboratory equipment required for kisra evaluation.

Striga

1. Studies (ARC/University of Khartoum/INTSORMIL) of weed control, including Striga, in sorghum and millet will be undertaken. Particular aspects to be studied will include methods and timing of land preparation, effects of safeness on grass weed control, and integrated control methods for Striga.

Sudan Sorghum Workshop

1. INTSORMIL will support a "Sudan Sorghum Workshop" in November 1983 at Wad Medani.
2. Plans are presently being made to assemble and growout the various Sudan sorghum and millet collections at Wad Medani in the summer of 1983. The collection growout would be highlighted at the Sudan Sorghum Workshop.

Extension Service Study in North Kordofan

1. This study will focus on ways of improving the effectiveness of the Sudanese Extension Service both with respect to information dissemination and linkages with experiment station and on-farm researchers.

Other Areas Under Consideration

1. Seed production and technology (University of Khartoum)
2. Macro economic (University of Khartoum)
3. Grain storage pests ARC/University of Khartoum
4. Plant pathology (ARC)

Intsormil Annual Report

Country Rep -t: REPUBLIC OF PHILIPPINES

INTSORMIL Country Coordinator: C. A. Francis

Recent Activities:

The collaborative activities with the Institute of Plant Breeding, University of the Philippines and the International Rice Research Institute in Los Banos were initiated in discussions between the Director of INTSORMIL, Dr. Earl Leng, officials of the university, and the former director of IRRI, Dr. Nyle Brady. These were further developed in concept during a trip to the Philippines by Drs. C. A. Francis and R. L. Thompson in March, 1981. The details of the collaboration were articulated in the following memoranda of understanding:

1. Memorandum of agreement between the Philippine Council for Agriculture and Resources Research and the Sorghum-Millet Coordinated Research Support Program (INTSORMIL), dated March 19, 1981.

2. A research and training program to evaluate the potentals for sorghum in rice-based cropping systems in Southeast Asia, March 19, 1981.

The basis for these agreements is detailed in the trip report of Francis and Thompson from March, 1981. Further elaboration of the working agreement and the progress to date can be found in trip reports of Dr. Leng (May 11-22, 1982 and September 26-October 2, 1982) and Dr. Dale Anderson (August 16-23, 1982).

The most direct involvement of INTSORMIL in the field implementation of the cooperative agreements centers on the work of Dr. Jerry Maranville, University of Nebraska, who arrived in the Philippines in June, 1982 to spend a one-year sabbattic leave working with both institutions. Reports on his specific activities are forthcoming.

Students from Philippines:

The following students from the Philippines have been enrolled for graduate training during the period of this report:

Mr. Luis Bernardo (degree of M.S., June, 1982): "Techniques for mineral analysis in plant digests and nutrient solutions by X-ray" (with Dr. R. B. Clark, Nebraska)

Miss Gloria Cagampang (working toward Ph.D.) Breeding for quality traits in sorghum (with Dr. John Axtell, Purdue)

Mr. Arnel Cardenas (working toward M.S.) Climatic interactions in the production of sorghum (with Dr. Ralph Nield, Nebraska)

Miss Pamela Fernandez (working toward Ph.D.) Physiological and biochemical studies on nitrogen metabolism in sorghum (with Dr. Jerry Maranville, Nebraska)

Mr. Catalino Flores (working toward Ph.D.) Breeding grain sorghum (with Dr. W. M. Ross, Nebraska)

Mr. Reynaldo Santos (working toward Ph.D.) Nitrogen cycling and fixation in cropping patterns (with Dr. Max Clegg, Nebraska)

Future Plans:

The linkage established by Dr. Maranville during his year in the Philippines provides the basis for a solid research committment in a continuing way by the consortium. The fact that ICRISAT has no personnel in Southeast Asia nor any plans to station anyone there, and the importance of sorghum as a complement to rice in the rotations in this region, make this a logical place for the consortium to work. The excellent working relationships we have with the international center and with the national program will allow cooperative work to proceed with efficiency and broad potential benefits. With the linkage in IRRI with the multiple cropping program, there is access to the network of research people throughout the region, as well as with the breeding programs in the several countries. There is also a potential linkage with the Peoples Republic of China through the cooperative agreements already in place with IRRI. We hope to identify additional staff persons from the consortium to continue this linkage, as well as to expand the training component where possible and appropriate.

PROJECT SUMMARIES

Summary

Evaluation and Development of Sorghum/Millet Germplasm for Arid Land Agriculture

Institution: The University of Arizona Project No.: UA-1

Project Leader: Victoria Marcarian

Over three hundred sorghum and millet entries were screened for drouth tolerance under a sprinkler irrigation gradient systems. Entries were obtained from plant breeders from Kansas State University, University of Nebraska, Texas A&M University and the University of Arizona. Water delivery ranged from 600 mm to virtually zero along the irrigation pipe. Physiological and agronomic data were collected at "high", "medium" and "low" water application regions of the gradient for the checks and entries submitted by our cooperators.

SUMMARY OF ANNUAL REPORT - 1982

Institution: Kansas State University Project No. XII KSU 1

Project Title: Pearl Millet Improvement

Project Leaders: W. D. Stegmeier, and T. L. Harvey, Fort Hays Experiment Station, F. L. Barnett, Department of Agronomy.

Other Project Personnel: B. Kaleeq, Department of Agronomy

Development and selection of millet materials with improved agronomic and quality characteristics was continued. Several items are being evaluated and screened in India, Sudan, Mali, Honduras, and Mexico and in several states. Lines sent to ICRISAT, India in earlier years show promise as parental materials in hybrid combinations. Sufficient variation in downy mildew resistance was present in the materials to allow selection for higher levels of resistance. Grain quality appears to be good. Materials sent to ICRISAT, India and Sudan, in 1981 are being evaluated. Results from Sudan indicate that populations SBC-RM(3) and HMP559 had the best performance. Gradient drought stress screening of 50 items at Yuma, Arizona identified 3 lines, 5 hybrids, 5 population selections and 3 F_3 bulks as having fair to good drought tolerance. Techniques for using infrared thermometry techniques are being examined for screening and selecting for drought tolerance in breeding materials. A linkage has been established between Sudan and the Kansas INTSORMIL program. Dr. Tareke Berke has been hired to conduct an agronomic and breeding program in western Sudan. Informal linkages are underway between Honduras via Texas A & M and with Mali.

SUMMARY

Project title - Identify and Evaluate Physiological and Developmental Processes Adversely Affected by Environmental Stresses

Project number - XII KSU 2

Project leader - E.T. Kanemasu

A field study during the 1980 growing season was conducted to determine the effects of soil moisture gradient on sorghum water relationships, growth, and yield of 4 hybrids: (*Sorghum bicolor* L. 'G-623 GBR', 'RS 626', 'RS 671', and 'A 28+'). June to September was warmer than normal (2.3 to 4.8C), with precipitation only 16.2 cm during the cropping season. Sprinklers provided a continuously decreasing moisture gradient away from the water source. Plant height, dry matter, and leaf area index (LAI) decreased as watering level decreased. Higher leaf diffusive resistance and lower water potentials were associated with decreasing plant height and decreasing LAI. Canopy temperatures (T_c) of the water-stressed sorghum were generally 3.2 to 3.7C warmer than canopy temperatures of well-watered plants. Canopy temperature also correlated well with water use by all hybrids. The average canopy minus air temperature ($T_c - T_a$) was positive for all hybrids receiving less than 25 cm of irrigation and precipitation during the growing season which corresponds to soil moisture values of 0.32 maximum available. Increasing the watering levels increased the water use efficiency for total dry matter and grain yield. A statistical analysis using a multivariate method was developed for analyzing the results from this type of experimental design.

International linkages have been developed with Dr. Phool Singh at Harayana Agricultural University and Dr. Seetharama at ICRISAT, Hyderabad, India. The principal investigator visited ICRISAT in September, 1981 and discussed results of previous experiments and recommended modifications in methodology. In written correspondence with Dr. Singh, the principal investigator suggested treatments, instrumentation, and methodology. If additional support is provided by INTSORMIL, more direct cooperation will be developed.

Best Available Document

34

PROGRESS REPORT - 1982

PROJECT: A Farming Systems Approach to Millet Production XII KSU-3

PERSONNEL: B. Michie, Dept. Sociology, Anthropology and Social Work

OVERSEAS LINKAGES:

Mohan Lal Sukhadia University (formerly U. of Udaipur) - affiliation with Department of Agricultural Economics, College of Agriculture.

SKN College of Agriculture, Jobner (MLSU) - coordination with departments of Breeding and Plant Genetics, Entomology, Plant Pathology

ICRISAT - coordination with Economics, Millet Physiology, and Millet Breeding programs.

