



PD-ABB-249  
67000  
INTERNATIONAL SORGHUM/MILLET

**INTSORMIL**

Collaborative Research Support Program

**Collaborating U.S. Institutions**

Kansas State University  
University of Kentucky  
Mississippi State University  
University of Nebraska  
Purdue University  
Texas A&M University

**Collaborating Host Country  
Institutions**

ARC - Sudan  
DOA - Botswana  
ICA - Colombia  
INRAN - Niger  
Recursos Naturales -  
Tegucigalpa, Honduras  
IER - Mali  
ISRA - Senegal  
ITA - Senegal

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**INTSORMIL**

**Triennial**

**External Evaluation**

**Panel Review**

**(EEP)**

***Fighting Hunger with Research ... a team effort***

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**INTSORMIL**

**EEP**

**TRIENNIAL REVIEW**

**Section I.**

**1988 Site Review of U.S. Participating  
Institution Programs.**

## INTSORMIL EXTERNAL EVALUATION REPORT - 1988

July-September, 1988, reviews of all U.S. INTSORMIL programs were conducted and discussed by External Evaluation Panel (EEP) members with some 23 individual project evaluations to be found in the appendix of this report. This review essentially covered progress through year 9 of the CRSP which ended June 30, 1988. Previous reviews available for reference include 1980, 1982, 1984, 1986, and on-site reviews as recently as 1987. Since country reviews comprise most of the 1986-87 reports i.e. Mali, Niger, Honduras, and Botswana, most of the attached report deals with projects at the five primary U.S. institutions, namely Kansas State University, Mississippi State University, the University of Nebraska, Purdue University and Texas A&M University. Reviews and those participating were as follows:

**Texas A&M University**                      **July 11-15, 1988**

**College Station/S. Texas**

Dr. Glenn L. Johnson, Team leader  
Dr. N.G.P. Rao  
Dr. Ricardo Bressani  
(Yohe and Schilling of ME)

**University of Nebraska**                      **Sept. 12-14, 1988**

**Lincoln**

Dr. Clarence Gray, Team leader  
Dr. Orrin Webster  
(Yohe of ME)

**Kansas State University**                      **Sept. 15-16, 1988**

**Hays/Manhattan**

Dr. Bruce Maunder, Team leader  
Dr. Clarence Gray  
(Yohe of ME)

**Mississippi State University**                      **Sept. 15-16, 1988**

**Starkville**

Dr. Glenn L. Johnson, Team leader  
Dr. N.G.P. Rao  
(Schilling of ME)

**Purdue University**                                      **Sept. 19-21, 1988**

**West Lafayette**

Dr. Bruce Maunder, Team leader  
Dr. Ricardo Bressani  
Dr. Glenn L. Johnson  
(Yohe of ME)

**Texas A&M University**                                      **Sept. 19-21, 1988**

Dr. Clarence Gray, Team leader  
Dr. N.G.P. Rao  
(Yohe of ME)

Unfortunately, an original and current team member, Dr. Brhane Gebrekidan, was unable to participate in the 1988 review due to an accident. We, however, greatly appreciate the assistance given by his replacements, Dr. N.G.P. Rao and Dr. O.J. Webster, both outstanding sorghum scientists.

The beginning of the year 10 appears to be a new phase and certainly a period of opportunity for this CRSP to (1) put its many INTSORMIL accomplishments to use and (2) restructure itself for maximum future accomplishments. By encouraging more involvement in host country planning and priority setting, the PI's have promoted collaborator enthusiasm and progress. More qualified collaborators are also the result of extensive training efforts the first nine years. Activity with *Striga* continues to increase and we applaud the Board for dedicating more funding to solving this costly weed problem of Africa and Asia. Two positive developments include: biochemical results on *Striga* germination by means of a sorghum root exudate, sorgolene, and the able work on resistant strains conducted by graduate student (Dale Hess). Finally, we see a significant shift out of areas of the world in which sorghum is limited into regions of greater economic opportunity. Market development research is now needed. Also, possibilities exist for using INTSORMIL in the Lake States and in the Southeastern part of the U.S. to develop new phases of the sorghum industry in the U.S.

In recent years, INTSORMIL has brought the objectives of its social science efforts into line with its limited funding of such work. The result is a smaller, but more relevant and leaner, social science component that is generating useful information on the relevance of different kinds of sorghum and millet technologies in specific on-farm environments.

This evaluation looks first at accomplishments and then at constraints and opportunities. Finally, given the constraints and opportunities, the EEP's recommendations are presented.

### Accomplishments

Key changes and progress following the last review have been noted in the preceding paragraph. However, some broader generalizations about accomplishments are pertinent. The prime site/global plan concept that is continuing to build is a wise route to follow especially under reduced funding. The effective SADCC (Southern Africa Development Coordination Conference) training program brings overseas monies into the CRSP while the conventional INTSORMIL student programs continue to increase the available pool of collaborators. The germplasm/technology transfer must certainly be considered an important success. So too, are the productive workshops and such publications as the food quality manual for West Africa. Inter-institutional as well as multi-disciplinary cooperation and team efforts continue to illustrate how PI objectives successfully channel personal ambitions and needs for recognition into highly productive and well coordinated group outputs. Generally and most importantly, U.S. inputs overseas have been kept at levels that can probably be sustained should US/AID be forced to pull out. Another accomplishment is improved understanding, often from basic, relevant research in such disciplines as biochemistry, of the biological limitations to sorghum and millet around the world.

The collaborative Research Support Projects (CRSPs) are an important U.S. institutional innovation now being emulated by Australia and West Germany. Unfortunately, this valuable way of organizing agricultural research is now being "whittled away" in AID budget processes to the extent that it is in danger of becoming AID's latest forgotten "fad." As one of the very successful CRSPs, INTSORMIL has an important story to tell. Combined with stories from other CRSPs, the INTSORMIL story can be used outside of AID's project planning and budgetary processes to help build broad support for the CRSPs in scientific, political, academic and industry circles.

An important factor contributing to the ongoing support of the International Agricultural Research Centers (IARCs) is the analytical evaluation work done outside that system to assess its productivity. Some of the CRSPs now have histories long enough to permit similar quantitative-qualitative assessments of their performances and potential contributions. Such assessments would help open new, highly legitimate, public relations channels and financing opportunities for INTSORMIL and the CRSPs. These opportunities should not be missed.

The following subsections deal with more specific accomplishments in subject matter areas involving sorghum and millet:

**Agronomy/Physiology:**--Through INTSORMIL research, nine water stress-resistant sorghums have been released and are being tested in Niger. Water and nitrogen availabilities are major bottlenecks to increasing sorghum and millet production in developing nations, especially in food-deficit nations of Africa. This is significant progress, given the period of operation of INTSORMIL. Further, INTSORMIL research has shown clear improvements in nitrogen availabilities and increased water use efficiency when sorghum is intercropped with cowpeas and/or grown in rotation with cowpeas. These research results show that there are excellent opportunities to significantly increase sorghum and millet production in the difficult environments of Asia, Africa, and Central and South America through the use of water and fertilizer nutrients and stress-tolerant genotypes used alone or in combination with certain agronomic practices. A case in point is identification of genotypes that can be productive on high aluminum soils where few crops can now be successfully grown. The basic research on sorgolene, an exudate from sorghum that triggers *Striga* seed germination, promises to produce agronomic recommendations to help control that parasitic weed in Africa. On-farm economic research in Niger continues earlier Burkino-Faso research on agronomic practices to produce important results for conserving water and making effective use of fertilizer in West Africa.

**Plant Breeding:**--Cooperative efforts in the area of sorghum breeding have furnished data and breeding materials valuable to producers in the U.S. as well as in the less developed participating countries, some of the more prominent being:

- a. The release of Hageen-Dura 1 sorghum hybrid in Sudan and Sureno for some Latin American situations;
- b. The development and release of lines highly resistant to midge that can be used by public and private agencies all over the world; further contributions to the understanding and incorporation of resistance to various biotypes of greenbug; and the development of integrated insect management strategies for sorghum pests;
- c. Significant contributions towards the incorporation of high levels of host plant resistance to the prevalent diseases and the development of disease management strategies (see pathology below);
- d. The development and release of Al-tolerant A, B, and R lines and promising advance generation progenies for the acid soil situations of Latin America;

e. A better understanding of the processes governing productivity, nutritional quality, and responses to the various kinds of stresses encountered;

f. Training of graduate students with exposure to applied problem situations in their respective countries as well as to basic science aspects. Such students will eventually provide the personal and scientific linkages as collaborators at the prime sites.

The above accomplishments are ongoing and hence indicative of opportunities to be exploited.

**Entomology:**--The midge screening nurseries in Texas have made important contributions to the development of the midge resistant varieties reported as "item b" under **Plant Breeding** above. Materials are also screened for head bug resistance in Niger. Entomological studies at Texas, Mississippi and in Africa of stem borers, the sugar cane aphid, the fall armyworm, and millet head girdlers have increased knowledge of pest life cycles, the population dynamics of pest parasites and the damage done by pests as conditioned by plant characteristics. Such studies contribute to breeding programs and the development of integrated pest management programs of which the release and establishment of *Cotesia flavipes* (a stem borer parasite) in Honduras is an example.

**Food Quality and Nutrition:**--The review of the different projects under the area of food quality and nutrition revealed that significant advances have been made in our understanding of the potentials and limitations of grain sorghums as food and feed. Although this understanding and knowledge is still short relative to that for maize and more so for wheat, such information suggests opportunities to expand the uses of grain sorghum and is removing it from the category of the "poor man's food." Accomplishments may be divided for purposes of presentation into basic and applied.

a. Among the important basic results, which can be applied are those on tannins and phenols; the detailed study of proteins during grain development and in the mature grain; the roles of carbohydrates and proteins in the nutritional functions of food products; the important impacts of food processing on protein digestibility; the possible association of the low digestibility with protein fraction III; and the protein differences between the hard and soft endosperm to mention a few.

b. Accomplishments on the applied side include: the use of sorghum flour to extend wheat flour; the sorghum quality laboratory manual on methods for physical, chemical, and food quality analysis; the development of sorghum food products for Latin America and Africa; the development of parboiled sorghum to be consumed similar to parboiled rice; factors affecting food quality and acceptability of sorghums; and high quality foods (including fermented products) made from sorghum and

food legumes. Increased knowledge of the break-down of tannins after treatment with ash is also important.

**Biochemistry:**--Important basic biochemical accomplishments by INTSORMIL include new knowledge and understanding of the synthesis of cytokinins as a way to increase resistance to charcoal rot; sorgolene as a potential *Striga* germination stimulant/inhibitor; flavan-4-ols and/or precursors in weathering; polyphenols and bird resistance; osmolytes for drought resistance; tannins or other biochemical compounds for storage resistance as they have recently been studied for beans; and chemical substances which aid against midge.

**Pathology:**--Regional disease nurseries have been developed to screen exotic varieties in southern Africa. Disease surveys and studies have been conducted for charcoal rot, sooty stripe, leaf blight, anthracnose and sorghum viruses in southern Africa. These and other results contributed to the successes reported above under **Plant Breeding**, "section c."

**Socioeconomics:**--In 1983, INTSORMIL social science work was extensive, underfinanced and, in some instances, of questionable relevance. What is left is relevant and well focused with financing at levels appropriate to the remaining project. Substantial accomplishments have been attained by rural social scientists in farm-level technology assessments in Niger and Burkina Faso. While these assessments are superior to those commonly used in administering and planning INTSORMIL agricultural research, difficulties still exist with respect to data quality and the logical structures of assessment models. Present work indicates that water conserving and fertilization practices are important in the adaptation of INTSORMIL technologies. This work complements the plant breeding work on the development of stress resistant varieties of sorghum reported above in **Plant Breeding** "section e" while also increasing millet yields.

## Constraints

Farmers, INTSORMIL administrators, and researchers encounter more than biological and physical constraints to sorghum and millet production. One such constraint is budgetary; other constraints involve poor institutions, inappropriate policies, undeveloped markets, lack of trained personnel (collaborators), inadequately developed and maintained natural and man-made resource bases. Also important are social unrest and political and military instability that constrain ongoing production systems and particularly with the introduction of new technologies such as Hageen-Dura 1. Probably, the most severe constraint faced by INTSORMIL is the budgetary one. This constraint is the concern of INTSORMIL's administrators: Its ME, Board of Directors, PIs, and EEP as well as of the administrators of

INTSORMIL's U.S. and international collaborating institutions.

Biological and physical constraints have been the main focus of INTSORMIL's crop and soil science research. Sorghum and millet production is biologically and physically constrained by:

Inadequate varieties for coping with drought, high and low temperature, insects, diseases, and weeds; tastes and preferences; human and animal nutritional (particularly protein components) needs; polyphenol limitations on digestibility and acceptability; and bird damage. These constraints are the concerns of plant breeders.

Diseases such as anthracnose, ergot, charcoal rot, long smut, sooty stripe, *fusarium*, and downy mildew are the concerns of the pathologists. Common domestic and international diseases make it important that pathological research on these constraints be conducted at both domestic and overseas locations.

Constraints of concern to entomologists include: sorghum head bugs, shoot fly, stem borer, greenbugs, armyworms, midge, head girdlers, and sugarcane aphids.

Poor food quality and acceptability traits are of particular concern to nutritionists (both human and animal) and food technologists. Included here are digestibility, protein composition, cooking characteristics and a vast number of other constraints on the usability of sorghum and (to a less extent) millet that influence the welfare of the world's poor and both international and domestic food and feed grain markets. U.S. sorghum producers have a vital stake in the elimination of these constraints.

Market, demand, social and political instability, international trade, human and entrepreneurial, capital (natural and produced) and institutional and related constraints are all important for U.S. and LDC sorghum and millet productivity and utilization. These important constraints are the concerns of rural social scientists.

## Opportunities

Progress reveals additional opportunities and INTSORMIL's progress to date is no exception:

**Agronomy/Physiology:**--INTSORMIL has generated materials and methods ready or near-ready to be used that have a potential for achieving progressive increases

in millet and sorghum production in collaborating countries over the next decade. At this time, there is an opportunity to concentrate INTSORMIL's activities in several priority prime sites for field testing and demonstrating the use of yield-increasing agronomic practices with improved cultivars. INTSORMIL must take advantage of this opportunity which will be noted also under socioeconomics.

**Entomological** opportunities for INTSORMIL include the establishment of a head bug screening nursery in West Africa. Establishment of this much needed facility has been inordinately delayed by administrative and other difficulties in Niger and Mali. There is now danger that AID's budget limits may permanently postpone it. The opportunity to establish this nursery is in addition to continuing the excellent entomological work being done abroad and at such U.S. sites as those in Texas.

Opportunities for pathologists consist largely of a continuation of the present good work with an important exception--a long smut nursery is needed in West Africa for screening new materials for resistance.

**Biochemistry:**--The important biochemistry accomplishments summarized in the earlier section illustrate continued opportunities to exploit the important synergism between basic, more disciplinary research and INTSORMIL's prime concern with the practical objectives of its breeding and related practical supporting programs. Undoubtedly, besides training, the greatest U.S. input will very likely be problem solving of a basic/biochemical nature.

INTSORMIL's basic and applied research results are increasing opportunities for greater use of sorghum as a food and as a feed. The identification of the reason for the low protein digestibility will make it possible to develop better quality human food and animal feeds with greater bio-utilization. This will make it possible to utilize more effectively the high lysine sorghums. Greater understanding of the effects of different methods of food processing will make it possible to incorporate greater amounts of sorghum flour into composite flours for breadmaking. It will be possible, also, to develop better quality weaning foods and foods for pregnant and lactating women and to use higher yielding varieties for producing such traditional foods as basha and tortilla as well as new products to be made in developed countries. With respect to food quality and nutrition, there are extensive opportunities to continue and expand the excellent breeding and food technology work now underway. Work on tastes, preferences, and nutritional values constitutes building blocks for demand analysis and market development work by social scientists.

INTSORMIL's present socio-economic component is sparse and lean to the extent of being almost non-existent.

However, INTSORMIL's successes have generated multiple opportunities for socio-economic work. INTSORMIL's contributions to world and domestic agricultural need to be analyzed on a cost and returns basis. Domestic contributions need analysis to answer potential "Bumpers Amendment questions" that could threaten INTSORMIL's AID funding. Opportunities exist to do feasibility studies for "CRSP-like" activities to help develop sorghum/millet production in the SE states of the U.S. and in more northern, short season regions.

At year 10, INTSORMIL is well positioned to initiate forced-paced increases in sorghum and millet production through applied research at one or more selected prime sites. INTSORMIL now has improved materials and methods which need to be tested/adapted rapidly and made available for use as soon as possible in priority Ecogeographic zones. Such materials and methods can impact production significantly if put to use. The arrangements and resources are available. Adjustments in priorities, operations, and budgets will be required. What is lacking is a specially designed research strategy and the will and sense of urgency to put it into effect. Over the next several years, INTSORMIL has an opportunity to demonstrate the role of its research in accelerating food and agricultural development.

In addition to the biological and physical opportunities for sorghum and millet production are the opportunities to help overcome marketing, institutional, policy, and human constraints on production, distribution, and utilization of sorghum and millet. World developed countries and LDC's and the U.S. domestic food and feed grain markets for sorghum are underdeveloped in view of the great improvements being made in sorghum grain quality. Research, extension, price, input, and production programs are so inadequate as to severely constrain researchers, producers and consumers. Poor national policies and inadequate human development programs are also constraining. Sorghum production and storage are constrained by managerial limitation of LDC producers.

INTSORMIL biological and physical researchers are increasingly constrained by lack of budget just as the CRSP is attaining major capacity to contribute both internationally and domestically. Socio-economic analytical and evaluation research is needed on the CRSP to help overcome these budgetary constraints.

In the AID context there is the constraining danger that the so called Bumpers Amendment (Congressional Record Senate, June 6, 1986) might be invoked to limit expenditures on INTSORMIL's sorghum research even if it is beneficial to domestic producers. As indicated above INTSORMIL has many opportunities to initiate market development, strategic planning, and technology assessment of its own; fortunately much such work can be done cooperatively with rural social science departments

of its member universities and collaborating institutions. Many U.S. rural social science departments are already funded to do the kinds of work required.

## Recommendations

The following are general, rather procedural recommendations. They, like the subsequent, more specific recommendations, are based on INTSORMILs demonstrated or available skills, accomplishments, and the opportunities and constraints considered above:

- a. INTSORMIL must continue to upgrade its overseas linkages to assure maximum productivity, application, and utilization of its results. Effective communication and two-way feed back concerning research activities and problem recognition should be stressed.
- b. A more aggressive approach to funding from within or outside AID resources is recommended. We commend this activity where it already exists.
- c. The EEP must again recommend as much collaborator involvement in planning as possible to insure effective conduct of on-site research. Also, more research activities should be conducted under host country conditions.
- d. Activities of the Technical Committee, the Ecogeographic Zone Council, and the ME need to be coordinated in depth rather than in a peripheral manner. Two or more projects for the same science require effective workplans to attain productivity while avoiding unproductive duplication. These committees should be the best source of recommendations for the PI's and cooperating institution's of INTSORMIL. For example, the EEP sees substantial reasons to include Dr. Wayne Hanna of Tifton, Georgia in INTSORMIL activity; he has an outstanding reputation and record in millet research. Also the EEP has previously suggested Dr. Ronny Duncan of the same state as a logical source of acid soil expertise in sorghum improvement.
- e. While grain storage research within INTSORMIL has been inadequate certainly much has been done by the IARC's which may suggest a greater input now as an economic issue. The same could be said for "value added" input by the CRSP to enhance greater support through appropriate public relations.

*How about tapping into existing networks?*

- f. Formula reduction or expansion of budgets should be avoided. Budget changes should be on the basis of contribution or opportunity for success. Discipline or state bias should be avoided. The need for prioritization is there, the opportunities are great, and no better group of sorghum scientists have ever been assembled into one program.
- g. We encourage basic inputs including **biotechnology** to help solve some of the challenges confronting PI's and collaborators. Programs in place at INTSORMIL institutions or elsewhere, if necessary, may be required for effective progress on topics e.g. acid soil adaptation, disease and insect resistance, and nutritional improvement. h. An effort to present the objectives and accomplishments of INTSORMIL for better seed industry relations is essential. Current opinion by the seed industry suggests INTSORMIL may have diluted U.S. sorghum improvement.
- b. A testing network should be established to enable identification of materials with broad adaptation and high yield, important elements in cooperative programs. Such a network should be designed to promote cooperation between participating scientists and to select materials for further enrichment through incorporation of multiple resistances. Weather and climate related parameters should be incorporated into the network studies. INTSORMIL scientists could look into the establishment of an adaptation network for sorghum. Except for those imposed by maturity genes, genotype alterations diminish the barriers to adaptation *per se*. This was true for the use of hybrids based on combinations of Kafir 60 and similar females, the performance of lines and hybrids based on derived zerazeras, and the use of yellow endosperm caudatums on a global basis.
- c. Whole plant, food grain, and feed grain utilization should receive greater attention in the INTSORMIL programs. Developed countries look at grain sorghums as feed grains and developing countries as food grains. INTSORMIL programs designate breeding nurseries accordingly. The good quality, white grain types, devoid of tannins should be good for both food and feed; they now command a premium in several markets. The use of sorghum grain for direct food use is on the decline in several countries. It is, therefore, necessary that sorghum improvement programs also be oriented towards whole plant utilization of silage, stalks for forage, hay, energy source, etc., and grain for food, feed, malting and other industrial uses. The protein profile of the grain, the digestibility of starch and protein, the brown mid rib, the tan plant, etc., are all compatible and amenable for breeding to fill specific needs.

**Agronomy/Physiology:**--The EEP suggests that:

- a. INTSORMIL should select priority prime sites for testing and demonstrating the use of improved agronomic practices with the improved cultivars being produced by INTSORMIL.
- b. Increased physiological research will benefit both millet and sorghum improvement.

**Breeding:**--The EEP recommends the following:

- a. INTSORMIL should critically assess the current status of its germplasm utilization and the breeding methods it employs to devise ways and means of attaining further breakthroughs in qualitative and quantitative improvements of sorghum. Our understanding of the genetics of height and maturity genes, the discovery of cytoplasmic-genetic male sterility, and its exploitation in developing commercial hybrids, and the use of tropical germplasm through the conversion program are considered the major milestones that have contributed to progressive qualitative and quantitative improvements in sorghum production and productivity. In recent years, the zerazeras and the yellow endosperm caudatums, in particular, have contributed a large share of the advances in quality as well as yield.
- d. Pearl millet breeding programs in the U.S. universities should have a strong orientation towards disease resistance, particularly downy mildew and ergot. Since these diseases are not serious in the U.S., experiment station research may concentrate on basic aspects including biotechnological approaches with emphasis on field screening at overseas prime sites.
- e. As India has vast acreages of sorghum and millet, it is recommended that INTSORMIL develop cooperative research projects with the Indian National Program. Some suggested areas for cooperation are food and feed quality, alternative uses, cytoplasm, apomixis, head bugs, ergot, and drought, etc. Both basic and applied aspects could be included.

- ICRISAT  
IPBGR
- f. An organized effort at germplasm collection, evaluation, maintenance and distribution should be established within INTSORMIL. This obvious ingredient in a total effort for sorghum/millet improvement will result in a closer, more appreciated support from the seed industry and will make INTSORMIL more effective.

**Entomology:**--For this discipline the following recommendations are made:

- INTSORMIL should supplement its effective U.S. insect screening nurseries with a head bug nursery in West AFRICA.
- continue the excellent work being done at Texas.
- reorient the entomological work at Mississippi to major insects of the Southeastern U.S. and to millet as well as sorghum.

**Food Quality and Nutrition:**--A number of specific recommendations follow:

- INTSORMIL should research and study storage facilities to decrease grain damage; the factors responsible for resistance to insect attack (see next section) in storage; the effects of storage on function and nutritive value of sorghums in the diet using more in vivo nutritional evaluations of both highly productive varieties and processed sorghum foods. It is important to include storage studies in the research program as they are an important component for LDC food chains.
- High grain production should not be achieved at the expense of lost nutritive value. Also, processing may easily affect biological value. There is need to implement some of the technologies which have been developed, for example, "par-boiled sorghum" to be used as with rice.
- Other food products from sorghum should be developed besides those already known, with attention to the bioavailability of such nutrients as oil, mineral and vitamins.
- Non-food uses for sorghum should be researched--for example, the use of sorghum as a source of starch would leave the germ available as a by-product for oil extraction.

**Biochemistry:**--INTSORMIL should continue and expand its emphasis on basic biochemical and biotechnological research of known and suspected relevance for INTSORMIL's applied objectives for sorghum and millet. Such work has contributed substantially to INTSORMIL's important successes to date (see ac-

complishments) and is expected to make increasing contributions in the future. It is reasonable to expect such research to be supported from central university sources, the NSF, as well as the US/AID and the experiment stations. There is synergism between basic disciplinary and plant breeding work that INTSORMIL is beginning to exploit.

**Pathology:**--The following is recommended:

- INTSORMIL's good pathological work for sorghum should be continued in close collaboration with its plant breeders. This work should be expanded to include a long smut screening nursery in West Africa.
- INTSORMIL should emphasize millet diseases with collaborators in millet producing countries.
- The EEP encourages a continued and strong awareness of economic priorities with response often only possible in the collaborating country.

**Socioeconomics:**--It is now time to expand INTSORMIL's social science work. Much of the needed relevant research outlined here can likely be financed outside of regular INTSORMIL funds. INTSORMIL should take steps to initiate rural social science and related research in the opportunity areas mentioned at various points in this report and summarized here:

- possible foreign market expansions for the higher quality feed and food sorghums being more rapidly developed as a result of INTSORMIL's domestic and international collaboration,
- possible domestic market developments for both food and feed grain based on INTSORMIL's contributions to sorghum grain quality,
- the feasibility of further development of sorghum and millet production in the southeastern states of the U.S. with publicly supported research and extension. Both Mississippi and Georgia are interested in developing grain sorghum and millet production in the southeastern states of the U.S.

The above socio-economic recommendations can probably be carried out at low cost to INTSORMIL through collaboration with domestic agencies and personnel having responsibilities and funding for doing such work. Texas A&M, for instance, has an effective Agricultural Economics Department with personnel capable of collaborating with other INTSORMIL agricultural economics departments and industry, including the National Grain Sorghum Producers Association, in doing foreign and domestic market development research. So

do Kansas, Oklahoma and Nebraska, all large sorghum producing states. Such research would help leaders in the domestic sorghum industry such as The National Grain Sorghum Producers Association realize the benefits they are deriving from INTSORMIL, thus legitimately forestalling Bumpers Amendment questions about INTSORMIL's research.

- d. INTSORMIL should also support and help mobilize support for relevant basic, conceptual and theoretical work by economists and other social

scientists researching farming systems, doing technology assessment studies and the adoption of new technologies. Basic descriptive research is needed on, (1) improved measurements of the non-monetary values associated with food quality, food security, family size, environmental degradation, institutional reform and education and the like, (2) managerial processes, (3) ensuring (control of events) as contrasted to insuring and chance taking (adjusting to existing probability distributions).

## Conclusion

INTSORMIL needs to elaborate and publicize their very significant accomplishments. Combined with stories from other CRSPs the INTSORMIL story should also be used outside of AID's project planning and budgetary processes to build broad legitimate support for the CRSPs in scientific, political, academic and industry circles to help overcome funding constraints. Two broad approaches are needed--one by the CRSPs collectively and one by the individual CRSP including, specifically, INTSORMIL. More than the recounting of success stories is needed. There is homework to be done. Current and prospective costs and benefits--nonmonetary as well as monetary and social as well as private--need analysis. While the accomplishments to date have been remarkable their appreciation and recognition has for too long gone mostly unnoticed. Now is the time to put these practices and products in front of LDC producers. Also, now more effort must also be made to secure the understanding and support of the seed industry throughout the world.

INTSORMIL should proceed within its own institutions to first analyze the significance of what has been done, i.e. "situations and outlook" analysis should be done for the different phases of INTSORMIL's biological and physical science efforts--grain quality, insect and disease resistance, cold tolerance, drought resistance, aluminum toxicity tolerance and the like. Second the momentum of what is underway must be described and communicated.

*Correct*

We must describe and effectively communicate prospective benefits and payoffs both for domestic producers and the disadvantaged hungry of the LDCs who depend on sorghum and millet for subsistence. With respect to domestic sorghum producers, the seed industry and U.S. consumers, it is particularly important to document past and prospective accomplishments.

Finally, we of the EEP recognize and value the strong support for INTSORMIL by the Management Entity (Nebraska) and certainly from the Board representing Texas A&M, Mississippi, Kansas, Purdue, and Nebraska. Only with their universal effort and backing could this program have come so far the first nine years yet have so much opportunity to make even greater progress in the immediate future.

Respectfully submitted,

1988 EEP members:

Dr. Bruce Maunder, Chair  
 Dr. Clarence Gray, Vice Chair  
 Dr. Glenn Johnson  
 Dr. Ricardo Bressani  
 Dr. N.G.P. Rao  
 Dr. O. J. Webster

**1988**

**Individual**

**Project Reports**

## KSU-106

### Seedling Vigor and Stand Establishment in Pearl Millet

Principal Investigator: Richard L. Vanderlip

#### Research

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Objectives and work plan. The objectives of this project are sound and realistic. There is no work plan for Year 10 collaboration in Botswana; no LDC activity under this CRSP is scheduled for 1988-89. Operations in Kansas at Fort Hayes and Manhattan are outlined adequately in a satisfactory work plan.</li> <li>2. Implementation. The Kansas component of this program is being implemented satisfactorily.</li> <li>3. Productivity. The project is productive in Kansas.</li> <li>4. Short and long range objectives. The project has short and long range objectives. The short-term objectives are to develop some sort of effective management techniques with local seed types. The long-term objectives are to find and make use of genetic differences.</li> <li>5. Transferability. Genetic materials, research procedures and cultural practices developed in Kansas could be useful in LDC's.</li> <li>6. Integration. The work is not currently integrated in programs in Botswana, but it is integrated in other CRSP activities in Kansas.</li> <li>7. Relevance. The work underway at Fort Hayes and Manhattan is relevant to Botswana, but currently it may have a low priority in that country.</li> </ol> | <ol style="list-style-type: none"> <li>8. USA benefits. The work could be of substantial benefit to US farmers.</li> <li>9. Feedback. Very little at the present time.</li> <li>10. Changes. No changes so far.</li> <li>11. Resources. For present activities which are limited to operations at KSU, resources are adequate.</li> </ol> |
|--|---|

#### Training

The P.I. reports that the project is fairly comfortable with respect to training.

#### Sustainability

Given the current state of collaboration with Botswana, there is question as to whether the initiatives begun in Botswana can be sustained.,

#### Comment:

The interruption of activities in Botswana, leaves this project without an effective, LDC collaborative partner. This situation combined with questions about the priority appropriateness of the research for LDC's raises questions about the direction and future of this project which should be looked into by the Technical Committee and the Management Entity/Office.

## KSU-108

### Bacterial and Fungal Diseases in Sorghum and Millet

Principal Investigator: L.E. Clafflin

#### Research

The research goals far exceed the available INTSOR-MIL funding which suggests that much of the work should be conducted on-site with training, however, possible at Manhattan. There may be concern that the research is too basic, however, this may be the most significant aspect of KS 108 since the serological assay and the heavy orientation in the department to biotech gives necessary basic

science into the CRSP. Staffing is strong and includes a post-doc and a Ph.D. student from Thailand--both on *Fusarium* plus a strong graduate student from Lesotho. Manhattan is a suitable location for much of the disease work but, of course, not useable for field work on long smut, a quarantined disease.

## KSU -101

### Pearl Millet Breeding

**Principal Investigators: W.D. Stegmeier,  
T.L. Harvey, B. Khaleeq**

#### Research

The research goals for both domestic research and overseas collaborators are well conceived with clear perceptions as to opportunities and limitations. Certainly the program has been effective in distributing early maturing, photoperiod-insensitive, female material of a dwarf nature. Breeding in Hays with limited off-station sites and limited winter activity due to budget constraints along with quarantine restrictions on rapid generation cycling overseas suggests concern on the immediate use of this material in many countries, e.g. Africa. The current size of the program and the many constraints for improvement point to a need for more technician-type assistance as well as plant physiology input to obtain the kind of productivity desired by the PIs. Currently the program is operating as effectively or more so than could be expected, all things considered.

The program, as with most breeding programs, has a relatively good mix of short- and long-term activities. The overseas collaborators will play an important role in introgressing the released materials although in India, they have been used directly. The work is well integrated with research at collaborating sites although there may be questions as to the coordination of activities between NU 118 and KS 101. It was not clear as to the role played by the Technical Committee or ME in this regard. No doubt closer ties between overseas linkages would strengthen the understanding of requirements as well as strengths and weaknesses of the germplasm. The research should be relevant to LDC needs as it (1) exhibits diversity; (2) is early and photoperiod insensitive; and (3) overcomes or improves upon certain constraints such as stand establishment. The output has not yet been beneficial to farmers' needs in the U.S. because of many factors, some of which would be (1) stand establishment; (2) restoration of F1s; (3) stalk quality; and (4) control of grassy weeds. Seedling vigor, shoot length, secondary rooting, and susceptibility to high (40°C) soil temperatures, are all limiting factors for stand establishment. Drought tolerance, currently at a favorable level for U.S. conditions needs improvement and a better understanding by LDC PIs. Generally, the overseas component has opportunity to set priorities and objectives although finding appropriate as well as permanent collaborators has been a major challenge. More collaboration needs to be developed away from the Hyderabad ICRISAT program.

#### Training

Because of the separation of Hays from Manhattan, training of graduate students has been limited but probably could be improved by keeping students at Hays throughout the summer and even one of two fall semesters, if necessary. To the contrary, KSU 106 has effectively trained 9 or 10 students regarding millet cultural practices.