MAJOR OBJECTIVES:

1) augment affiliating university's research programs, 2) further develop farming systems methodology, linking agricultural and social science, 3) develop/modify technologies for increasing and stablizing pearl millet production in project area, particularly for small and marginal farmers, 4) develop farm level tested technologies for further extension.

SIGNIFICANT RECENT FINDINGS:

This first season of work (kharif 1982) has laid a foundation of information and coordination between KSU-3, MLSU, and ICRISAT, for a proposed four season baseline study to establish a dryland research program in our area of operations - Sikar District, Rajasthan - planned by the University. The agro-climatic gradient of the district (350 to 750mm rainfall - deep sandy to deep sandy loam soils - single and double cropping regimes - totally rainfed and irrigated regimes) across which our nine sample villages are located provides an excellent cross section of conditions under which pearl millet is grown in Rajasthan.

The atypical weather conditions of this season, particularly the highly unseasonal early rains in April-May followed by drought and a sparse weak monsoon in July, underlines the necessity of at least four seasons of work to obtain a representative idea of the farming system/s of this area. Detailed analysis and results of this season's work await collection of complete field data. Threshing and marketing operations are still in progress and sociological-anthropological questionnaires are still to be administered to the 180 participant farmers.

Effects of erratic weather:

- two plantings: 1) with first rains in April-May, 2) sowing/resowing with weak monsoon in July. First planting affected by drought, second by dessicating winds in early September.
- erratic effect on life cycle of insect pests. Incidence of two major pests, red hairy caterpillar (Amsacta moreei) and white grub beetle (Holotrichia consanguinea) both associated with light soils, was practically nil to nominal. Jobner coordinated program to monitor and control white grub was scrubbed.
- incidence of pearl millet diseases was also very low.

Farm level trials:

- two promising composite varieties under development at Jobner were planted to side by side trials with the hybrid BJ-104 and local

pearl millet in sample villages. These improved varieties are based on local land races from Sikar and adjoining districts, are adapted to drought, and under rainfed conditions should perform as well or better than BJ-104 in dry matter and grain production. Results were mixed due to upset of distribution and planting schedule by unseasonal rains.

- Two improved varieties of mothbean (Phaseolus aconitifolius), one released and one under development at Jobner, were planted in side by side plots with local varieties. This cultivar is an important pulse in drier tracts as a mixed fodder crop and as a sole grain crop in rotation with pearl millet. The improved varieties are resistant to yellow mosaic virus, the major disease constraint of this cultivar. Both varieties did extremely well incomparison to the unimproved locals that were heavily infested with virus that in combination with moisture stress gave little or no yield. The improved varieties did give yields, although suboptimal due to moisture stress.

Other findings:

- farmers will plant whenever and however early there is sufficient moisture for germination under rainfed conditions. However they will not plant beyond the third week of July. This is consistent with ICRISAT Village Level Studies findings in other areas.
- farmers are as concerned with dry matter as with grain production in millet. This is due to complementarities with animal husbandry.
- BJ-104 hybrid is planted primarily for its resistance to striga. Farmers appreciate its synchronous maturity and evenness of heads but prefer the locals for dry fodder and grain quality (milling and taste). BJ-104 is grown for sale, locals for home consumption.
- stand establishment is major constraint. In light sandy soils the seedlings either wash out or are buried during heavy direct rains up to 10 days after emergence. This and other factors will be investigated further next season in coordination with Jobner and the millet program at ICRISAT.
- tree-animal husbandry-field crop interaction. A thorny tree, locally called 'khejri', of the Prosopis genus, is commonly found in fields, often in dense stands. These afford protection to crop seedlings from rain damage and also organic material to the soil. Millet stands are usually denser under such cover. The 'khejri' leaves are harvested for animal fodder each winter (Dec.-Jan.) by lopping the new growth, removing and storing the leaves. The bare branches and twigs are used for fuel, fencing, and hutments. Unfortunately the 'khejri' is a preferred host to the white grub beetle.
- mixed-cropping is standard proceedure under rainfed conditions. Cultivars sown with pearl millet are cluster bean, green gram, cowpea, sesame, mothbean and/or several local varieties of melons and cucurbits. These are all line drilled but not intercropped.

Coordination with other INTSORMIL projects:

- collection of local millet flour for KSU-5, millet nutrition.
- collection of storage and pest problems for KSU-4, storage project.

Concluding remarks: KSU-3 finds it sad and perplexing that given approval by Government of India, excellent support by Mohan Lal Sukhadia University, ICRISAT, and AID/Delhi, INTSORMIL has no interest in supporting this project beyond 1982-83.

SUMMARY:

Project Title: Storage and Preservation of Pearl Millet - Project No. XII KSU 4

Principal Investigators: Robert B. Mills, Department of Entomology, KSU
John R. Pedersen, Dept. of Grain Science and Industry, KSU

Research findings: Among 76 millet entries there was wide variation in numbers of rice weevil progeny and Angoumois grain moth survival in samples of a free-choice test. The more resistant entries were smaller-seeded, and harder as determined by impressions in the kernels produced by a weighted diamond crystal. Studies of factors affecting resistance are continuing.

Individual Angoumois grain moths that developed in small millet kernels were smaller, laid fewer eggs, and caused less weight loss than those from larger kernels. Lesser grain borers also were smaller from smaller kernels.

Rice weevils caused less damage to heads of millet than to threshed grain; there was little difference for the Angoumois grain moth in these small samples. Location of planting in the state of 27 lines of millet did not affect relative susceptibility of the grain to RW or AGM.

In plastic garbage cans modified to simulate well-ventilated basket-type storage and the nonventilated mud brick, or mud-plastered storage structures, rice weevils alone, or in combination with red flour beetles produced fewer insects and caused less damage to in-head millet in the ventilated containers.

Threshing residues placed in a layer on millet as a barrier was found to delay the invasion of the millet. Investigation of this is continuing.

The rice moth, *Corcyra cephalonica*, a pest of stored millet in W. Africa, developed faster and had greater survival in millet than in rice, corn, sorghum, or wheat.

Moisture content determination by placing a sample of millet in a metal can containing oil and heating to drive water out of the grain (then wt. loss is determined) required more accurate temperature control than can likely be achieved in most developing country situations.

International linkages. Yousif Seifelnasr visited Sudan and held discussions with personnel of ARC, University of Khartoum, WSARP, Ministry of Agriculture, and INTSORMIL at El-Obeid. Communications are underway regarding possible cooperative research on grain storage in Sudan.

Summary

Nutritional Quality of Pearl Millet KSU-5

R. Carl Hoseney, Carol Klopfenstein, K. Zeleznak, A. Abdelraham, P. Vijaya, and M. Olewnik

Fine particle size and optimum water absorption appears to be critical factors in producing a good roti. Roti dough appears to be a dry powder-water system not a dough in the classical sense. Thus, liquid bridges provides the cohesive forces in the roti dough. These forces can be monitored with the Instron Universal testing machine. The Instron can be used to determine optimum water level. Any pearl millet will produce a good roti if particle size and water absorption is correct. Thus, poor quality millet for roti's are those that produce unusual particle sizes and distribution upon grinding. Pearl millet is known to go rancid rapidly after it is ground. Increases in fat acidity and peroxide value accompany millet meal going rancid. Total fatty acids did not significantly change as a result of storage. Thus no significant oxidative degradation of fatty acids occurred during storage. Hexanal is the major product of oxidative degradation of lipids. Hexanal production in ground pearl millet was similar to that found for other cereals. This does not correlate well with the rancid odors found during storage of ground millet. Thus, the peroxide value obtained after short storage is not the result of the classical oxidative degradation of lipids.

The small size and irregular shape of the pearl millet kernels make it difficult to hold and dissect into its anatomical parts. A special technique was developed to hold the kernel and dental tools were used to separate the kernel into endosperm (75.1%), germ (17.4%) and bran (7.5%). Each fraction was, or is being, analyzed for fat, protein, ash, amino acids, and fatty acids.

Ultrastructural features of pearl millet and grain sorghum caryospsis were investigated with thin sections of the dry, mature grain in the transmission electron microscope, and fractured kernels in the scanning electron microscope.

In 1981, reports from Sudan (Osman, Ecology of Food and Nutrition 11:121 (1981), linked high consumption of pearl millet with high incidence of goiter, suggested that the grain might contain a goitrogenic factor. Although some analyses remain to be performed, and the data we have are still being evaluted, however, we can report: 1. Histological changes did occur in millet-fed rats. Thyroid follicles of those animals were much enlarged and the epithelial cells flattened, while those of the sorghum-fed animals were not. 2. T_4 levels were significantly higher and T_3 levels significantly lower in millet-fed rats than in sorghum-fed animals. (In simple iodine deficiency goiter, plasma T_4 is decreased while T_3 is increased). 3. Results with fermented millet were not significantly different than those with unfermented millet. 4. The "goitrogenic factor" is apparently associated more with the endosperm fraction than with the bran fraction.