#### Sustainability of Performance

We would suggest more support at the technician level which could be partially accomplished by graduate student help and perhaps temporary help in the fall. Certainly the quality of the current professional staff is strong with Professor Stegmeier and Dr. Khaleeq. The research has reached a point of application e.g., India, but not in the domestic market where limitations already discussed must be resolved before a new drought tolerant grain crop can be released to Great Plains farmers. No outside financial sources are involved. There is sufficient evidence of project cooperation and collaboration with other INTSORMIL programs, ICRISAT projects, and host country programs.

#### General Remarks

This program is vitally needed to maintain millet input into the CRSP. The PIs are dedicated to making grain millet a viable U.S. crop as well as to give support to overseas collaborators and have made a major contribution in this regard already. Unfortunately, Hays' conditions don't necessarily relate to millet areas in the LDC's so direct application of the germplasm won't always be easily accomplished. Although training isn't a major part of the project the PIs are capable of giving support while overseas as well as providing a key working/training location for collaborators who visit the U.S. The program emphasis is on hybrids for the U.S. but for international purposes, may need to think in terms of synthetics or the possibility of an appropriate blend which can be pre-packaged for ease of seed production and result in a high percent of F1 hybrids in the following or commercial generation.

INTSORMIL needs strong input on millet improvement with KSU-101 a major contributor.

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The research is integrated with activities in Southern Africa and Niger. A question was raised, however, by Oumar Niangado on the relevance of the diseases being studied -- at least related to Mali -- where he felt long smut, sooty strip and charcoal rot were more significant than the bacterial stripe/streak complex or *Fusarium*. This again raises the question of appropriate activity having the highest priority to assure efficient use of limited funds. Certainly the *Fusarium* work, especially with the unusual isolate (yellow strain) is very relevant to U.S. farmer needs but the stripe/streak work has more limited economic impact, except it is certainly valuable basic information.

Certainly LDC collaboration can readily relate to this project in its design and most obviously in the conduct of research. The nematode aspect of the project did not seem appropriate and has been dropped. Under current funding, collaboration is likely at or near maximum.

### Training

Training has been alluded to already and seems very appropriate, considering the project size. Additionally, Dr. Claffin has made a real effort to expand his expertise on the dot immunobinding assay by means of a one week workshop in Bulawayo. This technique will allow for identification of corn/sorghum diseases -- a critical tool for INTSORMIL-ICRISAT-SADCC scientists. Expertise at

KSU in pathology should be considered of a diverse nature when contrasted with the three Texas PI's engaged in this discipline and generally having other interests and inputs. Additionally, much needed millet pathology needs to be a significant aspect of KS 108. Certainly student training and guidance of collaboration will be a major contribution from KS 108.

### Sustainability of Performance

Resources of CRSP funding are adequate for this project to make only limited contributions unless most of the activity gains outside support. Certainly staff quality and numbers seem appropriate and the research in the case of the assay has already become applicable. Currently some extra funds were used for travel. Collaboration with other INTSORMIL and ICRISAT activities is effective.

### General Remarks

KS 108, if applied primarily to millet diseases, will be a vital part of INTSORMIL. More input on critical areas of research seems needed. The KSU pathology infrastructure is strong and could be significant for major sorghum and millet problems in the future provided adequate funds are available.

## **KSU-108**

### **Identification and Quantification of Nematodes in Interaction with Bacterial and Fungal Incitants in Stalk Rot Complexes of Millet (Subtitle: Epidemiology and Etiology of Bacterial Disease of Grain Sorghum and Pearl Millet)**

**Principal Investigators: L.E. Claffin and J.F. Leslie**

The circumstances with regard to this project are such that the EEP's Scope of Work is not appropriate for a review at this time.

This project, initiated in 1985, was terminated in 1987 due to the AID budget reductions; however, funding in the amount of \$15,000 was continued during 1987-88 to enable the completion of a graduate student's program. The program has been given a second start for 1988-89 with funding at \$15,000 for the year; thus, the project has had an off-again/on-again circumstance. The project's subtitle indicates the work is now limited to bacterial diseases of sorghum and millet.

The objectives and plans appear to be sound and realistic at the current level of funding and scope of work.

Several interrelated issues are apparent and outstanding for this project: LDC collaboration; the importance and/or the priority of the research for LDC's, including its role/place in INTSORMIL; and the level of funding. These are issues which require the attention of INTSORMIL leaders and officials, i.e. P.I.'s, TC ME/MO and Bd.

### Comments:

This project is severely constrained by limited funding. The experience of the forthcoming project year (1988-89) should provide a basis for determining whether the funding is below that required for a viable, LDC collaborative CRSP project. The Pathology Department possesses special strengths which could provide balance to INTSORMIL initiatives in disease control.

**MSU-104****Sorghum Breeding and Management of Insect,  
Disease and Acid Soil Problems****Principal Investigator - Lynn M. Gourley****Research**

The major aim of the project is with respect to the acid soil problems of the prime site in Colombia and similar Latin American situations. Screening methods have been developed for evaluating sorghums as to Al-toxicity. Consistent screening and breeding efforts have resulted in the development of several Al-tolerant A,B, and R lines. Three A&B lines and 5-R lines have been approved/ready for release. Random mating Al-tolerant populations with A,R. reactions have been developed and are also ready for release. An Al-tolerant commercial sorghum variety is likely to be jointly released by ICA-INTSORMIL in Colombia. Advanced generation Al-tolerant lines are now available from hybridization programmes.

Al-tolerant lines are presently being evaluated for Mn-toxicity and response to low levels of phosphorus. The research goals are thus sound and realistic and implementation effective. The short and medium range objectives with particular reference to Al-toxicities have been met and it is necessary that the breeding materials generated be channelized for commercial utilization in the targeted area.

The Al-toxicity work is largely specific to Colombia and similar Latin American situations. Subsequent work in Zambia, Niger and other locations should open up opportunities elsewhere.

The work is well integrated with ICA, student research, ICRISAT-SADCC, SIDA, etc., and plans are on for the development of a Regional Network with TROP-SOILS and IBSRAM.

The research is relevant to acid soil areas in LDC's as well as U.S.

The project objectives now include screening for tolerance to MN-toxicity and low levels of phosphorus.

The resource distribution between U.S. base, Colombia, Niger and Zambia appears reasonable.

**Training**

This training program is well related to the research goals of MSU-105. Both long- and short-term programs are effectively carried out. Trainees are selected to participate in a wide range of educational activities, as well as to do research, in conjunction with INTSORMIL collaborators in Africa, as well as Latin America. Sustainability of Performance

The infrastructure and staff are adequate. The Al-toxicity work has reached a point of commercial application. Project cooperation with public agencies like ICRISAT and national programs has been good and has attracted some private funding as well. With the trainees getting into position, sustainability should be assured.

**Summary**

- Al-toxicity work has reached a stage when the advanced breeding materials, A&B lines and R-lines could be exploited on a commercial scale. Studies on Mn-toxicity and response to low levels of phosphorus need to be continued.
- Genetic studies based on Diallel and other mating designs are concentrating on phenotypic traits. In studies of this nature carried out at a single location, the error variances are likely to be large. Supplementing these studies with plant analysis might lead to more rational conclusions. Support to such work and the need for such studies should be considered.

## MSU-105

### ECOLOGICAL INVESTIGATIONS AND MANAGEMENT OF INSECT PESTS ON SORGHUM

Principal Investigator: Henry N. Pitre

#### Research

The project objectives, "(1) Studies on biology, ecology, behavior and population dynamics of pest and beneficial insects (2) Development of host-plant resistance to Insect Pests and (3) Development of Pest Management Strategies for the LDC's," are too broad to provide any focus. The research is aimed at studying the behavior of a large number of polyphagous insect pests, foliar feeders, panicle feeders, soil inhabiting insects, etc., which affect a range of crops including sorghum as one of the components of the agricultural system.

Studies on the fall armyworm in relation to the corn-sorghum cropping system have led to the recommendation of the use of corn as a trap crop to reduce losses on sorghum. Some evidence of antibiosis for resistance to the fall army worm in the local sorghums has been obtained. Information on other lepidopterous defoliant and soil inhabiting insects in the region has been obtained. Some chemical seed treatments including kerosene have been suggested.

Keeping the objectives of the project in view, it is difficult to assess the productivity output, assessment of the

results has, therefore, to wait. It is desirable that the objectives be reviewed.

Collaboration with the prime site in Honduras is satisfactory.

#### Training

Two M.S. and one Ph.D. student have worked on problems of the region and upon return and placement in the host countries should be able to carry out further entomological studies.

#### Sustainability

Apart from the prime site in Honduras, there is collaboration with Georgia and the INTSORMIL agronomist of the Mississippi State University.

#### Summary

review and reorient the project with focus on major insects affecting sorghum.

## NU-113

### Agronomy and Cropping Systems

Principal Investigators: Max Clegg and Steve Mason

#### Objective

The long range objective of this research project is to optimize the nitrogen contribution of legumes to sorghum-millet grown in rotational and intercropping systems.

#### Research

1. The research goals and work plans are sound and realistic. In West Africa phosphorus is for most soils the prime limiting element followed by a lack of nitrogen. Since commercial sources of nitrogen are expensive and often non-existent the use of legumes in rotations is important in maintaining production. To accomplish this ob-

jective long-term on site cropping systems have been established.

In addition, plant establishment studies are being conducted. Also the place of crop residues in the rotation for maintaining fertility and soil conservation is being studied (NU 113, KSU 107).

2. The International portion of this project has focus on two African prime sites (Botswana, Niger) but as trained students return to Mali and Sudan, future collaborative research is anticipated in their countries.

3. Results from cooperating countries is limited to date. The most significant contribution has come from the work of Dr. Joan Youngquist in Botswana. Various fertilizer studies have been conducted in Nebraska the results of which can be related to those expected in the LDCs.
4. The objectives in general are long range. The use of improved farming systems can and do have an immediate effect on increased crop production. The effects, at least in West Africa, will be more pronounced than those possible from cultivar improvement.
5. Generally speaking the research findings are transferable within an ecological zone. Many results from water plant relationship, fertilizer uptake are universal in application.
6. The project can only be effective when integrated with collaborating sites.
7. The research is beamed primarily for LDCs. It is also applicable elsewhere.
8. The results of these research projects will provide information to the U.S. farmer as to the most economic use of fertilizers and the use of plant and animal wastes. The results will demonstrate the value of grain/legume rotation.
9. This project is designed as a "two-way street." The principle investigators make frequent visits to the prime sites to develop cooperative experiments.
10. Since this is a long-term project no changes are contemplated (began Niger 1986).

11. With resources available increases are not possible.

#### Training

1. The training phase is well integrated in the research goals.
2. During the past three years students from Bhutan, Botswana, Philippines, Sudan and the US have been trained. At present, students are from Botswana, Malawi, Mali, Sudan, Zambia and the U.S. Students are expected from Niger and Honduras.
3. These trainees will strengthen the research capabilities of the host countries.

#### Sustainability of Performance

1. The local facilities are very adequate to supervise and train students. Resources for trainees when they return home are possibly limited but good work in farming systems must use the equipment available.
2. The staff are highly trained and committed to their work.
3. There is adequate knowledge to move forward in an on-farm cropping system.
4. No outside financial sources are available. No doubt there are other international agencies interested in this activity. IITA has a project for the humid tropics.
5. This project is integrated with all research work dealing with plant growth and development.

## **NU-114B**

### **Mineral Element Uptake, Use Efficiency and Tolerance in Sorghum and Millet**

**Principal Investigator: Jerry Maranville**

#### Research

1. Objectives and work plan. The objectives of this project are sound and realistic. The work plans for Mali and Nebraska have been developed with several collaborators (agronomists, plant physiologists and others) in Mali and Nebraska (i.e. INTSORMIL cooperators in the Institute of

Rural Economy, Mali and in the University of Nebraska); thus the work plans are realistic with respect to needs in Mali and Nebraska. The Philippines component, which is being phased out, had close collaboration with scientists in the University of the Philippines (Los Banos) and

the Philippines Council for Agricultural Research and Development. A Niger component is uncertain.

2. **Implementation.** Excellent in Nebraska and in the Philippines. Prospects for implementation in Mali are promising but less so in Niger.
3. **Productivity.** Satisfactory in the Philippines and Nebraska. The Mali component is just getting underway.
4. **Short and long range objectives.** To be developed as the project gets underway in Mali.
5. **Transferability.** The work is largely site specific; however, there are plans for research at collaborating sites in Africa.
6. **Integration.** The research has been and will continue to be well-integrated at collaborative sites.
7. **Relevance.** The work is highly relevant to improvement of sorghum production in LDC's and in the U.S.
8. **U.S. benefits.** The results have been and will continue to be beneficial to U.S. producers.
9. **Feedback.** The project is organized and conducted in a manner that insures feedback for adjustments in design and execution.
10. **Changes.** There have been modifications/improvements in the project design for Mali and for Nebraska resulting from the experience in the Philippines.

11. **Resources.** Available financial resources are probably inadequate for building and sustaining desirable levels of research work on the project's multiple objectives.

#### Training

This project has had an excellent training record. It has been fortunate to have had trainees each year over the past 6-7 years.

#### Sustainability

1. **Infrastructure.** Highly adequate in Nebraska and in the Philippines; perhaps, marginally satisfactory in Mali and Niger but with good prospects for sustained improvements in both countries.
2. **Staff.** Outstanding in Nebraska; weak but improving in Mali and Niger as scientists and specialists return from baccalaureate, graduate and/or specialized training.
3. **Use of research results.** Not known
4. **Outside financial resources.** None
5. **Collaboration.** There is extensive/close collaboration with other INTSORMIL projects in Nebraska and Mali.

#### Comment

This project has an outstanding record of collaboration and productivity in the Philippines. The new initiative in Mali has gotten off to a fine start with excellent prospects for a highly-collaborative endeavor of benefit to Mali, other nations in West Africa and the U.S. Very satisfactory.

## NU-115

### Breeding Sorghum for Developing Countries

**Principal Investigator: David Andrews**

#### Research

1. **Objectives:** To 1) develop material which is genetically useful to breeding programs in developing countries and the U.S., 2) to collaborate in host country breeding programs, and 3) to provide post-graduate training.
2. **Research Approach:** In order that this project contributes in a complimentary way to the total INTSORMIL effort on sorghum breeding, a different approach has been taken:
  - a) in the choice of the tropical and U.S. germplasm used to build the germplasm base of the project, and

- b) the mode of collaboration preferred is that of strengthening an existing objective of a national breeding program by producing the most appropriate segregating populations for early generation selection in situ in the country concerned.

Therefore:

- a) The tropical parents chosen for crossing to U.S. lines have been high yielding breeders lines, with apparent good food quality grain, mostly from ICRISAT, which have been developed and tested in the tropics for yield and adaptability. Few conversion programs releases have been used, and landrace varieties only where specifically indicated.
- b) The U.S. parents used in the tropical x U.S. crosses have been chosen for their diversity and popularity -- particularly in their combining ability for yield.
3. The objectives and approach are realistic. It is impossible for a breeder in the U.S. to develop varieties and lines adapted to much of Africa especially in tropical West Africa. The success ratio is much higher for the Sudan and Southern Africa.
  4. The present project revised in 1985 has made rapid progress in screening potential germplasm and has developed a well organized cooperative approach between participating countries. Staffing at present is the minimum but with the present training program it will improve.
  5. Good progress is being made toward realizing the research objectives.
  6. The short-term objectives are to begin training candidates in host countries and to begin a well planned breeding program. The future plans call for a staff in each country to carry on its cooperative program.
  7. This project will supply the source for improved production but to accomplish this goal it must be a part of an overall approach which includes grain storage and marketing.

8. To date three seed parents (N94, N95, and N96) have been released for use by the U.S. farmer. Two more are to be released in 1989 and the releases will be continued.
9. The principal investigator visits the host countries each year for consultation in preparing work plans and germ plasm exchange. This visit includes interviews with potential trainees.
10. There are prime sites in four of the host countries. The INTSORMIL persons at these sites collaborate with the principle investigator as well as the staff in their host countries.

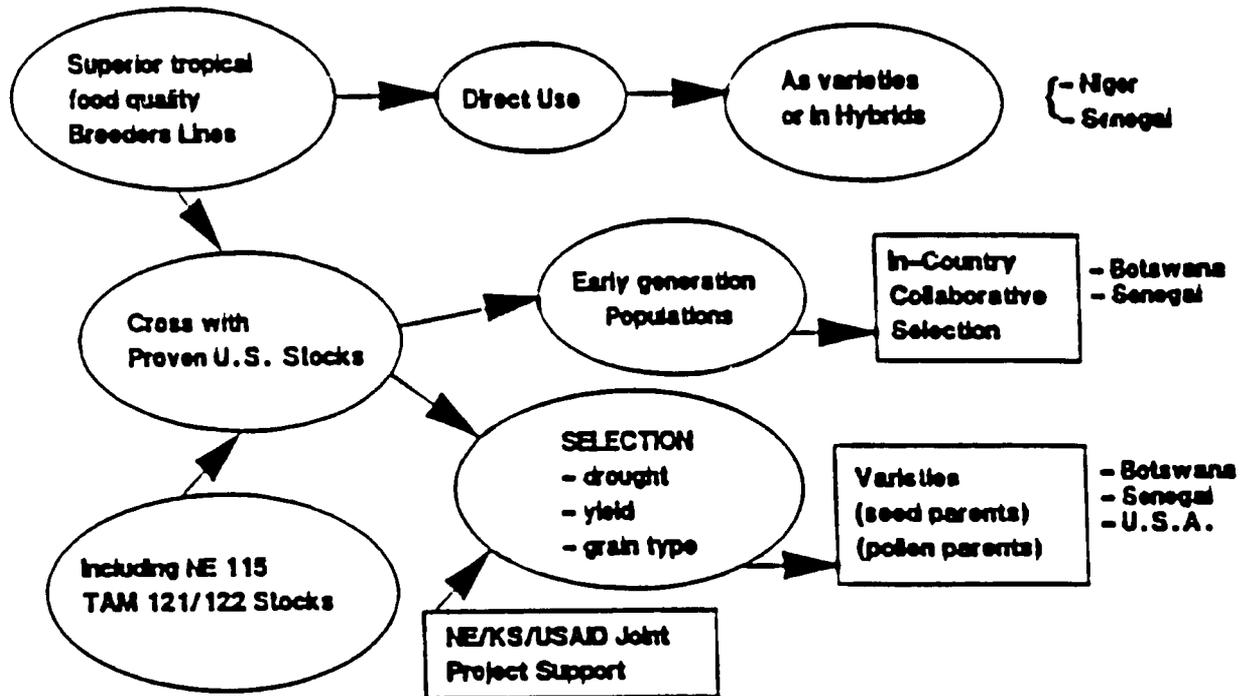
#### Training

1. The trainees under the project are actively engaged in its operation. There are three Ph.D. candidates from U.S., one Ph.D -- Botswana and one Ph.D., Tanzania.
2. As candidates become available, they will be assigned to the project.
3. Trainees are top priority in order to promote crop improvement in a host country.

#### Sustainability of Performance

1. A greater effort should be placed on recruiting additional trainees and additional financing is needed for their support while in the U.S. Financing a project in a host country is desirable but only to the extent to which the host country can continue when the support is terminated.
2. The quality of the present staff plus trainees is super.
3. There have been three releases of sorghum lines and two additional are pending. Germplasm material has been transferred to each host country.
4. Limited financial support is coming from the Nebraska Grain Sorghum Board.
5. NE 115 is a partner in all of the Nebraska projects as well as other states. This is illustrated in the following flow chart.

## NE 115 SORGHUM BREEDING - FLOW CHART



NU-116

### Water and Temperature Effects on Sorghum and Millet as Related to Grain Production and Breeding

Principal Investigator: Jerry Eastin

#### Research

1. Objectives and work plans. The work of this project had its beginnings in Nebraska several decades ago and has been included in the CRSP because of its predictable value to improvement of sorghum in LDC's. Because of its origin, the principal focus has been on Nebraska; however, through the CRSP, the scope of activity has expanded to include direct collaboration with LDC's and cooperation with an international agricultural research center (ICRISAT) dedicated to servicing the sorghum improvement needs of LDC's. Collaborative relationships have been established with Niger, Sudan and Botswana. The objectives of the project are clear, sound and realistic. The work plan for Niger that has been developed with INRAN

scientists is directed towards improving millet production in the cowpea-based systems used in Niger. Currently, programs in Sudan and

Botswana are languishing because of problems beyond the project's control, but they are expected to proceed when conditions permit.

2. Implementation. Prospects are bright for effective collaboration in Niger.
3. Productivity. In less than 10 years: Nine sorghum genotypes -- stress-tolerant germplasm -- are to be tested in Niger, Sudan and USA.
4. Short and long range objectives. The project has short and long range objectives.
5. Transferability. By its nature, some of the work to be undertaken is site specific. The stress screening methods and cultural practices are transferable. Also, some germplasm is transferable; segregating material can be useful in LDC's.

6. **Integration.** The work is well-integrated with INTSORMIL activities in Niger and Nebraska.
7. **Relevance.** The research is highly relevant to the needs of LDC's.
8. **USA benefits.** This project has demonstrated benefits to US farmers.
9. **Feedback.** The nature of the work is such that there is a built-in mechanism for feedback in the project design and work plan.
10. **Changes.** In the early years of this project, the emphasis was on screening techniques and acquiring knowledge of stress mechanisms. Decreased funds produced shifts. There is now increased activity on cultural practices.
11. **Resources.** Finances and available personnel (LDC's) limit the scope of the work to be undertaken.

### Training

The supply of students and money are major constraints to securing an increase in training. There have been a number of foreign students over the years -- two from Mexico (Ph.D.) and one from Nigeria (Ph.D.). Currently there is a M.S./Ph.D. student from the Sudan.

### Sustainability

1. **Infrastructure.** There is uncertainty and unevenness with regard to the future of the programs with LDC's: Niger is shaky; in Mali the prospects

are bright; in the Sudan there are problems of the economy and low salaries.

2. **Staff.** Generally satisfactory and improving.
3. **Use of results.** Four early lines will be proposed for release in 1989. Many of the highest-yielding lines have been sent to ICRISAT and several (3) have been released.
4. **Outside financial resources.** The Kansas and Nebraska Sorghum Boards are providing important funding for collaborative field research in Nebraska and Kansas involving KSU, University of Nebraska and INTSORMIL.
5. **Collaboration.** There is collaboration with other INTSORMIL projects.

### Comment

The Nebraska component of the NU-116 project is rated outstanding in every major respect. It has been an imaginatively conceived, skillfully/expertly executed, highly productive activity with yield-increasing results for domestic producers. It is very impressive. The collaborative component with LDC national programs is less impressive and is just beginning to establish effective, collaborative relations with INTSORMIL - targeted countries. As conditions for collaborative research improve in Sudan and Niger, this component can be expected to improve substantially. It should be noted that the Principal Investigator provided an informative hand-out that put the research of this project and its status when the original project began into historical perspective. This provided understanding of the progress that has been made during the nine years of activity. Very Satisfactory.

## NU-118

### Breeding Pearl Millet for Grain Yield

**Principal Investigator: David Andrews**

### Research

Pearl millet is the major millet of Africa and the Indian subcontinent, where about 25 million ha are grown. It is the principal dryland cereal in the lower rainfall, hot, drought-prone sandy areas of these continents, because it can give more reliable yields under these conditions than other cereals such as sorghum or maize. However, in the last 10-20 years in these pearl millet zones, because of rainfall instability, possible climatic changes, and increasing pressure on the land, demand for food has greatly increased. While the problem has been recognized,

there has not been an adequate response in efforts to stabilize and improve food production. Against this background, research into the genetic improvement of pearl millet should be accorded a high priority.

The research objectives for the project are:

Introduce new material from LDC's (commenced in 1983/84) to cross with U.S. stocks.

Select among existing program stocks for appropriate parents.

Visit LDC locations (Bambey, Senegal; Cinzana and Sotuba, Mali; Western Zambia; Sebele, Botswana; El Obeid, Sudan; and possibly Kenya) to assist in cooperative breeding and testing activities. Visit other locations and participate in workshops to transfer millet breeding technology.

Cross exotic material and U.S. stocks to produce variability for pedigree selection and constructing breeding populations in chosen LDC locations and in Nebraska.

Evaluate breeding material selected in Nebraska nurseries jointly with KSU and other INTSORMIL projects.

Provide post-graduate training in millet breeding at Nebraska.

1. Pearl millet for grain is not grown as a commercial crop in the U.S.A. but has a potential for the dry-sandy areas. The germplasm being used in the project originated in Africa and any developments in the U.S.A. program are transferable back to Africa.
2. The work in progress in the project in Nebraska and Kansas has resulted in a number of excellent cultivars for growing locally and in the LDC countries.
3. The staff, although small, is highly competent. At present there are three student trainees and one technician on the staff in Nebraska in addition to the principle investigator. The reviewer recommends that W.W. Hanna, USDA-ARS Experiment Station, Tifton, GA, be added as a collaborator. Dr. Hanna is a world reknown millet breeder-geneticist.
4. See flow chart for information relative to research activities at collaborating sites.
5. The research work under this project is primarily beamed to meet LDC needs since there is at

present only a potential in the U.S.A. for a new cereal crop.

6. This project was initiated in 1985 and significant progress has been made. Excellent potential cultivars have been developed and are available for trials in LDC. Hybrids are being developed which may enhance pearl millet as a commercial crop in the U.S. and could find a place in some of the collaborating countries.
7. The INTSORMIL staff at the prime sites are cooperating in this project.

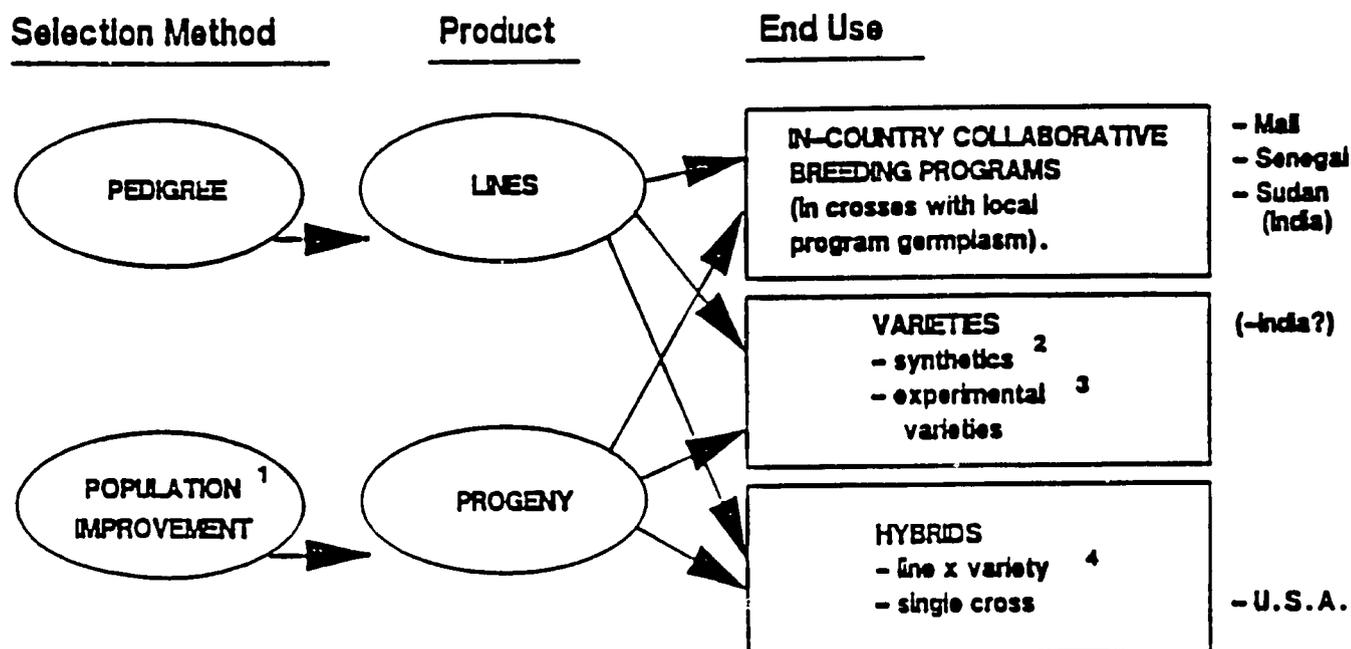
#### Training

1. The training under this project is a function of the research goals.
2. At present there are three graduate students in training who will soon return to their respective countries and conduct their own research in cooperation with the project. Training will be a continuing activity.
3. K. Traore will return to the prime site in Mali and function as a collaborator.

#### Sustainability of Performance

1. Good work is being conducted with the resources available. The number of trainees is limited by lack of funds. Research at the prime sites is limited by available funds.
2. The staff at present is excellent and committed.
3. Cultivars are available for trial plantings in the LDC as well as the USA.
4. There are no outside financial sources involved in this project.
5. The following flow chart illustrates the project activity and cooperation.

## NE 118 PEARL MILLET BREEDING - FLOW CHART



### Study Areas:

- |   |  |
|---|--|
| 1 - Use of simple methods.                | 3 - Potential for improvement.                 |
| 2 - Prediction from parental evaluations. | 4 - Tests of utility (and production options). |

### NU-123

## Mechanisms of Drought and High Temperature Resistance In Sorghum and Pearl Millet

Principal Investigator: C.Y. Sullivan

### Research

- Objectives and work plan.** The research objectives of this project are clearly stated, realistic and sound. Similarly, the work plan has been thought through carefully and in consultation with the host country (Mali) Principal Investigator, Moussa Traore. The plan, which focuses on long and short range objectives, provides for an appropriate division of labor between the Institute of Rural Economy (Mali) and the University of Nebraska.
- Implementation.** The program has gotten off to an excellent start with mutually supportive activities underway in Mali and Nebraska.
- Productivity.** Output from this project has been excellent.
- Transferability.** By its nature, most of the results will be site specific and limited to use in similar situations; however, the methods and procedures under development promise to have widespread usefulness.
- Integration.** The work is fully integrated into the research programs of Mali and Nebraska.
- Relevance.** The project is highly relevant to Mali and other similar sorghum-producing regions of Africa.

7. **USA benefits.** This project is of potential benefit to US producers and others wherever sorghum is grown.
8. **Feedback.** The project is structured so as to provide for constant feedback into its design and work plan.
9. **Changes.** None so far.
10. **Level of effort.** The level of effort appears to be adequate.

### Training

The Mali Principal Investigator was trained at the University of Nebraska under the Nebraska Project Leader and Principal Investigator. Currently, there are two students in training -- one a master's student from Mali that is just beginning and another from Mali under the PSTC program. Thus, though modest, the training effort is satisfactory, given the constraints of money and the availability of trainees.

### Sustainability

1. **Infrastructure -- Adequate.**
2. **Staff quality -- Excellent.**
3. **Applicability of research results.** Screening for deep rooting potential using hydroponic techniques seems to be a feasible procedure and nearing the point of use. The use of abscisic acid to increase germination of sorghum seeds appears promising but more research is required.
4. **Outside financial resources -- none**
5. **Collaboration with INTSORMIL projects -- Yes.**

### Comment

With regard to its objectives, organization and operations, NE-123 is a model CRSP project. It is an example of exactly what is intended under the Title XII legislation. Highly Satisfactory.

## PRF-103A

### **Development of Agronomically Superior Germplasm Having Improved Nutritional Value and Good "Evident" Grain Quality for Utilization in Developing Countries**

**Principal Investigator: John Axtell**

### Research

This project essentially has been the catalyst for other Purdue activities. The philosophy of maintaining an equilibrium of basic and applied in contrast to the heavy applied overseas research component gives considerable problem solving ability to INTSORMIL. The original emphasis to this strong component of the CRSP centered around protein quality but current objectives most strongly emphasize cold tolerance and digestibility -- both medium to long range objectives with the inheritance of diastatic power, a collaborative thesis study with ICRISAT in Zimbabwe, more of a short term objective as is, of course, have been developed and are available

The project utilizes two technicians and a secretary plus currently 3 graduate students. Productivity has been exceptional over the past nine INTSORMIL years with Dr. Axtell considered a major designer and strong supporter of the CRSP idea and mission. He was instrumental in developing the prime site/ecogeographical zone concept unique and beneficial to the efficiency of this

CRSP. This project integrates well, for example, with the East Africa/West Africa zones i.e. Sudan and Niger.

The digestibility efforts are medium to long range but affect essentially all sorghum growing areas both domestic and international. Cold tolerance/seedling vigor both involved in stand establishment and early growth are somewhat more specific but early growth can generally be beneficial. Continued efforts at forage and grain quality are of perhaps lower priority, and at least medium range objectives. A significant breakthrough may be the location of a cultivar, IS2319, which has reduced fraction III protein, a low quality alcohol soluble component.

Purdue research in general and PRF 103A in particular is oriented towards wide application and is not location specific. Obviously this then leads to strong collaboration especially as the research relates to LDC needs. The results from the project have led to more domestic efforts toward improved grain quality germplasm while finished cultivars from this research re-

late to world-wide improvement of grain and forage quality. Also PRF-103A has trained a large number of collaborators both domestic and international. The same PI helps coordinate and work with collaborators to effectively operate the Niger in-country (PRF 109) program successfully improving many aspects of millet and sorghum. Much joint planning also goes into the Sudan project. The protein quality research has currently evolved to a point needing national program application. In general, collaboration is at the right level or better than expected.

### Training

Approximately 25 students are INTSORMIL related with three currently undertaking studies. These people have always been an integral part of the research and collaboration as they were prepared to return to prime sites around the world. Field, lab, and classroom experiences are exceptional. Most trainees are selected with regard to LDC site activity. Contacts around the world, often through these students, have allowed Purdue, especially PRF 103, to have strong overseas linkages.