SEEDLING VIGOR AND STAND ESTABLISHMENT OF PEARL MILLET

Project No.: XII KSU 6

SUMMARY

Dr. R. L. Vanderlip

Our results showed that head selection and low spikelet density were effective in the improvement of seed size, seed weight and seed density. Subsequent seedling stand and grain yield also were substantially increased. Nitrogen fertilization improved seed protein, but subsequent effect on crop performance was not consistent. Four plants per hill and tiller removal did not change seed quality.

The greenhouse study showed that the advantage of seed quality may be greater under poor than good crop growing conditions. Ease of head selection makes it attractive, but success may depend on genetic variability in plant population. Selection based on seed size rather than head size could increase farmers' benefits from the management.

The yield of pearl millet is less variable over environment than that of grain sorghum. Pearl millet had yields ranging from 2167 kg/ha in 1980 to 3200 kg/ha in 1981. This compares to sorghum with yields of 1967 kg/ha and 6314 kg/ha in 1980 and 1981, respectively. This shows pearl millet's greater resistance to drought (1980 abnormally hot and dry) and its less interaction to improved growing conditions than that of grain sorghum.

SUMMARY

Project Title: Sociocultural Constraints in the Production and Consumption of GS/PM in Less Developed Countries

Project Number: XII UK 1 and 2

Project Leaders: C. Milton Coughenour, Lawrence Busch, William B. Lacy, Bill R. DeWalt, Kathy DeWalt, and Ed Reeves

Objective 1:

In southern Honduras, sorghum is becoming increasingly important as a food crop due to changes in the cropping system. The major constraints are post harvest losses to inserts. Sorghum is most used as a food by renters and landless laborers. In Kordofan, Sudan millet is the principal staple of the diet with sorghum used during the dry season. Erosion, pests, lack of rainfall, insufficient labor, seeds, and chemicals are major constraints. Both millet and sorghum have important uses that are secondary to their use as human food. Desertification is the most serious, long range problem in the el-Obeid area, and it is associated with present cultural practices in raising millet.

Objective 2:

The international sorghum research community is only loosely linked is divided along disciplinary and crop utilization lines and is often narrowly focused on terms of goals for research. Significant effort will be necessary to insure that research directly confronts the problems of Third World countries.

The Sudan Agricultural Research Corporation is one of the largest research systems in sub-Saharan Africa and has a well-trained scientific staff. However, as a result of budgetary constraints and management difficulties, it is seriously hampered in fulfilling its mission.

INTSORMIL

ANNUAL REPORT - 1981/82

INSTITUTION: Mississippi State University

PROJECT NO. XII/MSU-1
(390-1505/MIS 1505)

PROJECT TITLE: Seed Factors Influencing Germination, Emergence and Stand Establishment

PROJECT LEADER AND INVESTIGATORS: J. C. Delouche, C. H. Andrews, H. C. Potts, G. Reusche, E. Cabrera

SUMMARY: Observations in humid and arid/semi-arid countries and a seed survey in cooperation with the NSS-Upper Volta indicate that poor physical condition and insufficient moisture of the seedbed are major causes of emergence and stand establishment problems. In humid areas low seed quality is a contributing factor, but seed quality is generally good in arid regions.

Some sorghum lines have been identified which exhibit superior capability for germination/emergence under high and low temperature stresses, high and low soil moisture stress, and mechanical impedance (crusting). If these properties have good heritability, their incorporation in lines and varieties would ensure good capability of improved varieties for germination/emergence under the generally adverse conditions that prevail in many LDCs at planting time.

Variability in weathering resistance (i.e., capacity to maintain germinability and vigor under weathering pressure) has also been identified. This type of resistance would be equally useful in reducing the field deterioration of planting seed and head molds. Fungicides applied as a foliar/head spray also appear to reduce deterioration of sorghum seed under severe weathering pressure.

The accelerated aging test - already very widely used for maize, cotton and soybean seed - appears promising as a means of rigorously assessing the storage potential of sorghum and millet seed lots. AA test responses also appear to be related to weathering resistance.

Work in progress will be continued and other studies initiated to validate findings and exploit leads developed. The work is being closely coordinated with the ICRISAT group, and some field validation work is scheduled for CIAT.

INSTORMIL

ANNUAL REPORT

1981 - 1982

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: Dr. Mary Futrell, Nutrition

INVESTIGATOR: Eunice R. McCulloch, Sociology

Sociological and nutritional field research in southern Honduras during 1981 and 1982 has documented farming methods, social and economic factors and the nutritional condition of subsistence farmers in three localities where grain sorghum is a staple food. It has been found that a substantial amount of malnutrition exists in the areas studied. Preliminary findings indicate that, although farms are on the average very small (less than 3 acreas) in the areas visited and the technology primitive, it is possible with the use of sorghum in the diet to grow enough maize, sorghum and beans to meet energy and protein needs provided all produce is consumed and none is sold. The traiditional diets of tortillas and beans, however, are sadly deficient in at least four essential nutrients and the requirements for these are not being met in most households. For complete nutrition, additional vegetable, fruit, and dairy foods must be grown or purchased at costs far beyond the means of these people. Some meats products would also be desirable. In addition, the nutritional condition of small children has been found to be worse than that of other age groups, and more specific information concerning household food distribution patterns is needed. Continuing field research will focus on particular data which is needed to round out the previous research findings. In order to obtain this data, a revised questionnaire will be used in upcoming field surveys in Honduras to be conducted in January and February, 1983. Graduate students from Honduras will participate in this study.

A high protein product comparable to casein was produced by carefully blending of vegetable proteins of soybean flour, sorghum flour, and wheat flour, at a ratio of 2:1 of soybean to sorghum flour. One of the products SWSoy met the FAO essential amino acid patterns. This SFP also had a PER above 2:1, a low fiber content, over 25 percent of calories provided by fat, available protein of 7.9 percent, and NDPCal of 10 percent as recommended by Protein Advisory Group (1971) in formulating high protein foods for children. Therefore, this SFP can be used in children feeding programs to prevent calorie protein malnutrition in deprived areas of the world where sorghum and legumes are cultivated. This research was carried out by a student from Nigeria. She is returning to work in a university research program and the Nigerian government is interested in producing this product. Other graduate students from Taiwan, Malaysia and Thailand are also working on sorghum related problems. Papers were given at International workshops in India and Mexico which gave an opportunity for planning of future international linkages with Indian research institutions.

Project No.: XII MSU 4 Mississippi State University

Project Title: Sorghum Host-Plant Resistance and Genotype Evaluation.

Project Leader: Dr. Lynn M. Gourley

SUMMARY:

Evaluations of lines from the World Collection of Sorghum and the Meridian Collection have identified potentially useful new sources of aluminum tolerance. Some of these lines, along with some previously identified tolerant lines, survivied in field trials at CIAT-Quilichao, Colombia in soils with 80% of the ECEC saturated with aluminum. In virgin soil, 91% AL saturation, seeds of none of the entries germinated and/or emerged.

Dr. Lynn Gourley, leader of project XII MSU 4, has received clearance and will be assigned to CIAT-Colombia November 1, 1982 for a period of 1-2 years. The purpose of the assignment is to initiate a long-term program of INTSORMIL-CIAT-ICRISAT cooperative research of breeding aluminum-tolerant sorghums for Latin America. Other INTSORMIL projects conducting aluminum-tolerance research will be associated with this program.

Candido R. Bastos, received his Ph.D. degree in Agronomy-Plant Breeding in August, 1982, with dissertation research on "Inheritance Study of Aluminum Tolerance in Sorghum in Nutrient Culture". His research assistantship was sponsored by EMBRAPA.

SUMMARY:

PROJECT TITLE: Biological Investigations and Management of the Fall Armyworm and Stem Borers on Sorghum.

PROJECT NO.: MSU-5

PROJECT LEADER: H. N. Pitre, Entomologist (MS)
INVESTIGATOR: B. R. Wiseman, Entomologist (GA)

RESEARCH FINDINGS:

Fall armyworm (FAW) moths were shown to demonstrate oviposition preferences for different closely related host plants, an insect/plant relationship that will be useful in host plant resistance evaluations, as well as in the development of pest management strategies involving manipulation of host plants. The latter relationship is being investigated in host plant interplanting studies, using a highly preferred ovipositional host, corn. Sorghum plant density studies have indicated the effects of plant density on behavior of the FAW; behavior of adults and larvae is also affected by interplanting corn with sorghum, as is seedling establishment. Interplanting may also impact on stand density in LDS's where poor plant stand is a limiting factor in sorghum production. Procedures have been developed for studies dealing with developmental rates of the FAW using live plant material, and for evaluations of sorghum genotypes in the laboratory for host plant resistance. Biological "back tracking" procedures provided evidence of long range movement (immigration) by moths, an important consideration when developing IPM strategies for the US and linkage LDC's. Some INTSORMIL genotypes evaluated for FAW resistance show evidence of trends for low levels of resistance.

International linkages include programs with Brazil, Honduras and Mexico (INIA, CIAB). INTSORMIL sorghum genotypes are evaluated in the linkage LDC's and graduate student participation in insect pest management research in Honduras and Mexico is possible during 1983 and/or 1984. Students will conduct research in the linkage LDC and receive academic training at Mississippi State University.

Title - Sorghum Disease Resistance Evaluation and Pathogenicity Investigations, Project Leader - Dr. Natale Zummo, Institution - Mississippi State University, Number XII MSU 6.

SUMMARY:

Sources of resistance to seed mold, maize dwarf mosaic, yellow sorghum stunt, and rough spot have been identified. This germplasm will be made available to sorghum breeders. These resistances will be incorporated into sorghum lines where they are needed in the LDC. A method for the rapid determination of seed mold resistance in sorghum lines was developed at Meridian. Results from trials of the International Sorghum Anthracnose Virulence Nursery indicate the occurance of a possible new race of anthracnose in Georgia in 1981. There is a possibility that sprinkler irrigation may play an important part in overcoming innate resistance of some varieties to anthracnose.

Dr. Zummo has been asked to organize a sorghum and millet disease workshop to be held in Kamboense, Upper Volta in October 1983 for sorghum and millet workers in West Africa. ICRISAT will cooperate in this venture and make its facilities in Upper Volta available. Participants in this workshop will be mainly Africans. Preparations for this workshop are well underway but no funds have yet been committed.

Victor Canez, received his M. S. degrees in plant pathology in August, 1981, with thesis research on "Fungal Invasion of Sorghum Panicles and Assessment of Grain Mold". His research assistantship was paid primarily by INTSORMIL funds.

1982 Summary INTSORMIL Project XII NU-8

Institution: University of Nebraska

Project leader and investigator: R. E. Neild, Leader
Student investigators: Joanne Logan-M.S., Ph.D. student in Dominican Republic. Arnel Cardenas-Phillipine M.S. student in U.S.

Research findings, internationallinkages, L.D.C. institution progress:

Research: Sorghum and maize differ in rate of development during critical stage. Maize is vulnerable to temperature stress, days with maximum above 35°C, during 42% of the growing cycle compared with 15% of cycle for sorghum. Phenological developed for proso (Panicum) millet. Growth chamber and field studies show Nebraska strains photosensitive. Producers grow grain rapidly in the tropics, Tanzania and Dominican Republic. Agroclimatic procedure to determine and evaluate sorghum growing season requested by researcher in Mexico, Malawi, Mali, ICRISAT, and Peoples Republic of China.

International Linkages: ICRISAT, Dominican Republic, Phillipines, Peoples Republic of China, Tentative Mexico, Mali, Malawi, Nepal.

Institution Building: Contributed computer for use in research and training at ICRISAT. Research plots in Dominican Republic used in field data. Student lecturing to agronomist on sorghum and agriclimatology. Phillipine student training in agroclimatology. Mali ag climatologist requesting WMO to study in UN-8 project.

46

Identification of genes controlling the reaction of sorghum to MDMV.
Project No. UN-10
S. G. Jensen

In the work reported last year, the Asgrow Bugoff hybrid, was found to give a mosaic reaction to MDMV-A and MDMV-B at warm temperatures but a necrotic reaction to MDMV-B only when subjected to cool temperatures. Progeny from selfing this hybrid gave 5-6 different classes of symptoms. Parental lines of this hybrid were obtained, tested and found to give more severe reactions to the two virus strains than the hybrid. It appears that there may be at least two types of genes and their alleles involved. One type determines the symptom type for each virus strain i.e. mosaic, necrosis etc. and the other type controls the temperature sensitivity. This temperature sensitivity effect which is not normally seen unless the plant is virus infected may have other significance in the growth and development of healthy plants in different environments. Forty A-lines and 60 R-lines in common usage were tested for their reactions to MDMV-A and MDMV-B. Most developed a mosaic symptom with MDMV-A but only about half with MDMV-B. Red leaf symptoms were more common with MDMV-A, the red stripe and local lesion symptoms more common with MDMV-B. Selected lines were chosen for crossing onto the A and R parents of Bugoff. Progeny testing will help determine the number and type of genes involved. Preliminary tests suggest that the physiological reason for the red leaf response is the inability of susceptable plants to recover from cold shock of a critical duration. Entries from the world collection of millets were found in general to have good resistance to infection with MDMV but high susceptibility exists.

Nov. 10, 1982

INTSORMIL ANNUAL REPORT

INSTITUTION: University of Nebraska
PROJECT NO. XII UN 4 (Final Report)

PROJECT TITLE: Adaptation and Yield Stability in Grain Sorghum

PROJECT LEADER AND INVESTIGATORS: C. A. Francis, W. M. Ross, and J. D. Eastin

GRADUATE STUDENTS ON PROJECT:
Twelve graduate students have participated in this project; six were from developing countries, and six from the USA. Three of the US students have previous Peace Corps experience, and all are currently overseas working in a development situation. Two of the students conducted dissertation research in other countries: Tanzania and Dominican Republic.

PROJECT OBJECTIVES:

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

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

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

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

RESULTS AND DISCUSSION:
Hybrids appear more stable over a range of environments than either populations or lines. Random mating populations did show higher yields under the most unfavorable environments included in the experiments. The hybrids were highest yielding in the medium and good environments, and also responded more to improving environments. It is possible that the genetic variability in random mating populations for plant height, maturity, tillering capacity, and other traits makes these populations more tolerant to stress through a range of mechanisms for adapting to that stress, and with different plants in the population doing relatively better than others under each set of stress conditions. This result has important implications for developing countries where both sorghum and millet are grown under conditions of stress, and the program planners must decide if varieties or hybrids are most appropriate as the major breeding objective. Maturity is an over-riding consideration in the analysis of a set of materials for yield stability. It is important to work with a restricted range of maturities, or at least to subdivide materials by maturity in the analysis in order to best understand genotype by environment interactions in grain sorghum.

From these same trials an evaluation was made of the relative contributions of replications, locations, and years to minimizing

48

error mean squares, and thus the potential for identifying significant differences among genotypes under test. The experiments over years and locations showed that increasing number of locations is the best way to improve results, followed by increasing years of testing. Increasing replications more than two in these tests had only minimal effect on the error mean square. These results confirm the common practice of commercial companies in the U.S., which use multiple locations in one year to substitute for years in assessing the value of new hybrid combinations.

Detailed analysis of the results from several locations did confirm the importance of seed number in determining yield of grain sorghum. Although both seed number and seed weight are important in yield and in yield stability, there was a clear indication that stability of seed number per square meter was more important in the determination of yield stability than the comparable contribution of seed size. These results depend on the timing of stress: if moisture or temperature stress occurs during gs2, there is undoubtedly a greater effect on seed number, while this stress in gs3 will have a greater effect on seed size. An analysis of climatic variables and their relationship to yield did show the importance of both moisture and temperature on yield and on stability, and the combined regression analysis using temperature minima and maxima plus rainfall during each of the three growth stages was able to explain about 64% of the variation in yields.

Populations are being developed which differ in relative amounts of time spent in the filling stage of plant growth. Two populations are being synthesized from an RP2B source which have short and long durations of grain fill. Rate of fill is also important, and populations are being synthesized which have rapid and slow filling characteristics, based on grams of dry matter per day accumulated in the grain from flowering to physiological maturity. A check population is being selected which has yield as the only criterion, with all five populations coming from the same original RP2B source. Comparisons among these populations will await at least one additional cycle of testing and synthesis.

Testing of germplasm in other climates is the slowest phase of the roject to develop. Currently, there are limited field tests under way in Tanzania and in Dominican Republic, and this activity will be expanded as more material is available and more linkages are established through students, visiting scientists, and national program personnel.

PRESENTATIONS AND PUBLICATIONS:

From the results of the work in this project, there have been six graduate theses completed. In addition, there have been six published abstracts in Sorghum Newsletter or Agronomy Society Proceedings of the annual meeting. Five journal articles are in press or have been submitted, and several more are under preparation. There have been two presentations at international conferences. These are listed with titles and authors in the complete final report on the project.