### Sustainability of Performance

The infrastructure gives a well rounded education and research opportunity with some 5 on-campus PI's heavily involved in the CRSP. These people have a long history in INTSORMIL where they have had opportunity to be a part of building collaboration overseas. The research has reached a point of application as regards techniques, germplasm, and trained collaborators. The "bottleneck grant" on forage quality brought in necessary outside money and currently a strong proposal to the McNight Foundation relating to drought is being reviewed. Collaboration exists with other INTSORMIL projects, with ICRISAT and certainly with host country programs.

### General Remarks

This program should gain more visibility as the CRSP goes into year 10 with the need to tell its story of training; linkages with strong collaboration; planned research which systematically attempts to solve problems of grain quality, tannins, striga; and germplasm improved for drought, digestibility, cold tolerance/vigor; and improved overseas program development. New CRSP PI's could benefit from familiarity with the design and operation of this project.

## **PRF-103B**

### **Chemical and Physical Aspects of Food and Nutritional Quality of Sorghum**

**Principal Investigator: Allen Kirleis**

#### Research Performance

1. Grain quality is an important component of research efforts to increase food availability in LDC's. This project deals with this problem by identifying, defining, and developing chemical methodology which will allow selection of sorghum cultivars acceptable to consumers in the different forms in which sorghum is processed and consumed. The research goals and work plans are sound and realistic.
2. The research project is well staffed, with capable personnel and the appropriate equipment. The project has been implemented in a very effective way.
3. The output of research results is not only acceptable in quantity, but of a good quality, providing answers to the research objectives which will eventually lead to implementation.
4. As with most projects, the emphasis here on chemical and physical aspects of grain sorghum as food has short, medium, and long-term objectives. The same basic aspect of the research on long-term, but short-term and medium-term objectives includes the training program and chemical and biological methodology being developed.
5. The research site is not specific, and results can be easily transferred to other sites. Certain aspects of the research, however, can only be conducted in well equipped laboratories. Once these are defined, then they can be transferred.
6. The research being conducted complements very well the research of a similar nature conducted in other collaborating sites. The information obtained is useful to other groups working on food quality of sorghum.

7. The research problems being studied are based on the needs of LDC, since the aim is to understand the role of physical and chemical components in sorghum which contribute to the functionality of the foods processed and consumed from grain sorghum.
8. The basic data being produced is of benefit to U.S. farmers in an indirect way, since the foods being studied are not consumed in the U.S. However, the basic data which is derived from the research was applicable to sorghum produced in the U.S.
9. Since the research is based on products made from sorghum as consumed in LDC, the information from LDC is very useful to design experiments and introduce that information into the workplan of this project. Such mechanisms exist either from visits of the U.S. research team or from the students working on the problem.
10. The purposes and objectives of this research have not changed. The research is long term, with knowledge being obtained step by step.
11. The project is collaborating at about the right level with other groups involved in similar types of activity at other sites.

### Training

1. All the reports on the research conducted and all training is a function of the research goals of the project.
2. Training is being conducted in a very effective way. The quality of the presentation suggested effectiveness. The training is long- and short-term.
3. Trainees are selected in conjunction with collaborating LDC with activity most of the time.

This way of selection is useful for increasing the capabilities of collaborating sites in LDC.

### Sustainability of Performance

1. The laboratory and library facilities are indeed adequate. The interaction with other groups is also very useful to the development of the research objectives.
2. The quality of the staff is appropriate and very competent.
3. A number of results have reached a point in which they can be applied. In fact, this has already taken place.
4. No other financial resources are involved in this project.
5. Research teams on food quality of grain sorghum under INTSORMIL collaborate well in the development of the research objectives. There is good implementation between those in the U.S. and with host country programs, as well as with similar activities being carried out at ICRISAT in the food quality facility of that institution.

### Comments

- a. More biological testing would be recommended including in vivo and in vitro digestibility.
- b. Research should not be concentrated on only one nutrient - now this is protein. Attention should be given to carbohydrates, fat and the nutrients involved in the fermentation processes.
- c. Attempts should already be made to implement more results at a large scale.
- d. Some research should be conducted in LDC facilities with human resources.

**PRF-104B****Sorghum Tannins and Other Phenols****Principal Investigator: Dr. Larry Butler****Research**

1. As the principal investigator indicated, tannins and other phenolic compounds are: good for the plant, good for the producer and difficult to analyze. This research is providing useful answers to the three characteristics, answers applicable to sorghum and to other food crops containing phenolic substances. Thus the research goals are realistic and the approach and workplan are sound.
2. The development of this research project has been very effective. Analytical techniques with the appropriate equipment have been implemented effectively. However, staff is short, as judged by the fact that only the principal investigator reported on the problem. Due to the complexity of the research, to the implications of the results, the staffing short, it needs additional support.
3. The results reported were enriching and meeting the research objectives very well. Output of information is high and useful, with respect to analytical techniques; the role phenolic compounds play on striga and as important, the metabolic role and the nutritional implications of tannins in the animal organism.
4. This research has short, medium and long term objectives. Training and development of analytical techniques are short term objectives, since their availability to other research helps in advancing to answer the questions associated to tannins and phenolic compounds. However, due to the nature of the research the objectives are more of a medium to long term, particularly those related to striga and to the metabolic effects these organic substances have on animal performance.
5. The basic aspects of this research are site specific, however, if facilities were available including capable human resources, the research could be conducted in other sites. The more practical effects of the research and research outputs can be easily transferred to other sites. The later has been demonstrated by the research results on striga.
6. In general, the research under this project is relatively well integrated with other collaborating sites, in particular the research related to striga. Similar importance should be given to tannins in relation to the importance these substances have in nutrient bioutilization, as it was in previous years.
7. The research conducted is indeed relevant to LDC needs in all aspects, that is those related to striga, to processing and to bioutilization.
8. In terms of the long term objectives, the outputs of this research will benefit U.S. farmers. The results will also be useful eventually to the agrochemical industry.
9. The design and workplan of this project have taken into consideration the needs of LDC. Because it is integrated with collaborative sites, there is inserted a feedback mechanism into the project.
10. The project objectives have not changed during the life of this project. Due to a number of circumstances, emphasis has changed somewhat, although all activities and objectives are related to the same organic substances, the polyphenols and the role they play in sorghum as compounds protecting the plant and as compounds affecting nutritive value.
11. This project is collaborating at the right level with other sites, although more attention should be given to the metabolic role of tannins and phenolic compounds in nutrient utilization.

**Training**

1. All training under this project is a function of the research goals.
2. Both long term and short term training is being accomplished in an effective way. The research is on the basic side, but it is needed for successful applications in the future.

3. At the time of this review, except for one post doctoral student, the project had no foreign trainees. The principal investigator suggested however, that he plans to do so in the near future. The problem with this research is that it may be difficult to find LDC trainees capable of working on the problem in the one hand, and using his training capabilities upon returning to his country.

#### Sustainability of Performance

1. The infrastructure and resources are adequate, and efforts are being made to optimize them. Economic support may be somewhat limiting.
2. The quality of the staff is excellent. There is also very good collaboration making the capacity of the staff very capable and strong.

3. Some aspects of the research have reached a point of applications. For example analytical techniques. Other aspects are long term.
4. This project does not receive financial support from other sources.
5. There is ample evidence of project cooperation and collaboration within the same institution and often collaborates at participating sites.

#### Comments

A good balance of the research activity should exist in the three main problems associated to tannins and phenolic compounds in sorghum. These are those related to striga; to their metabolic effects in the animal organism, and as a defense mechanism for the grain.

### PRF-105

## Economic Evaluation of New Technologies in Sorghum and Millet Production

Principal Investigator: John Sanders

#### Research

1. Goals and work plan are well related to resources, needs and opportunities.
2. The implementation is good. Staffing and work are well coordinated.
3. Project outputs contribute directly to project objectives.
4. The objectives are mainly short and medium range with the exceptions being the longer range methodological objectives and training.
5. Most of the short and medium range results are site specific.
6. Integration with collaborators is good at the four sites: Niger, Sudan, Burkina Faso, and Honduras.
7. Research is on subjects closely related to the LDC needs, particularly those administering and doing biological research on sorghum and millet.
8. As this research is LDC specific, it contributes little to U.S. farmers; however, as it contributes mainly to food production of poor subsistence

farmers it does not weaken the competitive position of U.S. sorghum.

9. Adequate provision is made for use of collaborator feedback in designing and planning activities under this project.
10. The project has evolved collaboratively as experience has been gained in understanding farm level problems, the focus of the work on farm level problems has improved. Increasingly, the focus is on water conservation, fertilization, financial resources and cultural practices.
11. The level of collaboration is appropriate.

#### Training

The shortage of trained agricultural economists and farm specialists in Niger, Sudan, Burkina Faso and Honduras makes the large training component of this project important. The site specific nature of much of the research needed on this subject makes it important to establish local capacity in agricultural economics and farm management.

1. The training program of this project goes beyond immediate research goals to the establishment of

the institutional and human capacity needed to generate site-specific results.

2. Both long and short term training goals are being attained.
3. As opportunities arise at both collaborating sites and at Purdue University, trainees are selected in such a way as to strengthen LDC collaborating institutions.

#### Sustainability of Performance

1. Supporting institutional and personnel infrastructure are inadequate; hence, the short term need for technical assistance and training provided by this project.
2. Expatriate staff quality is adequate with the quantity being appropriate for funding levels.
3. Research results are being used by research administrators and IBRD.
4. The project is attracting and using non-project funds and resources from Purdue University, ICRISAT, AID and SAFGRAD.
5. Experience in developing agricultural economies indicates that this project is contributing to the development of sustainable institutional and human capability to do farm land technology assessment work in Niger and Sudan.
6. Cooperation and collaboration with other Purdue INTSORMIL projects is good and is increasing, as well, with ICRISAT and the institutions of collaborating countries.

#### Summary: The EEP

1. congratulates project personnel on focusing the project so well on problems and subjects relevant to INTSORMIL, LDC agencies and (less directly) LDC farmers that are pertinent for sorghum and millet.

2. notes that this project probably displays better millet/sorghum balance than any other INTSORMIL project.

3. regrets that more resources are not available to improve the inadequacies of the data being used in analyses carried out in this project.

4. recognizes shortcomings in the conceptual models being used in this project but regards the models used as superior to those commonly used by agricultural researchers and agricultural administrators addressing such problems and questions requiring technology assessment. Nonetheless, much basic conceptual and theoretical work is needed by economists and other social scientists and, even biological scientists on (1) risk bearing and chance taking, (2) improved measurements of non-monetary values associated with food quality, food security, family size, environmental degradation, institutional reform and education and the like, (3) managerial responses, (4) ensuring (control of events) as contrasted to insuring and chance taking (adjusting to existing probability distribution). Such disciplinary work is relevant to this project and should be encouraged by it even if available project resources precludes its support. Until such work is successfully completed, projects such as the present one will be less productive and the technology assessment of administrators (including EEPs) less adequate than they should be. Project personnel should try to understand these theoretical and conceptual difficulties and encourage economists and other disciplinarians at Purdue University and elsewhere to address them.

5. recognizes that such rural social sciences as rural sociology and such basic social sciences as sociology and anthropology have potential contributions to make to projects such as this if they focus their efforts on problems and subjects pertinent to sorghum and millet and LDC decision makers. The multi-disciplinary nature of practical problems and issues makes it important that sociological and anthropological contributions be utilized.

## PRF-107

### Breeding Sorghum Varieties and Hybrids with Improved Grain Quality, Drought Resistance and Striga Resistance

Principal Investigator: Gebisa Ejeta

#### Research

All research objectives are particularly appropriate for international collaboration with drought tolerance and striga resistance obviously of a medium to long range in reaching fruition while grain mold resistance may be of a shorter term. Certainly reaching any of these goals would make an invaluable contribution to sorghum production in much of the world. Staffing of primarily graduate students provides another short term objective as it relates to training. As mentioned previously the germplasm development work, much of it being finished in Sudan or Niger, is ideally conducted to apply to collaborators as well as to domestic programs. The research also relates to Texas (Rosenow) and Nebraska (Mason) projects and actively works with the Sudanese and Nigerian sorghum improvement efforts. The research is without question relevant to LDC needs when one looks at the economic losses caused by grain mold, striga, and drought. Since the project has only been in existence for less than five years obviously the primary contribution possible for U.S. farmers needs would be the isolation of lines having both pre- and post-bloom drought tolerance; the association of high levels of glycine betaine with these; and internationally a line showing *Striga* tolerance over a wide geographic area; and a compound, flavan-4-ol, associated with mold resistance regardless of the tannin level. Obviously, drought and grain mold have universal application. As to collaborator feedback Dr. Osman El Obeid of Sudan works closely with PRF 107 on drought tolerance research. A graduate student project with Rosenow/Gebisa was instrumental in sorting out these new and exceptional drought lines. Thus, this project collaborates well with prime site PI's, U.S. PI's and industry.

#### Training

Graduate students (4) with two having completed their programs, are an integral part of this INTSORMIL ac-

tivity. Training might be considered long term in that the student very likely will be a future collaborator where training and joint planning will continue. Trainees related well to LDC site activity which certainly contributes to strengthening and institutionalization of collaborating site research capability.

#### Sustainability of Performance

The infrastructure within the Purdue program as well as the overseas site responsibility suggest an ideal arrangement to progressive activity. The close association to Axtell's program and support from Kirleis and Butler as well as Sanders are obviously resources of the highest quality and better yet all work together closely. Certainly with the key findings related to striga, drought, and grain mold one sees research at an active point of application. An AID International Support Grant to Purdue University is also a part of the project and is provided through the office of International Programs. Besides cooperation with INTSORMIL projects and host country programs this project has close ties with the ICRISAT East Africa regional program.

#### General Remarks

PRF 107 was designed as an INTSORMIL project and is led by a scientist with LDC accomplishments having developed Hageen-Dura 1. This PI perhaps better than anyone understands the CRSP from both directions which adds considerable effectiveness to his program and INTSORMIL, in general.

## TAM-121

### Breeding for Productivity in Sorghum

Principal Investigator: Fred Miller

#### Research Performance

1. A particularly attractive feature of this project is that it incorporates significant findings from other INTSORMIL TAM projects and acts to deliver its best materials to other domestic and LDC sites. The work plan which is extensive because of the large number of entries and objectives, appears to be sound and realistic, and addresses the identified constraints in LDC's on improving the technology of grain sorghum production.
2. The research teams involved in this project are highly dedicated with much know-how. This makes implementation effective. There is good coordination and complementarity among different research teams with direct emphasis on the constraints to sorghum production needing attention.
3. A main objective of this project is to provide the improved germplasm to collaborators throughout the world. This objective is being met efficiently with a large number of improved materials with desirable characteristics that are being produced in the project. The project also tests materials to be used for other purposes and other INTSORMIL projects.
4. The general goal of this project is long-term, including the creation of a series of germplasm pools and cultivars with high and stable yield potentials, good food qualities, resistance to disease, and favorable pest and stress factors.
5. The Texas A&M researchers have selected experimental sites that allow them to carry out their research with confidence, and permit results which will be efficiently duplicated in other sites, particularly those in LDC's. The main problems are not with the quality of the Texas site, but with difficulties experienced in LDC's.
6. The research conducted under this particular project is very well integrated from conventional breeding objectives to food quality objectives. Such integration is not readily seen for other food crops or research institutions. Furthermore, this integration has been achieved among senior scientists as well as with students. It covers all collaborating sites.
7. The research topics selected are responding to constraints on sorghum production identified in LDC's. Problems addressed include productivity, grain quality and utilization.
8. The research conducted in this project is clearly of great benefit to U.S. farmers. With additional time the white grain types will be preferred by feeders, processors and consumers over the red colored grains, once it is appreciated that the white grains have a better nutritional value and that attractive intermediary products and final products can be made from them.
9. LDC's collaborator problems and constraints are considered seriously in developing work plans and research designs. This is evident by the concerns of the U.S. investigators with LDC's problems and by the participation of LDC students. There is also appreciation of the problems of U.S. sorghum producers.
10. Project objectives have not changed though they have likely expanded to be more inclusive of problems related to increasing sorghum productivity. The project has a long-term orientation with advances being implemented as improvements are made.
11. Project personnel collaborate effectively with LDC sites as evidenced by visits made to project sites in Honduras and West Africa.

#### Training Program

1. Training under this project is closely related to its research goals.
2. Both short-and long-term training goals are being attained.
3. Trainees are selected in collaboration with INTSORMIL's LDC activities. This strengthens both LDC research capacities and institutions for which purpose the sometimes duplicative, (simple and easy) student research projects may be appropriate.

Training

It will be necessary to involve more LDC scientists on drought research.

Sustainability

The drought research will be more site specific and this needs to be strengthened in countries like Sudan and Niger and parts of Mali. Results on host plant resistance could more easily be adapted and used by the cooperating researchers of LDC's.

Summary

- review and develop the procedures for breeding for drought resistance-involvement of plant physiologists is suggested. Drought programs of Nebraska and Purdue also to be consulted.
- More site-oriented drought work in prime sites and cooperating countries.
- More training in the areas of drought breeding and physiology.