SUMMARY ANNUAL REPORT
INTSORMIL

INSTITUTION: University of Nebraska PROJECT NO: UN-13

PROJECT TITLE: Agronomy and Cropping Systems

PROJECT LEADERS AND INVESTIGATORS:

Drs. M.D. Clegg and C.A. Francis; Dr. C.S. Sodhi, J.R. Santos, G. Mitawa, M.S. Mostafa, L. Gakale, P. Odo, Jo Logan, Elizabeth Bradford, Linda Pavlish and D. Carter.

RESULTS AND FINDINGS:

This project was established July, 1982 with a revision of the previous projects. Results through June 30 have been included in the established project reports.

The role of cowpeas as a nitrogen source for a cereal crop in rotation in Botswana is being investigated. Results show considerable growth of maize seedlings on soil from fields previously planted to cowpeas as compared to soil from a field previously planted to sorghum or a field previously fallowed.

Estimation of biomass of soils from continuous sorghum with applied levels of nitrogen (N) 0, 57, 114, and 170 kg/ha, sorghum/soybean rotation with the same N levels applied only when in sorghum, and continuous soybean plots were made. Highest biomass yields were obtained with continuous soybeans, followed by sorghum/soybean, continuous sorghum, and soybean/sorghum patterns. The effect of nitrogen showed plots with 57 kg/ha N had the highest biomass, followed by 0, 170, and 114 kg.ha.N. Implications from this study are that these systems are complex. The previous crop and/or rate of nitrogen application influences the soil microbial content which probably compete with the crops. However, at some point a complementary state exists.

Intercropping studies involving sorghum, maize, cowpeas, field beans, and soybeans in several combinations are being conducted in Tanzania, Dominian Republic, and Nebraska. Results from these studies will provide information on density interactions, plant competition, spatial organization, and genotype interactions with cropping systems. These trials will provide direction for future crop selection for multiple cropping systems.

INTERNATIONAL LINKAGES:

Research is being conducted in Botswana, Dominion Republic, and Tanzania.

INSTITUTION: University of Nebraska PROJECT NO: XII UN-5 and UN-6 (now UN-14)

PROJECT TITLE: MINERAL ELEMENT UPTAKE, USE, EFFICIENCY, AND TOLERANCE IN SORGHUM AND MILLET

PROJECT LEADERS: R. B. Clark and J. W. Maranville

INVESTIGATORS: W. M. Ross, M. D. Clegg, C. A. Francis, J. D. Eastin, C. Y. Sullivan, and R. E. Neild

SUMMARY

Sorghum genotypes were evaluated and screened for differences in plant performance and tolerance to low levels of N and Fe and to toxic levels of Al. Differences were noted among genotypes for N efficiency, N distribution, and dry matter yield. Differences were also noted among genotypes for Al toxicity, the uptake, accumulation, translocation, distribution, interactions, and balances of N, P, K, Ca, Mg, S, Mn, Fe, Cu, and Zn (and Al where applicable) in plant parts of plants grown at varied treatments of Fe and Al. Additional measurements on seminal and adventitious roots were made to better evaluate genotypes for Al toxicity tolerances. Hybrids made from parents exhibiting Al toxicity tolerance traits were evaluated for performance and inheritance of these traits when grown with toxic Al in nutrient solutions, and on an acid Al toxic soil in the field (Georgia). Screening techniques were developed and differential responses of 14 sorghum genotypes to Mn deficiency stress were noted. The effects of ammonium/nitrate ratios on growth nutrient solution pH and uptake of mineral elements were assessed to better refine screening techniques. Techniques for detectability of Al and conversion of liquid to solid samples were improved for X-ray analysis of samples. Studies on water gradient stress and N management effects on mineral uptake, translocation, and use in corn and sorghum genotypes and on depletion from the soil were continued and plant samples for these experiments collected and have been undergoing analyses. Four students have recently completed their M.S. and Ph.D. degrees. Trips overseas have enhanced cooperative efforts and helped others better understand screening for mineral stress tolerances and genotype differnces to mineral stresses.

Experiments were continued to evaluate the N efficiency of grain sorghum hybrids with respect of their parents, stage of development and environment. Significant differences in N use efficiency variables were observed for the hybrids and their common parent averages. Results showed a significant hybrid by N fertility interaction for each of the N efficiency variables with a larger range of N efficiency values under low N fertility conditions. Hybrid differences for N use efficiency at maturity in field experiments were not detected in seedlings grown under greenhouse conditions. Under field conditions, N utilization differences between 30 hybrids were not apparent until anthesis. Certain hybrids differed in dry matter production, total N uptake, and NE-1 values during vegetative development but showed no difference in total grain yield at maturity. Comparisons across location showed significant hybrid by location interactions. Nitrogen utilization variables had higher correlations with grain yield than N efficiency variables. Experiments were conducted on grain sorghum to evaluate N supply and plant water use relationships using a system which could accurately detect plant water use. Daily water use rates generally followed fluctuations in photosynthetically active radiation and vaper pressure deficit differentials, whereas longer term water use rates were a direct function of leaf area. Contrary to field studies, more dry matter was produced per unit of water use by plants grown in low N supply treatments. This possibly indicates different physiological responses between field and hydroponic conditions.

SUMMARY-INTSORMIL ANNUAL REPORT

INSTITUTION: University of Nebraska

PROJECT NO.: XII UN 15 (final)

PROJECT TITLE: Recurrent Selection in Sorghum

PROJECT LEADER & INVESTIGATORS: W. M. Ross, C. O. Gardner, and C. A. Francis

The mechanisms of developing, maintaining, and evaluating families from sorghum populations have been established and documented, and breeding techniques used in maize have been implemented. To date, S_1 progeny testing has emerged as the most promising method of population improvement for grain yield, pest resistance, mineral uptake efficiency, and certain aspects of grain quality. Mass selection holds promise and is being studied for yield traits. Mass selection was effective in increasing grain protein over four cycles, but a negative correlation between grain yield and protein percentage existed. S_1 progenies derived from a population in different years proved to be equally suitable for recurrent selection, and evidence indicates that as few as 120 S_1 progenies will produce valid estimates of means, standard errors, and variance components for yield, height, flowering, and grain protein. A preliminary study of F_1 hybrids indicated that it should be possible to improve a population simultaneously for agronomic and forage residue traits. Inbred lines derived from NP3R produced hybrids that yielded as well as male parents which were original components of the population. Electrophoresis techniques, adapted from maize, produced largely negative results with little differentiation of isozyme patterns among genotypes.

Graduate student training has been an important component of this project. Three students will complete degrees in 1983 and return to their home countries. These are A. B. Mohamed (Sudan), C. I. Flores (Philippines), and L. M. Mazhani (Botswana). Linkages with these three countries should then be firmly established. In addition, R. S. Mushi (Tanzania), who is working on a degree, furnishes linkage to his country. Currently, an INTSORMIL-funded plant breeder/agronomist is being recruited by the University of Nebraska to strengthen overseas program involvement. The original breeding projects are being consolidated into a single new project, XII UN 15.

SV

1982 INTSORMIL Report, UNL Project 2, Summary

Project objectives relate to (1) temperature influences on grain yield and yield components of sorghum and millet plus corn used as a comparative reference, (2) investigate temperature x water interactions on yield and its components and (3) develop screening techniques for plant reaction(s) under 1 and 2.

Sorghum-millet-corn comparisons Bushels/A and water use efficiencies (WUE) for crops grown under a water gradient at Garden City, KS follow:

	No irrigation	Full irrigation	Respective WUE (#/A in.)
Pear Millet	50	60	217 to 190
Sorghum	90	120	350 to 371
Corn	54	154	216 to 372

Millet was unresponsive probably due to its adaptation to drier areas and hence had a low WUE. However, its WUE in terms of photosynthesis/transpiration was high compared to sorghum indicating good primary physiological characteristics but poor developmental characteristics dictating favorable seed size and seed number yield components. Selection to improve the latter should proceed. Sorghum is the most stable of the 3 crops in terms of yield and WUE for intermediate and moderately severe environments. Corn is the most responsive crop to added water and is the most susceptible to stress (much of the 54 bu/A was on the ground), a point which needs to be pressed in Kenya and other East Africa nations where more marginal lands are being pressed into production. WUE studies under moderate elevation-cool conditions were initiated at Sidney and are being complemented by differential elevation investigations in Mexico in cooperation with Mr. Emrique Romo and Drs. Betancourt, and Guiragossian.

Objective 2 results show late floret differentiation to be the most sensitive pre bloom stage. An exceptional set of electronmicrographs depicting sensitive stages are being used by Dr. D. Oswalt in the ICRISAT student training programs. They are also being used for cooperative temperature x genotype sensitivity experiments at 3 elevations by INIA staff in Mexico.

S_1 population water stress screening experiments in NE and KS show large genotype x location interactions pertinent to population breeding approaches. Yield ranges for 400 S_1's were from 2000 to 8000 kg/ha in NE compared to 400 to 4000 in KS and only 8 of the top 10 S_1's in KS were in the top 50 in NE. Similarly only 11 of the top 20 in NE were in the top 50 in KS. S_1 selection for LDC's can be done most efficiently in local environments reinforcing the importance of student training for national programs. Texas materials are being screened and millets were sent to Arizona.

Four graduate students (India and Mexico) and one US student have programs going here. One Ph.D. and one MS will graduate in 1982. One student will be replaced by an ICRISAT scientist who will work on a Ph.D. Excellent germplasm has been provided the Egyptian and Sudanese programs. An extensive cooperative research program is being developed in Sudan. Numerous visitors were located from ICRISAT, Upper Volta, Sudan, Egypt, Mali and China. Visits were made to Egypt, India, Sudan and Mexico.

Eastin, Sullivan, Francis, Clegg, Dobrenz

Annual Report
INTSORMIL

Purdue University Project PRF-1

Subproject: Sorghum and Millet Marketing System
Subproject leader: Lee F. Schrader

Graduate and Post Doctoral Students: None

Project Objectives:

To describe the existing marketing system for sorghum and millet. Market structure, institutions, trading practices and information systems are included.

To assess factors affecting the demand for sorgum and millet in urban populations.

Research Approach

Prices for six crops (red sorghum, white sorghum, corn, peanuts, rice, and millet) have been monitored at five markets in Upper Volta from April 1981 to April 1982. The five markets include two at the village level, two regional and one large market. The survey was designed to identify price relationships between markets and within markets as well as short term price variation. These data reflect the performance of the marketing system and will allow quantification of risks and marketing alternatives available to farmers.

Market specialists in five Upper Volta markets were interviewed to determine trade flows, seasonal patterns of marketings, storage activities, transaction size distribution, and transportation means. These descriptive data combined with the analysis of market price data will provide the basis for recommendations for actions to improve the performance of the marketing system.

Transactions of 100 households in Quagadougou are being monitored for a period of 25 weeks centered on the grain harvest period. These data will be used to estimate price and income influence on the demand for sorghum and millet as well as other food products.

Results and Findings:

Analysis in progress.

Next Year's Plan

Marketing channel study report will be completed in Ouagadougou. Analysis of market price data for 1981-82 will be completed on the Purdue campus by June 30, 1983. Consumer panel data will also be processed at Purdue upon completion of the survey period.

Present International Linkages
SAFGRAD. Farming Systems Unit
ICRISAT

PLAIN LANGUAGE SUMMARY

INSTITUTION: Purdue University PROJECT NO: PRF 3

PROJECT TITLE: Development of Agronomically Superior Germplasm Including Varieties, Hybrids and Populations which have Improved Nutritional Value and Good "Evident" Grain Quality for Utilization in Developing Countries

PROJECT LEADERS: John D. Axtell and Allen W. Kirleis

The central focus of our project is to study and define the parameters effecting food grain quality and the nutritional value of sorghum grain, and to develop superior sorghum lines, hybrids and populations for distribution and utilization in developing countries. We have evidence that sorghum grain hardness is associated with differences in field weathering resistance, stored pest resistance, and milling and food making properties. As grain hardness is related to several quality properties it is a useful parameter for evaluating the acceptability of improved sorghum lines. We have developed a simple and reliable density procedure (percent floaters) for determining grain hardness. The percent floaters procedure is presently being used to study the inheritance of grain hardness in sorghum. Preliminary analysis on 1981 data from this work indicated the existance of adequate genetic variability for sorghum grain hardness. This implies that grain hardness is indeed heritable and grain from selection is possible.

Despite the usage of sorghum for many years as a staple food in the arid regions of Asia and Africa, little is known about the chemical and physical properties of sorghum grain that relate to food quality. The lack of information and the wide diversity in the preparation of traditional sorghum foods contribute to the lack of progress in sorghum-breeding programs for food grain quality.

We have evidence that the stickiness or consistency of a sorghum flour-water gruel is related to grain hardness. We consistently find that a soft grain produces a very sticky gruel whereas, a hard grain gruel is less sticky and firm. Preliminary evidance from an investigation of sorghum starch and its polymeric components indicates that gruel stiffness is controlled by the molecular size of the starch components found in the grain. That is, hard grain generally contain starch components of higher molecular weight than those found in soft grain. Thus, accounting for the fact that hard grain produces a stiffer gruel than soft grain.

Sorghum A lines used for commercial hybrid production have a relatively narrow genetic base. Seventy-five A-B line pairs have been developed from two random-mating sorghum populations. The objective of this study was to determine if significant variation exists among the B lines for yield, days to half-bloom, plant height, and/or lodging. Selection for these traits will be worthwhile if significant variation exists between lines. A randomized complete block design was used, and the agronomic traits were evaluated by the variance components, frequency distributions, and correlations between traits. The B line families differed significantly for each trait measured. Tall plants tended to have high yields; significant positive correlations were also seen between yield and lodging, and plant height and lodging. The significant variation observed for the traits measured indicates that development of A and B lines through population improvement can add genetic diversity not available in present A lines used for hybrid production.

A striga tolerant line from Purdue has been identified by Gebisa Ejeta (ICRISAT) in Sudan. The line (P-967083) appeared striga free in 3-row plots in both reps of a uniformly striga infested field in Kadugli, Sudan in 1981. Field observations at three Sudan locations in 1982 confirmed the striga tolerance of P-967083. General agronomic qualities of P-967083 are also good. Seed has been distributed to ICRISAT (Lee House) and Texas A&M (Darryl Rosenow) for confirmation and further studies. Crosses are being made by Purdue with elite SEPON lines during the 1982-83 winter season at Cali, Colombia (CIAT). Seed is available to all cooperators upon request.

A drought tolerant line has been identified in the Purdue International Food Grain Trial by the ARC/ICRISAT program in Sudan, and by the FOA/Kenya Dryland Program in Muchakos, Kenya by Dr. Felix Pinto. The line is designated P-898012 and seed has been distributed to ICRISAT (Lee House). Seed is available to all cooperators upon request.

SUMMARY:

Title: Enhancement of High-Tannin Sorghum Utilization

Project Number: XII PRF-4 (Biochem.)

Project Leader: Dr. Larry Butler, Biochemistry Department, Purdue University.
Co-Principal Investigator: Dr. John Rogler, Professor of Animal Science, Purdue University.

In our attempts to alleviate the "tannin problem" (the antinutritional effects of dietary tannin) we have developed several promising leads in the past year. For the first time we have some evidence that the components which are harmful may not be the same components which confer the agronomic benefits such as bird resistance. Thus there is some hope that the harmful nutritional effects associated with tannins can be eliminated without loss of the beneficial agronomic effects. We hope to find lines which lack the capacity to convert the short, apparently non-toxic tannin molecules to the longer forms which are nutritionally harmful. We also hope to find treatment conditions which prevent the formation of the harmful molecules. We find that high-moisture high-tannin sorghum is even more readily detoxified by our ammoniation process than is the dry grain. Ammoniation might be used to simultaneously retard spoilage of high-moisture grain and detoxify the tannin in it. Ammoniation of silage made from high-tannin sorghum should improve its nutritional value.

We have demonstrated that feeding high-tannin sorghum to chicks increased the activity of UDP-glucuronyl-transferase in chick liver, but not in rat liver. No differences were seen in the histology of digestive tract tissues from chicks fed low and high-tannin sorghum. Total glucosamine and sialic acid excretion in the feces were increased in rats fed high-tannin sorghum as compared with those fed low-tannin sorghum. Hypertrophy of the parotid gland of rats was noted with rats fed high-tannin sorghum with a concomitant increase in proline-rich protein. Increasing the total nitrogen in the diet with intact protein overcame much of the detrimental effects of high-tannin sorghum on chick growth, whereas a similar increase in total nitrogen as crystalline amino acids did not.

With our collaborators we are exploring a wide variety of sorghums which have been reported to be bird resistant, some of which should have good nutritional value. We are coming closer to a chemical characterization of the genetically defined tannins and related materials. We culture sorghum cells under conditions where they produce tannins and related materials, permitting us much more freedom in studying tannin metabolism than if our only source of tissue is developing seeds on intact plants.

November 1, 1982

Summary - Annual Report
INTSORMIL

Purdue University

Project PRF-5

Project Title: Pricing, Policy and International Trade Constraints on Sorghum and Millet Production and Utilization in Developing Countries

Principal Investigators: Robert L. Thompson and Philip C. Abbott, Associate Professors, Department of Agricultural Economics, Purdue University

Summary:

This project emphasizes the implications of agricultural policy and the international trading environment on millet and sorghum production and consumption in countries where they are imported. Economic models of the agricultural sector are utilized to examine the incentives which accompany policy and the likely consequences of those incentives. This work is intended to give INTSORMIL scientists insights into the economic forces affecting the technological alternatives they are investigating and will bridge the gap between farming systems research, which is investigating individual on farm behaviors, and national markets and policy, or macroeconomic behavior. Our hypothesis is that policy affecting international trade of substitute commodities and overall economic policy are as important as agricultural policy directed at millet and sorghum in this evaluation.