**TAM-123**

## **Increasing Resistance to Insects and Improving Efficient Nutrient Use by Genetic Manipulation for Improved Grain Sorghum Production**

**Principal Investigators: G.C. Peterson & A.B. Onken**

Research

1. **Goals and Work Plans.** This is a multidisciplinary sorghum improvement project with research facilities at several locations -- Texas, Georgia and Puerto Rico. The project lists seven objectives which are sound and realistic. It seeks to collaborate with scientists in Honduras, Botswana, Mali, and Sudan. Work plans have been prepared for Honduras and Mali. For 1988-89, activities/programs are on hold.
2. **Implementation.** TAM 123 activities involve a variety of activities that are largely backstopping in nature. Indications are that the project carries out this rule in a satisfactory manner.
3. **Productivity.** At the current level of funding, productivity is very satisfactory.
4. **Short and long range objectives.** The several components of this project have short and long range objectives.
5. **Transferability.** Though certain results will be location specific, the knowledge, methods and improved materials produced are expected to be useful and transferable.
6. **Collaboration.** Very satisfactory.
7. **Relevance.** This project is highly relevant to the solution of insect and nutrient use problems of sorghum production in LDC's.
8. **USA Benefits.** This project can be expected to produce knowledge and materials of benefit to U.S. farmers.
9. **Feedback.** The project operates in a manner which facilitates feedback from its collaborators.
10. **Changes.** No changes to date.
11. **Resource Adequacy.** Funding for this project is below that which is considered adequate for successful operation of its two components at several overseas locations.

Training.

It is not likely that this project can provide significant training for its collaborators, at its present level of funding.

Sustainability.

This project has been operational for just a few years. It is too soon to judge its sustainability, but at present the prospects are not promising.

Comment

This project is being conducted about as well as can be expected, given its present funding constraint and its limited opportunities for overseas collaboration. For this project to realize its full potential, arrangements should

### Sustainability of Performance

1. The Texas infrastructure for this project is excellent and sustainable unless unwisely scrapped in favor of cell biology.
2. The Texas staff is highly capable and skilled.
3. Significant applications are being made.
4. Additional outside financial resources are invalid.
5. The collaboration appears reasonably good.

### Some Recommendations for Future Research

1. Research should be done to identify chemical compounds in the plant during its different physiological stages which may be associated with disease resistance, pest control and grain quality.
2. Continued efforts should be made to increase lysine, the limiting amino acid in grain sorghum protein. Other nutritional parameters should also be studied, such as cultivars with high Fe content, high CHO digestibility and high oil content.

3. Of importance are continued studies on the physiology of the plant relative to drought resistance as lack of rain is a serious problem in LDC's.
4. Grain size and shape. Can grain size be increased? Larger white grain size, would be attractive.
5. Because of the large benefits accruing to both domestic and LDC sorghum producers as a result of adding INTSORMIL to U.S. sorghum breeding efforts, social science research on costs, benefits, and international trade competitive relations should be started. This trade research should be coordinated with the market development research recommended for TAM 126. Such research can probably be done at little expense to INTSORMIL by concerned agricultural economics departments.
6. Paul Thompson, a joint appointee in agricultural economics and philosophy at TAM, has researched the impact of international soybean research on U.S. soybean producers. His skills could be supplemented by those of a quantitatively skilled agricultural economist and possibly a political scientist with interests in agricultural political issues to do similar research vis-a-vis INTSORMIL research on both millet and sorghum.

## TAM-122

### Breeding for Disease and Drought Resistance and Increased Genetic Diversity

Principal Investigator: D.T. Rosenow

#### Research

1. As far as diseases are concerned, this project should be viewed in conjunction with TAM 124; Lubbock forms part of the multilocational program. Results pertaining to host plant resistance are generally transferable to the prime sites, although exceptions could occur. Observations made on TAM 124 are relevant here. Collaboration arrangements appear satisfactory with the prime sites in Honduras, Sudan and Mali. The results of research are beneficial to the U.S.
2. Drought is important in parts of U.S.A. as well as in the prime site programs. A range of materials are under assessment at Lubbock under rainfed and irrigated situations. These

diverse genotypes are rated for pre-and post-flowering responses. The non-senescent types stood post flowering stress better than senescent types. It is felt that more critical methods of screening for drought may be developed and the breeders and physiologists may together evolve standardized procedures.

The drought research is relevant to the LDC needs, but the materials need to be evaluated in the respective country situations. The results are useful to U.S. farmers in the region. Collaboration with prime sites with the exception of Niger is satisfactory.

be made for more of the research -- which is highly location specific -- to be conducted at appropriate sites in collaborating countries. The suitability of the Lubbock site for screening genotypes for nitrogen stress is a case in point.

Leadership of the project is highly satisfactory. Because of its importance, the project should be afforded the resources required for its success.

## TAM -124

### Sorghum and Millet Disease Control

Principal Investigators: Fredericksen and Toler

#### Research

The project has made significant progress in developing disease management strategies in Texas and has established links with several country programs.

1. The multilocational disease nurseries in Texas have enabled identification of resistant stocks for several of the prevalent diseases and their distribution into international nurseries for further study of disease reactions and utilization in breeding programs.
2. The long smut of sorghum, widely prevalent in West Africa and drier areas of India, has been defying efforts to control it. Inoculation techniques developed in Sudan have now been evaluated in Niger and this should furnish a mechanism for screening for long smut resistance.
3. The slow senescence or stay green trait and the role of cytokinins in preventing senescence will provide additional avenues for control of charcoal rot.
4. The work on host plant resistance in relation to pathotypes of sorghum downy mildew should provide a better understanding of the disease in Honduras and drier areas and should eventually lead towards cultivars with broad based durable resistance.
5. Acrimonium wilt is a relatively new disease and these studies should provide a better understanding of its control.
6. The characterization of pathogen populations of anthracnose should lead to better management strategies for this disease.
7. The viral diseases of sorghum have received critical attention and our understanding of viral problems has considerably increased. Strains of MDMV, SCMV and possibly new viruses are being identified and characterized. The inocu-

lation techniques used in the field and the laboratory are enabling researchers to correlate virus concentration with disease severity and to identify resistant/tolerant cultivars to determine inheritance mechanisms.

The occurrence of viral diseases in cultivated sorghums hitherto was on a limited scale and has generally been in the areas where maize-sorghum or sugarcane-sorghum combinations occur and pests common to both crops are present to act as vectors. The intensive inoculation of virus techniques on diverse lines of sorghum on a field scale might provide greater opportunities to the organism for adaptation to sorghum and possible evolution of virulent strains. Field screening methods of growing sorghum in between maize or sugarcane rows as spreader rows, and infecting sugarcane and maize, and allowing sorghum to be infected naturally or other alternative field screening techniques need to be considered so that opportunities for development of sorghum virulent strains may be avoided. As none of the three EEP members present were experts on this it only suggested that the pathologists consider this argument.

#### Training and Sustainability

With the excellent linkages established with several country programs and the graduate students to return to these programs sustainability is assured.

#### Summary: The EEP recommends:

- That the project continue with full support.
- That the problem of ergot (as anticipated) be researched in India.
- That safeguards be taken against any unfavorable changes in the population dynamics and virulence of strains of MDMV and SMV and other viruses that infect sorghum occasionally and under some farming systems. The highly infective field screening procedures may be reviewed if warranted by specialists in the area.

## TAM-125

### Development and Evaluation of Systems for Controlling Insect Pests of Sorghum/Millet

Principal Investigator: George Teetes and Frank Gilstrap

#### Research

1. Goals and work plans are sound, well conceived and well executed. The Project has made significant advances.
  - a. The midge component has made significant contributions to the overall understanding of the midge problem - biology, population dynamics, density-damage relationships, host plant resistance including genetic basis of resistance, integrated control strategies and development of models for forecasting. Multilocation midge nurseries have enabled identification of agronomically desirable midge resistant lines, some on the verge of release. Midge is a global problem of sorghum and the resistant lines could benefit many programs of sorghum improvement.
 

While the progress on incorporation of midge resistance in R lines is satisfactory, comparable results are yet to be accomplished with B lines. Efforts in this direction are in progress. The fertility reaction of midge resistant lines in the A2 and A3 cytoplasms may be studied and this in the immediate context could result in the incorporation of higher levels of midge resistance in the females with different cytoplasmic backgrounds.
  - b. Head bug studies in Niger have given useful leads. Simultaneous studies with the Calocoris bug in India could be rewarding and may lead to identification of lines with broad based resistance.
  - c. Similarly, studies on aphids presently being carried out in Botswana could be extended to other countries, including India.
  - d. The biological control studies on sorghum and millet pests in Honduras and Niger have provided useful leads.
2. Staffing is excellent - at all levels - from plot preparation to the conduct and administration of the research.
3. There is almost a one to one correspondence between outputs and objectives.
4. Long, intermediate and short-term objectives exist and are being attained. Long-term goals seem to be adjusted upward and sharpened as opportunities are revealed by excellent domestic/international collaboration.
5. Some of the research is specific as only U.S. pests are used in screening. Plans are underway for the establishment of a head bug nursery in Mali (previously scheduled for Niger) that is much needed for Africa.
6. Work integration between the various important Texas sites is exceptionally good. Though more difficult to attain, good collaboration exists with overseas scientists and locations. Though INTSORMIL has attained remarkably good collaboration among its U.S. member institutions, collaboration among them is not as good as has been attained within the Texas program and is probably less adequate than with the LDC countries.
7. Substantial contributions are being made to the food needs of disadvantaged LDC's. This humanitarian contribution is a substantial basis for justifiable U.S. pride. The major Texas investment in research on sorghum pests serves humanity abroad but while Texas is, itself, a recipient of germplasm, insights and knowledge from LDC's and such international agencies as ICRISAT and the Escola Agricola Panamericano, Honduras.
8. See 7 above for contribution to U.S. needs.
9. There is a mechanism for feedback from LDC collaborators; however, these collaborators have probably not been well enough informed on insect pests or well enough trained as entomologists to be as effective as they should be in this respect.

10. The objective of establishing a headbug nursery was abandoned in Niger for poorly understood reasons of the Nigerians. This nursery is now planned for Mali. It is badly needed in West Africa.
11. Collaboration should be higher and better with most collaborating sites; however, given existing resource, present levels are quite good. Extra resources could be advantageously used to establish insect nurseries abroad to control pests not present in the U.S. Biological control research is promising in both locations.

### Training

1. The training program is well related to the research goals of the project and to the closely related goal of creating indigenous entomological skills and institutions.
2. Both long- and short-term training goals are being attained.
3. Among the long-term goals being attained by the training program is a strengthening of collaborating institutions in increasing the capabilities of indigenous staffs -- however, inadequate numbers of entomologists are available in LDC's.

### Sustainability

1. The Texas component of this project is sustainable indefinitely unless such work is reduced in favor relative to "higher tech" approaches involving molecular biology. The Texas infrastructure is exceptionally well established. However, the corresponding LDC infrastructures in Africa and Latin America are marginal as to sustainability.
2. What is true for infrastructures is true for staff. Newly trained LDC staff are often diverted to other purposes.
3. Both plant resistance and biological control of insect pests are being applied in the U.S. and

abroad. As this contributes to both humanitarianism and international competitiveness of the U.S., combined and increased AID support of this part of INTSORMIL's work is required.

4. Collaboration with other INTSORMIL projects is close and effective. It is difficult to conceive of better cooperation among projects, persons, disciplines and the various multidisciplinary agricultural sciences. Cooperation with LDC institutions is good. Cooperation among U.S. INTSORMIL institutions is good. INTSORMIL is a unique, multidisciplinary and multi-institutional administrative arrangement for bringing together disciplines and agricultural college departments in configurations appropriate for researching the insect pests of sorghum. This unique arrangement should be maintained and improved.

### Summary -- The EEP

1. recognizes that this project is essential for the insect control work of INTSORMIL in LDC's. It is also important for U.S. sorghum producers. Continual and additional support from USAID, Texas and other U.S. sources should be provided. Valuable feedback to U.S. sorghum producers include both resistant germ plasm and beneficial predators and parasites.
2. believes that AID should provide additional support for - training programs in the U.S.--roughly two or three entomologists should be trained for each position abroad judged important for this project because of attrition and unavoidable diversions.
  - establishment of insect nurseries abroad for pests not located in the U.S.
  - travel and work of U.S. entomologists in LDC's.

## TAM-126

**Food and Nutritional Quality of Sorghum and Millet****Principal Investigator: Lloyd Rooney**Research

1. Productivity is usually defined as production per unit area. More generally productivity can be defined as total value of output divided by the total value of inputs where value is measured in terms of a common denominator that may be either monetary or non-monetary. Thus, productivity studies must also consider the various factors valued or desired by the consumer. This project contains research goals which relate to grain quality or value to measurable characteristics that can be used in breeding work to select sorghum and millet varieties with valued traditional and agro-industrial attributes for utilization. If the grain cannot be processed and utilized as valued food, then the agronomic and breeding research is less productive. The work plan is acceptable and realistic relative to its research objectives since it is conducted for the purpose of improving the overall quality of sorghum, and to a limited extent, millet.
2. Only two scientists are directly responsible for the project. However, they have accomplished a significant amount of work because of: one, the active participation of other scientists from different disciplines and two, the relatively large number of students responsible for one and even two research topics.
3. The research is highly productive as judged from the number of publications, research topics, number of collaborating scientists and students. The researchers are responding well to questions and problems raised by the program. Some duplication may be present; however, such duplication may be needed to arrive at sound conclusions related to the multiple constraints sorghum has as a food.
4. The project has short, medium and long-term objectives. Short and medium term objectives are those that demonstrate the importance of food quality characteristics and can be altered by breeding. Likewise, the development of methods to monitor changes and induce improvement by breeding represent short and medium term objectives. This is particularly more important if food quality characteristics are correlated with yield. The long-term objective is to have population groups (food) and/or industry (food or feed) use the improved varieties.
5. This question is not very applicable to this project; however, the research results, techniques and instruments developed in this project are not site-specific and can, therefore, be transferred to other laboratories in developed and underdeveloped countries and sites. This is particularly true for those simple to perform. This may not be as true for the more complicated basic research being conducted.
6. The work in this project is very well integrated at Texas A&M. In describing their particular research, researchers from all departments and disciplines, refer to grain quality as an important attribute to have in sorghum. Likewise, those grain quality researchers show concern for the research of others. Furthermore, there is recognition of research results reported by other groups in collaborating sites, particularly in the U.S., though less in LDC's. Integration with LDC's sites tend to be through students.
7. The research is devoted mainly on overcoming the food constraints of sorghum as perceived in LDC's.
8. The results of the grain quality project are also of great potential benefit to U.S. farmers. The white grain, for example, will find domestic uses in feeds and foods once its advantages are demonstrated with animal feeding trials and in agro-industrial processing as food.
9. The U.S. researchers are receptive to LDC collaborator feedback. Observations, doubts and needs of LDC collaborators are taken into consideration in project design and in work plans. In addition, the foreign students contribute greatly to this project. Feedback also takes place when technologies are transferred to LDC's.
10. Basically, the objectives of this project have not changed. If anything, they have expanded into nine basic types of activities in order to acquire a better understanding of the mechanisms responsible for the changes being obtained. This in turn serves to introduce desirable changes.

New research includes attention to malting quality, starch quality, and the development of weaning foods.

11. Workers in this project are collaborating efficiently with workers at other collaborating sites.

### Training

1. Presentations by the various students indicated that the training being conducted is a function of or relevant for the research goals of this project.
2. Both short-term, but particularly long-term, training is being effectively accomplished. The basic and applied research complement each other well.
3. Trainees are generally selected in conjunction with collaborating LDC site activity. Obviously this process contributes substantially to strengthening of institutions and research capability at collaborating sites. In this respect some limited support should be provided to the trainee upon returning home, to insure that he or she will use his or her newly acquired knowledge in his or her research.

### Sustainability of Performance

1. A visit to the facilities indicated that the infrastructure and available resources are adequate. Laboratories are well equipped, reference books and scientific journals are available, in a pleasant working environment.
2. The staff involved includes first class, dedicated, hard working scientists, aware of the responsibilities they have.
3. For the most part, research results from this project have reached the point of dual application. One application is as tools for selection of sorghum varieties with the desirable attributes of sorghum breeders. The second is in applying the results in real situations.
4. Though funding comes from INTSORMIL, some students working on this program are financed by other sources, Texas A&M supports work on grain quality.
5. There is good project cooperation and collaboration with other INTSORMIL projects, ICRISAT and host country programs judging from evidence provided during presentations of research results.

### Summary of Recommendations

The research being conducted in the Food Quality project is excellent and relevant to LDC problems with U.S. applications as well. This work should be continued to learn more about the importance of chemical components in sorghum that could be playing roles in resistance to insects, micro-organisms, and environmental stresses as well as in food quality. Some recommendations include the following:

1. Field trials with the best cultivars (yield and food quality) should be conducted in farmers' fields in LDC's and, more important, with housewives to learn if the materials really meet the expectations of the farmer and the technology of the housewife. Producing sorghum in experimental fields both in the U.S. and LDC's and running laboratory tests is one thing; the real tests, however, are in farmers' fields, in the kitchen, and in the eating.
2. The same approach should be followed in researching agro-industrial food processing, both small and large scale. This is important for products such as parboiled sorghum as well as others.
3. Nutritional fortification of sorghum products is recommended for food prepared at home and for industrially prepared foods, weaning children, and for pregnant and lactating mothers all more susceptible to malnutrition.
4. The food quality project should incorporate micro (animal) nutrition evaluation studies into their work plans, for final products at least. For example, CHO availability, protein quality and bio availability studies on other important nutrients such as carotene (vit. A), Fe and B vitamins. Yield should not be increased at the expense of the present nutritive values of sorghum.
5. Products developed with the new varieties or through new processes should be analyzed for nutrients, besides organoleptic (acceptability) and functional properties. For example, though parboiling increases fuel energy consumption at home, it enriches the product in B vitamins as has been shown for rice.
6. Grain storage studies for the new varieties should be carried out so as to have answers for the entire food chain.

7. Large feedings trials (chickens, cattle and swine) should be carried out with white and red grain to demonstrate to the feed industry the advantage of white over red grains.
8. It is important to continue with basic research in tannins, carbohydrates, protein bioutilization and behavior during processing.
9. Finally, sorghum food products different than those commonly consumed in LDC's should also be developed.
10. With changing food habits and with subsidized wheat and rice becoming available at prices comparable to those for sorghum, the need for alternative uses of sorghum has become evident in countries such as India. A collaborative research program oriented towards the development of alternative uses of sorghum should be developed with components including:
  - a. Feed grain studies with white (food) good quality grain sorghum for cattle, poultry and swine.
  - b. Biomass utilization for energy - methane and ethanol.
  - c. Malting and malt based foods and brews.
  - d. Industrial and other uses.
11. AID, INTSORMIL and particularly TAM should instigate market development work. TAM's Agricultural Economics Department could appropriately collaborate with INTSORMIL's U.S. and overseas institutions to research the effects of new sorghum varieties with improved human and livestock food characteristics on
  - a. export markets for U.S. produced sorghum as
    - livestock feed
    - human food as a grain and as a vegetable
    - industrial feed stocks
  - b. the U.S. domestic markets for U.S. produced sorghum for the same three uses
  - c. the markets for LDC produced sorghum for the same three uses
12. There is increasing evidence for the relationship between certain biochemical compounds in the sorghum plant and grain which are associated to problems affecting yield. A case in point is cytokinin levels and charcoal rot. Increased research efforts in these aspects is recommended as a means to increase production of sorghum grain.

## TAM-128

### Development of Control Programs for Millet and Sorghum Diseases in Semiarid Southern Africa

Principal Investigator: Gary Odvody

#### Research

This collaborative project aims at identifying major diseases of sorghum and millet in the SADCC region and developing suitable control/management strategies. Relative to the funding, the mandate is far too large. It should be viewed as a long-term goal.

The PI and collaborating scientists were able to assess the disease problems of sorghum and millet in Southern Africa and have directed their studies on sorghum downy mildew, head smut, charcoal rot, foliar diseases, leaf blight, zonate leaf spot, gray leaf spot, ladder spot, sooty stripe and anthracnose; grain molds, seedling diseases,

endomycorriza, viruses and some of the pearl millet diseases. SDM and charcoal rot seem to occur widely in the region. Severe infestations of sooty stripe and viruses were observed in the introduced lines. Head mold and grain deterioration were problems. Tackling the disease problems of the region needs prioritization.

In the Southern African region, the commercial farms cultivate hybrid sorghum on an intensive scale. Local sorghums and millet predominate in communal farms. Disease research needs to be oriented to these specific situations. The pathology program should critically assess

the disease reactions of potential new cultivars likely to be released to ensure that particularly susceptible ones are not released.

#### LDC Training and Sustainability

The training programs are quite satisfactory. Linkages with the ICRISAT-SADCC programs in the region are extremely good. Capacity for sustaining the program is building up in the region.

Perhaps the title of the project should be changed to "Development of Management Strategies..." rather than "Development of Control Strategies..."

#### Recommendations: The EEP believes that:

- Disease problems for hybrid sorghums of commercial farms and for local cultivars of sorghum and millet in communal farms should be prioritized to focus attention on more serious diseases.
- Safeguards should be established against the release of new cultivars that may exhibit extreme susceptibility to prevalent diseases.
- That the project concentrate on more important diseases only.

## **Section II.**

### **International Sites**

**1986**      **Mali**  
              **Niger**  
              **Honduras**

**1987**      **Botswana**

**1988**      **Colombia**

Cancelled by the American Embassy for Security  
Reasons

**Sudan**

Cancelled due to Summer Floods and Workshop Can-  
cellation

This INTSORMIL Year 7 Triennial Review Document contains the triennial review data on four Prime Sites; Niger, Mali, Honduras and Botswana. The document also contains a section on individual project annual reports which represents the annual review of all projects required by S and T Agriculture. This was packaged together with the Year 7 Triennial Review Report in preparation for a grant extension request in 1987.

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## INTSORMIL YEAR 7 TRIENNIAL REVIEW

INTSORMIL, the International Sorghum/Millet Collaborative Research Support Program (CRSP), has completed 7 years of operation and is currently in its 8th year. The current review by the External Evaluation Panel (EEP) attempts to fulfill part of the requirements for this CRSP to receive an additional three years funding beginning July 1, 1987. Members of the EEP are as follows:

Dr. Ricardo Bressani, Guatemala  
Dr. Brhane Gebrekidan, CIMMYT, Mexico  
Dr. Glenn Johnson, Michigan State University  
Dr. Clarence Gray, Vice Chair, Virginia Polytechnic Institute  
Dr. Bruce Maunder, Chair, DeKalb-Pfizer Genetics

The panel was briefed in Kansas City in early September, 1986 by country coordinators and discipline coordinators as well as by the ME and Dr. Harvey Hortik, AID/W. At the time, plans were made for on-site reviews of Niger and Mali in October, Honduras in December, and Botswana in March/April 1987. Additionally, the EEP met for two days in mid-December to discuss the following report.

The EEP was impressed with the high level of cooperation evident among INTSORMIL scientists from the different U.S. member universities. This cooperation has led to a high degree of coordination in the community of U.S. scientists with sorghum and millet expertise in focusing on problems requiring improved sorghum and millet technology in both less developed countries and in the U.S.

This CRSP has been remarkably successful in mobilizing resources in the U.S. centers of excellence in support of efforts to increase the production and utilization of sorghums and millets in developing countries. In 1986 (Year 7) 41 agricultural scientists from six universities were principal investigators of INTSORMIL supported projects in 12 countries of Africa, Asia, Central America and South America. The Land Grant universities involved are in Texas, Nebraska, Kansas, Indiana, Mississippi and Kentucky. Individuals involved include distinguished scientists who bring a wide range of experience and expertise to international sorghum improvement. CRSP funds have enabled these scientists to visit and work with collaboration at country and regional research sites; have opened up special training opportunities for foreign collaborators in the U.S.; and have

provided access to state of the art production and utilization technologies. The principal thrust of INTSORMIL is being directed to the improvement of sorghum. Less attention is being given to millet.

The EEP was created for each CRSP with responsibility "to evaluate the status, funding, progress, plans, and prospects of the research programs of the CRSP and to make recommendations thereon"<sup>1</sup>

As outlined in the BIFAD guidelines the purposes of the evaluation are to: "maintain programmatic focus and effective scientific balance of research toward achievement of objectives; identify inadequate performances, identify irrelevant, marginal activities to CRSP objectives; consider effective balance between research and training for development of institutional research capability; assess the balance of domestic versus overseas research in terms of effectiveness of solving constraints in developing countries; evaluate the cost effectiveness of the entire CRSP operation in terms of actual cost of doing business versus costs of alternatives that may be less, more efficient, and more effective; and examine ways of dissemination of research results, and the effectiveness of utilization, a measure of the appropriateness of the research".

### INTSORMIL Accomplishments Through Year 7

INTSORMIL is making a global impact by collaborating with 17 host countries in seven major regions: West Africa, East Africa, Southern Africa, Southeast Asia, Central America, the Caribbean and South America. Research/technology development, one of the CRSP objectives, involved some 41 U.S. scientists working with 88 scientists in LDC's associated with the 6 eco-geographical zones. Training and institution building are the additional objectives with some 15 workshops having taken place the first 7 years and some 376 students have been trained during this period. In year 7 some 157 students were involved in graduate degree programs sponsored in total or partial support by INTSORMIL.

PRF-104B, with Dr. Larry Butler as principal investigator, reported in Year 7 on the possible relationship of an oily phenol-rich exudate on each sorghum root hair which could relate to *Striga* resistance. His laboratory found the exudate to be a powerful stimulant for the ger-

1/ From Guidelines for the Collaborative Research Support Programs, June 21, 1985

mination of *Striga* seeds. He and his associate, Dr. D. Lynn found the exudate to be a highly substituted quinone never found before in sorghum or in any other organism. They named it "sorgoleone". This is the first *Striga* germination stimulant ever identified from a natural host. This same compound has herbicidal activity against weed competitors but *Striga* focuses on the exudate as a host-specific recognition signal. This discovery could lead to an effective means of *Striga* control where none is now available. For example, a stable synthetic of sorgoleone could be used to treat a field and induce germination in the absence of a host. Other means of control are being pursued.

Collaborating Honduran and Texas A&M researchers have developed two varieties and a sorghum hybrid that are superior to traditional maicillo criollos. These new cultivars evaluated under Dr. D. Meckenstock's leadership with TAM-131 will add more stability to sorghum production through drought, insect and disease resistance. They must, however, and do give superior yields of food quality sorghum. Their research has implications for Mexico, Central America, and the Caribbean area.

With the same program, Ronaldo Sequeira of TAM-125, developed a "no cost" insecticide applicator. The significance of such a device is obvious for the small farmer and even more importantly results in much more efficient chemical use when controlling stem borers.

Sociology, anthropology, and economic studies have been done in the Dominican Republic, Sudan, Philippines, Burkina Faso, Honduras, and Mexico. The INTSORMIL socio-economics studies provide base-line information and input for decision making for host countries and the U.S.

INTSORMIL, ICRISAT, and Sudanese researchers jointly developed a hybrid sorghum, Hageen Dura 1, and have seen its use expand rapidly. With some 3.5 million hectares of sorghum in the Sudan, a hybrid that more than doubles the yield of traditional varieties is without question a major accomplishment. The germplasm involved in this hybrid additionally helps refute concern expressed by those involved with the FAO understanding.

INTSORMIL food quality research has shown different chemical compounds to be involved in bird resistance and reduced protein assimilation. This finding should allow for increasing levels of one and reducing the other.

With more than 2 billion hectares of Brazil, Venezuela, and Colombia facing aluminum toxicity problems on acid soil, the discovery by INTSORMIL MS-104 and MS-111 of tolerant lines for breeding purposes will likely shorten the time before much of this non-producing world can in fact grow a food/grain crop.

Millet researchers in Kansas have contributed significantly to the dissemination of breeding techniques and valuable early maturity germplasm. Significant cultural improvements have been accomplished from work in the Sudan and Southern Africa. Quality work has been expanded to two projects.

Entomology and pathology support to varietal improvement is essential. INTSORMIL workshops and in-country research by these disciplines have indeed been beneficial to this CRSP.

CRSP relationships with USAID/Missions continue to strengthen. Currently Sudan, Paraguay, Honduras, and Botswana AID/Missions commit funds to INTSORMIL collaborative research.

A subgrant with ICRISAT provides for training of SADCC students. The program is funded by the USAID Zimbabwe Regional office. Currently 19 students are involved in this training.

Finally the External Evaluation Panel is pleased to note the strong efforts being made by the ME to strengthen this CRSP in the light of decreasing funding. We also feel good response and positive actions were taken in relation to our 29 recommendations made at the time of the 1984 review. With more information passed on to the EEP by the ME, the better our understanding and more positive input we can return. The EEP also will benefit from a closer relation to the Technical Committee.

### Niger Prime Site EEP Report

This evaluation took place October 19-24, 1986, by EEP reviewers, Drs. Brhane Gebrekidan and Glenn Johnson. The complete report may be found in the appendix with the following being the reviewers comments and recommendations:

A. **Millet Research.** It was repeatedly mentioned both by INRAN and USAID Niger that INTSORMIL was not sufficiently involved in pearl millet research in Niger. Since pearl millet is the most important crop of Niger it is understandable why this issue is of concern both to INRAN and USAID. It would be very much desirable if INTSORMIL would draw upon the available and appropriate expertise in the U.S. and get involved more in pearl millet research in Niger.

B. **INTSORMIL/ICRISAT in Niger.** It is clear that both ICRISAT and INTSORMIL consider Niger as the country of focus in their West African initiatives. Obviously, ICRISAT, through its Sahelian Center in Niger, is operating at a much larger scale than INTSORMIL. Currently there are 17 professional staff at the ICRISAT Sahelian Center (ISC). There was some concern ex-

pressed, especially by USAID Niger, about possible duplications of effort between the two organizations. However, at this time there is very little duplication because ICRISAT's concentration in Niger is on pearl millet and that of INTSORMIL is on sorghum. If INTSORMIL plans to work on millet it must be in areas complementary to ICRISAT's efforts. In view of the shortage of high level trained manpower in agricultural research in Niger and the subsequent limitations in the absorptive capacity of INRAN for truly Nigerien scientists to INTSORMIL scientists collaboration, it was pointed out, especially by USAID Niger, that the ISC may offer better opportunities for a more meaningful collaboration than INRAN. However, in the various areas of sorghum research, the ISC does not have much to offer now. Regardless of this fact, in the long run it appears much better for the national program of Niger if collaboration is between its national scientists and INTSORMIL scientists. Such a collaboration helps them develop their own capabilities and make them self-reliant.

C. Plant pathology. There is very little involvement of INTSORMIL in plant pathology research in Niger. Everywhere we visited in this trip, we have noticed long smut as a major disease. TX623 was especially susceptible to the disease. INRAN has expressed concern about the severity of this disease which is also serious in much of the lowland semi-arid areas of the rest of Africa. The Sudan, through INTSORMIL collaboration, does some work on long smut. It would be very much desirable if INTSORMIL would initiate work on this disease in Niger and also facilitate collaboration between the Sudan and Niger on research on this important but neglected disease.

D. Striga. This parasitic weed is a serious problem on both sorghum and pearl millet not only in Niger but in most areas of Africa growing these crops. The INTSORMIL initiated work on *Striga* is good and should contribute to the overall effort of tackling this problem Africa-wide. The sorgoleone work at Purdue is a unique development. Further effort should be made to explore the practicality of this chemical for *Striga* control. ICRISAT/IDRC have been working for a number of years on *Striga* in Burkina Faso. Further efforts are necessary to link up closely the ICRISAT and INTSORMIL *Striga* work in West Africa.

E. Sorghum Breeding. Much has been done by the INTSORMIL CRSP to introduce a wide array of selected sorghum germplasm into Niger. The sorghum breeding approach is a comprehensive one in that it covers both hybrid and variety development. Some of the advanced lines from the pedigree selection at Konnie looked outstanding agronomically with excellent grain quality. The hybrid sorghum work is justified because it does complement the variety development effort. Hybrid sorghum should have good future potentials in Niger especially in view of the projected USAID support to small scale irrigated crop production. Much of the breeding work

depends on making crosses and generation advance for Niger in the U.S. and conducting the selection and evaluation phases in the host country. This is a good and an effective mechanism for collaboration. The breeding work should continue to be the core of the Niger prime site program.

F. USAID and agricultural research in Niger. The major source of agricultural research support to Niger traces to USAID and much of this is in cereals research as it should be. USAID Niger has been talking about shifting priorities from cereals in favor of diversification primarily because of the current grain surplus and low prices in Niger. The surplus situation is certainly temporary resulting from the favorable rains of the past two seasons. The years of inadequate rainfall and poor crop harvests in the Sahel are sure to come again. In the long run, continued support to cereals research is indispensable to improve and stabilize cereal production in Niger. The INTSORMIL CRSP has certainly a significant role to play in this effort.

G. Seed Industry. For political as well as practical reasons, most countries would prefer to have their own seed schemes for their important crops. For West Africa, the Pioneer seed company based in Ivory Coast is proposing to sell seeds throughout the region. A letter distributed by the company to the USAID missions of the region seems to suggest that they are prepared to develop and/or introduce seeds needed in the region. Regardless of the involvement of a multinational seed industry in West Africa it would be very essential to continue to support the national programs in their crop improvement efforts.

H. Collaboration. Because of the limited availability of high level trained manpower in Niger, a point of concern raised was whether Nigeriens are sufficiently involved in the design and priority identification of research. This is a legitimate concern because the central concept of the CRSP is collaboration. Under the circumstances we are satisfied that Nigeriens collaborated at all levels starting from design to implementation of the current projects. When the trainees on-board return to INRAN, collaboration is expected to improve with the Nigerien collaborators taking more of the initiative in problem identification.