Two research thrusts involving work in African countries are included as part of this project. Our initial efforts have been aimed at establishing a cooperative research effort with the Department of Rural Economy, University of Khartoum, Shambat, Sudan. Michael Roth, a Research Assistant with this project intends to go to Sudan as part of that venture to investigate policy issues relevant to millet and sorghum technology adoption. We will also recruit a student to conduct a similar research project in a French speaking West African country. Thompson recently travelled to West Africa to begin that effort and identify important research issues. Other collaborative ventures to complement this work with the IFPRI/ICRISAT/IRAT project, Purdue's Niger Cereals Research Project, and Purdue's Upper Volta Cereals Research Project are also planned in West Africa.

Two initial reports present preliminary results from this relatively new project. The World Sorghum and Millet Economy documents and describes recent trends in the role of sorghum and millet in cereals production, consumption and trade and relates observed changes in cereals imports to changes in millet and sorghum supply and utilization. It provides necessary background information both to this proejct and to other researchers interested in the role played by millet and sorghum in the world cereals economy. The Effects of Alternative Food Security Policies on the Nigerien Cereals Sector: A Stochastic Simulation Analysis, by David Bieber is a master's thesis investigating the issues of food security for a country whose diet is largely based on millet and sorghum. It examines alternative policy options to protect rural and urban consumers in the face of uncertain production and uncertain international prices. The design of international trade policies to achieve stability in consumption levels is compared to alternatives involving domestic stockpiles of grain held by the Nigerien government.

Purdue University

Project No.: PRF-6

Title: Studies on the Mechanisms of Disease Resistance and Susceptibility and Screening for Improved Resistance to Fungal Pathogens with Emphasis on Colletotrichum graminicola (Anthracnose).

Project Leader: H.L. Warren

Summary:

Sorghum cultivars were evaluated in the greenhouse for resistance to Colletotrichum graminicola. The essential requirements for a successful test are to have plant 25 days or older, a temperature of 22 C or above, and a virulent isolate. The problem encountered with assaying sorghum seedlings younger that 25 days old reflect level of hydgrogen cyanide (HCN) which may be toxic to many organisms. After 25 days the HCN was below the toxic level. Thus, plant age is a critical factor for lesion development in sorghum seedlings.

Colletotrichum graminicola and other pathogenic fungi survived on sorghum grain for 28 months at 4 and 24 C. The effect of seed treatment on the percent emergence and blighted seedlings were significant for infected vs non-infected seeds, seed treatment vs no seed treatment and among cultivars. The effect of seed treatment on grain yield was significant for infected vs non-infected seed.

From August 23, to October 14, 1982, I consulted with EMCIP scientist on leaf blights and long smut. Information gained and contacts made should be helpful to the INTSORMIL Program in Egypt and Sudan. Participation in planning and initiating the sorghum workship in Sudan in November 83 is anticipated.

INTSORMIL ANNUAL REPORT

INSTITUTION: Texas A&M University PROJECT NO.: TX-21

PROJECT TITLE: Breeding for Productivity

PROJECT LEADER & INVESTIGATORS: F.R. Miller, Leader; W.R. Jordan, P.G. Morgan, and R.A. Creelman, investigators.

SUMMARY:

The sorghum maturity genotypes are allowing us to understand how photoperiod and night temperature influence flowering, morphology, and yield. This past year we have determined that genotypes that appear high in gibberellins possess the ma_3^R allele and are early (photoperiod and thermoperiod insensitive), are "grassy", tall plants with tall leaf sheaths and reduced leaf areas and are markedly low in yield. Previously we found that genotypes which have high levels of auxin are dominant Ma_1 Ma_2, are late, are "corn like", shorter plants with shorter leaf sheaths, larger leaf areas and are higher in yield. In the coming year we will go into more debth to determine how night temperature and the temperature at the day/night transition are involved in the flowering and yield behavior of the maturity genotypes. By learning how each of the maturity genes interacts with photoperiod, temperature and elevation (presumably this greatly influences the pattern of temperature cycles, i.e. the speed of cooling down at night after sundown) and identifying the maturity gene complement of breeding lines, we should be able to instruct plant breeders on how to custom make a hybrid for a given environment in an LDC. We can also determine how to identify the proper maturity genotype to carry improved characters (disease resistance, insect resistance, drought tolerance, etc.) into existing varities in LDC's with the least delay. Our work will begin the mesh with the information Dr. Fred Miller is developing on tropical adaptation. We should soon begin to reconcile the relationship of the maturity genes studied by Quinby and the phenomenon of tropical adaptation discovered by Dr. Miller.

By using reasonably simple laboratory methods mechanisms which maintain productivity under drought has emerged. Epicuticular wax (EW) varies significantly among genotypes. EW loads increase under hot, dry conditions and are not closely related to rainfall. Heritability of EW was 36% and females contributed 75% of the genetic variance. Tx430 and Tx623 were the best inbreds in increasing EW loads, while Tx7078, Tx7000 and A4R decreased EW loads in hybrids.

Sorghums which have high base temperatures do not transfer readily to tropical environments. Tx623, Tx430, TAM428, ADN55, 77CS1, 77CS2, 74CS5388, 76CS478 and 76CS490 have been identified as superior inbreds possessing low base temperatures, high number of kernels per panicle, non-senescence and wide adaptability. Early generation breeding materials involving these materials have been distributed to cooperating linkages along with F_1 hybrids for yield evaluation. Training programs with graduate students, workshops on grain quality characteristics and elite germplasm have formed a strong link to this project.

NSTITUTION: Texas A&M University

'ROJECT NO.: TAM-22

'ROJECT NAME: Breeding for Disease and Drought Resistance and Increased Genetic Diversity

'ROJECT LEADER & INVESTIGATORS: D. T. Rosenow, Leader, Roberta H. Smith, Investigator, . W. Wendt, Investigator, L. E. Clark, Investigator, and K. F. Schertz, Investigator

UMMARY 1981/82

he disease resistance breeding program continued to provide new disease resistance ources in improved agronomic types to the disease trials and standard disease tests sed by the Pathology project. Many of these are distributed internationally. Several reeding and converted lines were identified in Puerto Rico as having excellent anthrac- ose and rust resistance. An anthracnose resistant random mated population (GPT-2) eveloped cooperatively with Georgia and Puerto Rico was released. Emphasis was placed n selection of tall, white seeded, food type sorghums for potential use in LDC's. A arge amount of disease resistant and high-yielding germplasm was planted in Honduras or evaluation. Thirty lines, many of sources of disease resistance (downy mildew, rain mold, anthracnose, head smut, head blight, leaf blight, charcoal rot, rust, gre eaf spot and MDM) were selected for release.

ne field screening drought breeding program in West Texas identified several new con- erted sorghum lines with good drought tolerance. Breeding selections possessing high evels of pre-flowering drought tolerance with sources of high yield potential in heir pedigree were identified. The line B35-6, appears to be the best source of ost-flowering drought tolerance. Selected lines and hybrids were evaluated under a ne source sprinkler system with good differential in yield and lodging response. rainout shelter provided good differential reaction to moisture stress. In Sudan re- and post-floweirng drought stress performed very well. The line B35-6 and its 'brids were particularly outstanding. At El Obeid, under sandy soil and marginal oisture, several Texas lines identified as possessing pre-flowering drought tolerance owed outstanding promise.

enty-four cytoplasms from the converted lines have been found to induce male steril- y. Two cytoplasms from among the group have been determined to differ from milo in erility response. One of these has been released as A2 and the other is being pro- sed for release as A3. Selection on aluminum and sodium chloride-containing media owed levels of salt in the medium, and that there are differences amoung lines. ants have regenerated from IS3620C of the Margaritiferum group on both sodium loride and aluminum-containing media.

senow presented papers at the Latin American Disease Short Course at CIMMYT, the wny Mildew Workshop at Corpus Christi, and the International Symposia, "Sorghum the 80's", and "Sorghum Grain Quality" at ICRISAT. He also traveled to Mali, dan and Honduras to work with local scientists and develop plants and coordinate ant breeding collaborative research. Wendt traveled to Mali to evaluate the soils oratory.

PROJECT NO.: TAM 25

PROJECT TITLE: Breeding for Insect Resistance and Efficient Nutrient Use

PROJECT LEADER: Gary C. Peterson INVESTIGATOR: Arthur B. Onken

Insect Resistance

A midge resistant line derived from AF28 was released and distributed. New lines scheduled for release contain resistance from three additional sources - SC237, SC414 and SC424. F_1 hybrids combining different sources of resistance possessed a higher level of resistance than either parent, indicating a complementation of resistance. Work is underway to produce early maturing tropically adapted female lines with high levels of midge resistance. New greenbug releases contain resistance to biotype C. Selections are being made to produce agronomically improved tropically adapted biotype E resistant lines. Resistance from any of the four lines identified as possessing biotype E resistance is being utilized.

Collaboration with scientists in Egypt, Mexico and Honduras has resulted in significant technology transfer and sound cooperative associations. Midge resistant nurseries and specific tests were supplied to scientists in Mexico. Insect resistant sorghum lines were supplied to the Texas/INTSORMIL scientist stationed in Honduras. Insect resistant germplasm was also supplied to cooperators in Sudan, Mali, Uruguay, China, Argentina, Botswana, India, Venezuela and Taiwan.

Efficient Nutrient Use

Five elite breeding lines were identified for potential use in breeding for nitrogen use efficiency. The superior lines - SC630-11E, MR4(4606), R6956, Tx2536 and BTx623 - each possess other outstanding characteristics in addition to nitrogen use efficiency. Three lines - Tx2536, SC414-14 and SC175-14 - were superior in greenhouse nutrient culture screening for P use efficiency. An inverse relationship was found between P concentration in the leaf tissue and P use efficiency (R^2 = 0.99). Nitrogen use efficiency increased with decreasing N concentration in the nutrient solution.

A. B. Onken served as team leader in the signing of a Memorandum of Agreement between INTSORMIL and the Institute of Rural Economy of the Malian Ministry of Agriculture. Malian breeding material and soil samples are being evaluated in Texas. Equipment and technical assistance has been provided to Malian scientists for use in drought research. Dr. Charles Wendt and Dr. A. B. Onken evaluated the soils laboratory at the Sotuba, Mali, experiment station. Arrangements were made for Dr. Oumar Niangado and Mr. Mamadou Keita to visit research locations in the United States. Within the next few months a convention should be signed to allow for full-scale operations.

PROJECT TITLE: Sorghum and Millet Pathology PROJECT NO.: TAM24

PROJECT LEADER & INVESTIGATORS: R. A. Frederiksen, G. Odvody, R. W. Toler J. Craig, & L. Reyes

SUMMARY:

The project objectives are designed to identify sorghum lines and hybrids resistant to most of the internationally important diseases, secure genetic information needed to use these resistance in sorghum improvement programs and determine the vulnerability of sorghum to new strains of the pathogens causing these diseases.

INTSORMIL disease nurseries including the International Disease and Insect Nursery, Sorghum Downy Mildew Virulence Nursery, Downy Mildew Resistant Converted Line Test, Uniform Head Smut Nursery, Converted Line Anthracnose Test, International Sorghum Anthracnose Virulence Nursery, and International Sorghum Virus Nursery were grown cooperatively at key sites in Argentina, Brazil, Colombia, Egypt, France, India, Mexico, Philippines, Sudan, and Venezuela. A data logger for acquisition of remote weather data was placed at Ocotlan, Mexico in conjunction with collaborative sutdies on disease progress and yield losses.

A sporulation technique for *C. sorghi* was sufficiently improved to provide inoculum for successful greenhouse and field inoculations. Propagule isolation techniques for soil are of sufficient accuracy that they are being evaluated in quantitation of soilborne propagules of several sorghum pathogens including *P. sorghi* (oospores). Previously undescribed sheath blights of sorghum caused by *G. sorghi* (grey sheath blight) and *S. rolfsii* (pink sheath blight) were observed in Texas and the latter also in Puerto Rico. Metalaxyl continued to be an effective seed treatment to control SDM; another systemic fungicide, fosetyl-Al (Aliette), controlled SDM when utilized as a seed treatment at rates of 10 times greater than metalaxyl (5.0-10.0 g a.i./kg).

The antiserum program is growing and requests are world-wide. The study on inoculation with airgun demonstrates that genotype response was uniform under various virus concentrations and pressures in that the ranking from susceptible to resistant remained unchanged. In Mexico MDMV was the most prevalent virus in 1982, however, SCMV was detected. This will necessitate incorporating resistance to both MDMV-A and SCMV.

The new biotype of greenbug was a vector of MDMV-A and MDMV-B. It is more efficient than the old biotype C and the winged forms were less efficient than the non-winged aphids.

Sugarcane Mosaic Virus Strain H (SCMV-H) was found naturally infecting sorghum in South Texas and PAG 3387 was observed to be a differential host for SCMV-H and MCMV-A.

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

PROJECT NO.: XII TAM 25

PROJECT LEADER & INVESTIGATOR: George L. Teetes and Frank E. Gilstrap

Summary:

Graduate students who have completed degrees under this project have returned or are employed as entomologists in Colombia, Sri Lanka, Equador, Honduras, and Venezuela.

The development and evaluation of sorghum midge resistant sorghums has provided an insect management tool that compliments improved production of sorghum in Latin America and parts of Asia and Africa. Midge and aphid resistant sorghums are susceptible to shootfly and stemborers. Knowledge of the levels of resistance, economic injury levels, and antibiosis, efficacy is sufficient to describe the role of midge resistant sorghums in developing country ecosystems. Knowledge of the biotic and abiotic factors governing the population dynamics of sorghum midge have led to the employment of simulation models that will assist LDC entomologists in assessing the seasonal abundance of the pest which is critical to the development of integrated pest management systems.

The determination of the nature and intensity of damage to sorghum by species of panicle bugs prevalent in the Americas, and the development of appropriate statistical analysis to establish economic injury levels has provided the methodology for LDC scientists to deal with the problem of panicle bugs in tropical Asia and Africa where these types of insect pests are now most severe.

Collaboration with LDC entomologists has developed a line of communication for the effective transfer of technology for developing sorghum insect integrated pest management strategies. Extensive collaboration with ICRISAT entomologists had led to the development of a Sorghum Insect Identification Handbook that will be extremely valuable to LDC personnel involved in sorghum research, extension, or production.

Progress is being made to obtain background information necessary to assure successful exchanges of biological control agents between the US and LDC's for control of stemborers, aphids, sorghum midge, and spider mites. Graduate student training programs are presently contributing towards improved understanding of biological control mechanisms and agents and towards training students from LDC's to conduct independent biological control programs in their home LDC.

INTSORMIL ANNUAL REPORT

July 1, 1981 to June 30, 1982

INSTITUTION: Texas A&M University PROJECT NO.: TAM-26

PROJECT TITLE: Food and Nutritional Quality of Sorghum

PROJECT LEADER: Dr. L.W. Rooney, Professor

INVESTIGATORS: Dr. J.M. Faubion, Asst. Professor
Dr. M.M. Morad, Research Associate
Dr. M. Roushdi, Visiting Professor, Food Science and Biochemistry, Tanta University, Egypt

SUMMARY:

The existing information on grain quality of sorghum was discussed and evaluated at the first International Symposium on Sorghum Grain Quality which was jointly sponsored by INTSORMIL, ICRISAT and ICAR. The conference was organized and the proceedings edited by L.W. Rooney and D.S. Murty. It was a direct output of two years of international testing of sorghum quality among collaborators in India, Africa, Canada, U.S.A., Mexico and Denmark. Many young scientists participated.

A food quality workshop for Central American and Mexican scientists was jointly organized by INTSORMIL-ICRISAT/CIMMYT and INIA. The 80 participants were provided with lectures and practical hands on lab and field experience in evaluating sorghums via simple techniques. L.W. Rooney and V. Guiragossian, ICRISAT-CIMMYT cochaired the workshop.

Twelve graduate students were associated with the project. Three M.S. theses were completed and two Ph.D. dissertations were nearing completion. A major part of the research is being conducted by graduate students from African and Latin America. Dr. Da (Upper Volta) and Dr. Akingbala (Nigeria) will return to their national programs soon.

The project leader spent a total of 9 weeks in international travel related to this project. Eight publications and 23 presentations at workshops, symposia and conferences were made. The proceedings of the Sorghum Quality Symposium and Sorghum Workshop were coedited. More than 48 international visitors were hosted in the Cereal Quality Laboratory and numerous requests for information on sorghum utilization were answered.

Major progress was made in evaluating sorghum quality for Tô and tortilla production. It included relatively simple tests to predict quality in breeding programs and the development of relatively simple technology to produce improved tortillas through a combination of better processing with improved sorghum cultivars. The significant effects of environment, variety and pH level on Tô quality and their role in developing new cultivars of sorghums with acceptable food quality has been shown.

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