I. Funds for in-country collaborators. One of the main factors limiting the effectiveness of a collaborative activity is the lack of resources and funds for the collaborator in the host country. Often a relatively small amount of funds allocated for this purpose is very much cost effective and can go a long way in achieving the overall goals of the CRSP. In the case of Niger, particularly when a number of trainees are expected to return to their home country, it is highly recommended that some amount of the project funds be ear-marked for in-country spending by the col-

laborators for the CRSP projects. This is in addition to appropriate equipment purchases.

J. Linkages between prime and collaborative sites. A number of the problems being researched on at the prime site are relevant for and applicable to the conditions of a number of other INTSORMIL countries in Africa. It would be desirable if further efforts are made to strengthen linkages between the prime site and other collaborating countries, particularly in West Africa. One way of strengthening linkages would be to include all INTSORMIL collaborating national scientists in workshops like the one held in Niger in 1985. The excellent head bug work in Niger can be extended to Mali and could be another good basis for collaboration between Niger and Mali.

K. Overall impression. The INTSORMIL scientists and the prime site coordinator are to be commended highly for having initiated and mobilized the appropriate INTSORMIL talent and resources to concentrate on the sorghum research problems of Niger. This shift of emphasis and focusing on the real problems of a developing country such as Niger is a much appreciated development. Although there is much more to be done in Niger and similar other African countries in sorghum and millet research, we believe that the INTSORMIL CRSP is on the right track at this prime site and we have no doubt that they will contribute significantly in improving and stabilizing sorghum and millet production in the region. Our overall impression for this site is excellent.

### Mali Collaborative Site EEP Review

The evaluation took place October 24-29, 1986, by EEP reviewers, Drs. Brhane Gebrekidan and Glenn Johnson. The complete report may be found in the appendix with the following being the reviewers' comments and recommendations:

A. Millet research - Same comments as Niger (A).

B. INTSORMIL/ICRISAT in Mali - The issue of duplication between the activities of INTSORMIL and ICRISAT did not come up in any of our discussions. The ICRISAT/USAID/Mali sorghum and millet program has served INTSORMIL in much the same way as INRAN has in Niger. The significant contribution of Dr. John Schuering, who has now left ICRISAT, was emphasized by IER. There was an indication at the time of our visit that ICRISAT may choose Mali as the regional center for their West African sorghum program. If this materializes, it would be essential for INTSORMIL to work closely with ICRISAT/MALI so that their activities would continue to complement each other.

C. Plant pathology and entomology - The long smut disease of sorghum is also of concern to Mali as Niger but

there is very little work being done on it. INTSORMIL's work on this disease whether based in Niger or Mali should be planned to serve both countries. Duplication of work on this disease in the two countries does not appear justified. The strong head bug complex work in Niger should serve Mali also. USAID/Mali has indicated that the IPM work is being phased out and that they would like to see INTSORMIL continue some of the sorghum and millet entomology and pathology work. That is a suggestion worth a follow-up.

D. Striga - At this time there is not much that Mali is doing on this problem. INTSORMIL is concentrating on *Striga* in Niger. It is recommended that the INTSORMIL/Niger *Striga* work be strengthened and expanded so that it covers Mali's concerns also. It would be essential to coordinate the *Striga* research activities of ICRISAT/Burkina Faso and INTSORMIL/Niger and also Mali as a testing site.

E. Sorghum breeding - A strong breeding program should be the core of the INTSORMIL/Mali CRSP. Since the departure of John Schuering there appears to be a weakness in the Malian sorghum breeding program. Plans are that ICRISAT is to place a new sorghum breeder in Mali. If this materializes, it would be essential for INTSORMIL to link up closely with the new breeder as well as the young Malian sorghum breeders. It is recommended that efforts be made to strengthen the Malian sorghum breeding program. It was obvious that there was not a strong initiative in hybrid sorghum in Mali. It is recommended that the Niger hybrid sorghum work use Mali as a testing site to explore the potential of hybrids in Mali.

F. Plant physiology - This is certainly the strongest discipline at this site essentially because of Dr. Moussa Traore returning after his INTSORMIL training at Nebraska under Dr. C. Sullivan. He has received and continues to receive a wide range of plant physiology laboratory equipment from Sullivan's NU-123 project and in addition he has the new USAID grant. The plant physiology work is to continue on drought and heat tolerance. With this substantial support, all concerned hope and expect useful plant physiology work to be done in Mali. It is very important to link up closely the planned physiology work with breeding and practical agronomy research so that the effort will result in improved sorghum and millet production in Mali and hopefully elsewhere in West Africa. The plant physiology area is certainly one in which Mali can provide leadership and network with Niger. In view of the development of such a strong program in this discipline in Mali the justification for initiating a similar program in Niger now is questioned. Niger does not have the trained manpower for this purpose. It would seem logical for Dr. Eastin to move his project from Niger and together with the strong program in Mali could serve West Africa.

**G. Food quality** - The construction of the new food technology laboratory is near completion at Sotuba. Well trained personnel are available for the laboratory. IER has requested equipment for this laboratory through INTSORMIL funding and some has been budgeted. It is recommended that INTSORMIL participate fully in equipping and using the facilities.

**H. USAID and agricultural research in Mali** - The issue of diversification and reduced emphasis on cereals research did not come up in Mali as it did in Niger. On the contrary, USAID/Mali is very much supportive of cereals research. They are behind the current Malian sorghum improvement program. They were instrumental in facilitating the USAID-PSTC \$150,000 grant for Dr. Moussa Traore. They have emphasized the point that success stories have to be told, or even better, demonstrated to maintain their support.

**I. Seed industry** - Same comments as Niger (G).

**J. Collaboration** - To fully collaborate in the spirit of the CRSP, Mali has a much better high level trained manpower base than Niger in the physiology, food quality, and to a lesser extent breeding. The Malian scientists have excellent motivation and interest to do collaborative research.

**K. Funds for in-country collaborators** - In general the flow of INTSORMIL funds for Mali in-country spending has been satisfactory. Again, the new USAID-PSTC grant will improve the situation even more. The breeding activity may require additional support.

**L. Linkages between prime and collaborative site** - In addition to the suggestions made in the sections above, the comments under Niger (J) on this issue apply for Mali also.

**M. Overall impression** - The overall favorable impression expressed under Niger (K) apply for Mali also. The Mali site coordinator(s) and all the INTSORMIL scientists and their Malian collaborators involved in this work are to be commended for initiating and operating a good CRSP.

### **Honduras Prime Site EEP Report**

This evaluation took place December 7-11, 1986, by EEP reviewers Drs. Ricardo Bressani, Clarence Gray, and Bruce Maunder. The complete report may be found in the appendix with the following being the reviewers' comments and recommendations:

**A. To encourage additional project planning and review utilizing all available participants at such sessions with opportunity for review by the country coordinator and ME.**

**B. In this regard quarterly meetings may be in order to be sure the Ministry, EAP, INTSORMIL, and perhaps others are aware of projects, progress, problems, and opportunities.**

**C. Utilizing Dr. Dan Meckenstock's talents as a source of sorghum authority and support for country programs while he operates from the EAP base. It will be essential that the ministry accepts his tie-in with this private institution.**

**D. To minimize research for the Olancho sector since current commercial hybrids are available and effective there, already.**

**E. To encourage more research affecting storage and utilization, two of the three objectives stated in the memorandum of agreement signed in October, 1982. As more grain is produced we must assume it would primarily affect livestock feed. Utilization appears to be the weakest link in the food chain. Perhaps field days will give the research group more information on farmer requirements and in turn producers more opportunity to see, appreciate, and utilize the new products.**

**F. To suggest INTSORMIL play a role in farmer evaluation and distribution of the improved products resulting from their research if no more than participate in planning sessions with extension. Decisions need to be made following extensive testing.**

**G. To encourage more administrative support for Dr. Dan Meckenstock, e.g. budget, EAP arrangements. For example, INTSORMIL needs a MOA with the EAP considering that Dr. Meckenstock offices there and conducts research on their land and with their facilities. An active support person from Texas A&M working with Dr. Meckenstock on budgets, projects, and especially institutional coordinating would seem beneficial.**

**H. To investigate potential advantages and opportunities by working with the Institute of Nutrition of Central America in Guatemala.**

Now with trained staff returning to the program, INTSORMIL, ICRISAT, USAID/Honduras, and the Ministry must develop a cooperative, multi-disciplinary approach which best utilizes available resources and is coordinated by directors of all programs involved. As an example, besides these agencies doing breeding perhaps one should additionally take a lead role in pathology which seems rather absent in the program another in nutrition, and another in entomology.

## Botswana Prime Site EEP Report

This evaluation took place March 26-30, 1987, by EEP reviewers Dr. Brhane Gebrekidan and Dr. Bruce Maunder. The complete report may be found in the appendix with the following being the reviewers' comments and recommendations.

1. EEP has for some time felt a strong need for a prime site review of Botswana which essentially completes all prime sites since global plan was established. Past trip reports, project reports, and presentations had given us concern as to the effectiveness and accomplishment of INTSORMIL inputs into Botswana. We also questioned the opportunity for extension of research to neighboring countries with South Africa well developed and Zimbabwe a leading country from a seed technology/varietal development standpoint as well as having a major ICRISAT sorghum improvement effort there.

2. Our five day visit, however, has given us an opportunity to better understand the Botswana internal situation as well as the out-of-country support programs. We realized a positive outlook for various reasons e.g.

a. USAID/Botswana shows strong interest and support for INTSORMIL assistance as experienced by the John Hummond presentation which gave us a strong orientation. Certainly Paul Daly, ADO, showed a strong interest in our visit with conversation on three days plus participation in our Mahalapye field tour. Paul showed interest in locating a means for additional support funds and asked for suggestions regarding the seed situation.

b. The strategic position of Botswana to South Africa being 90-95% dependent on them for supplies including both food and hard goods, as well as the relation to SADCC countries. The need for more self sufficiency, however, must be a major concern when one considers the place of the diamond industry in relation to a social or welfare state.

c. Both INTSORMIL and ATIP seem mutually supportive of the others need for a satisfactory level of accomplishment. This good working relation undoubtedly is making each more effective.

d. We suspect that the very elementary research on basic agronomic practices related to drought can very well be applicable to other African countries where drought is a constraint -- pretty well all inclusive.

e. INTSORMIL should benefit by taking advantage of maintaining a close relationship with the SADCC and SACCAR activities based in Botswana.

3. The aim of INTSORMIL being able to build a strong collaborative program, we would encourage a closer

relationship to ARS staff. We do, however, encourage their staff to request such support as opposed to an attempt to pressure them with extensive externally recommended projects. More advance time and forward planning should be given to visits by PI's with as much orientation in advance as possible. Also, ARS staff as well as AID mission and ATIP need an opportunity for planning and especially taking advantage of the PI's talents.

4. We agree to the unanimous request for a soil physicist to investigate soil/water relations. This PI would:

- determine factors influencing infiltration rates
- look into changes of the cultivated soil zone
- interrelate with ATIP and ARS staff and graduate students.

We strongly recommend a short term (one month) consultant to investigate opportunities and need for the position. He hopefully could suggest the best possible candidate who preferably should have adequate experience to give significant and immediate input. Dr. Bob Stewart, director of the Bushland Station, Amarillo, seems a logical candidate for the short term as he can additionally make immediate suggestions helpful for projects prior to the next "rainy season."

5. Doug Carter should be listed as a PI with KS 107 but receive increased project planning in conjunction with Van Withee, also a project PI, Vanderlip, Norman, and key ARS staff as suggested by the director.

6. We would encourage some short term projects which can be adopted and used to illustrate progress to support the longer term approaches. These highly visible but perhaps more simplistic results or accomplishments can give strong impetus to continued or increased support.

7. We strongly support the fundamental agronomic approach to problems of the small farmer as opposed to a more specialized research effort.

a. Obviously all research must concentrate on drought/heat with stand establishment interrelated.

b. The re-direction into water harvesting and conservation was recognized by the EEP.

8. We encourage continued close cooperation between Mazhani and Andrews in all aspects of plant breeding with this collaboration hopefully an example for other disciplines wherever possible.

9. The talents of Harspool in the design of animal drawn equipment should be a positive asset for various INTSORMIL collaborative projects.

10. At current country yield levels agronomic inputs (cultural practices) along with needed varietal improvements seem most productive and offer the best opportunity for improvement as compared to more basic science (disciplines).

11. We strongly urge and appreciate the continuity of staffing and thus the opportunity for the completion of projects.

12. We only had limited contact with the seed multiplication unit and additionally it is out of the responsibility of INTSORMIL. We did offer to suggest specialists for such input and will make specific comments to Paul Daly.

We appreciate the courtesies extended to us by all involved during our visit. Continuation of active INTSORMIL collaboration appears most desirable.

### Individual Project Annual Reports

The 1986 EEP review placed primary emphasis on three overseas site reviews, i.e. Niger, Mali, and Honduras with a fourth planned in the spring in Botswana. Also, a September, 1987 discipline review of all breeding programs is being planned. The panel did, however, have access to all annual reports submitted by mid-December. The ME in turn requested scoring be done on a form for each project with four items evaluated and then an overall project evaluation be given with comments the reviewer felt appropriate.

At the December 16 meeting in Dallas four of the five EEP members discussed each project with an average score being calculated and included in the appendix. Some 13 projects were felt to be exceptional with high relevance to the CRSP functioning, and showed planning with appropriate objectives. Nine projects with some modification will make a useful contribution to INTSORMIL objectives. The following projects raised some question concerning progress, relevance, and/or likelihood of a significant contribution:

**KS-107 - Water Use Efficiency, Intercropping with Legumes, and Tillage of Sorghum and Millet in Botswana.** The EEP felt too little involvement existed of host country scientists. A suggestion was made that scientists working in Botswana should remain for at least five years to give continuity and reliable results. The on-site review is needed to determine opportunity for accomplishment given current inputs. Also, 35,000 ha sorghum and 7,000 ha millet (1984 FAO) in Botswana must be evaluated in relation to this prime site for south Africa. The EEP must question outreach potential from this prime site. Currently, for example, the Zimbabwe government only allows soybeans to be planted, no maize or sorghum (because of surplus).

**KS-108 - Identification and Quantification of Nematodes with Bacterial and Fungal Incitants in Stalk Rot Complexes of Millet.** The EEP feels millet disease work to be limited in Africa, but report suggests much of activity with sorghum. Also, question if millet a significant crop in Lesotho. FAO statistics only list sorghum there. We encourage more collaboration and trust project will finalize projects in Sudan and Niger. Project perhaps could use more planning.

**NE-113 - Agronomy and Cropping Systems.** EEP questions whether soybeans have much relevance in the traditional sorghum and millet growing areas. We commend project for being "agronomic practice" oriented. To be most effective we would hope that most of work take place with overseas linkages. Support for a non-INTSORMIL country trainee (Bhutan) questioned.

**NE-119 - Evaluating Pearl Millet Germplasm for Food Quality.** We realize the project is new and has not had time to show results with likely over-budgeting in Year 7. EEP would like more information on year 8 and chose by consensus not to evaluate year 7. TAM-126 essentially has same project title so obviously some coordination must be given by TC to eliminate duplication or more importantly maintain efficient use of INTSORMIL dollars.

**TAM-128 - Integrated Control of Millet and Sorghum Diseases in Semi-Arid Southern Africa.** Another project we felt too new to score. We encourage project to direct research towards objectives. Project should accelerate and strengthen activities in target host countries. Project needs more counterpart support. We commend PI for supplying 50 slide sets to SADCC countries helping in identifying diseases for use in extension activities regarding sorghum and millet diseases.

In general, as requested in the 1984 evaluation, the EEP feels they could be much more effective with a one on one opportunity to discuss projects as opposed to reading annual reports or group presentations. Certainly on-site visits have been extremely beneficial. Need for a millet authority on the EEP still seems a reasonable request.

## Year 7 (1985-86) Projects and Their EEP Rating

Project		Rating
KS-101	Pearl millet breeding	1.3
KS-106	Millet stand establishment	2.0
KS-107	Botswana agronomic research	2.2 **
KS-108	Stalk rot complexes of millet	2.2 **
MS-104	Host plant resistance	1.0
MS-111	CIAT Acid Soil	1.0
MS-105	Fall armyworm	1.7
NE-113	Cropping systems	2.2 **
NE-114	Mineral element update	1.0
NE-115	Breeding sorghum	2.0
NE-116	Water and temperature	2.0
NE-118	Breeding pearl millet	1.3
NE-119	Millet Quality	NR **
PRF-103A	Gemplasm/quality development	1.0
PRF-103B	Chemical aspects of feed	1.2
PRF-104B	Tannins	1.0
PRF-105	Economic evaluation	1.4
PRF-107	Breeding/drought/Striga	1.0
PRF-109	Niger	1.0
TAM-121	Breeding	1.0
TAM-122	Breeding/disease/drought	1.0
TAM-123	Insect/nutrient use	1.3
TAM-124	Disease control	1.0
TAM-125	Insect control	1.0
TAM-126	Food and nutritional quality	1.0
TAM-128	Disease control millet/ sorghum Southern Africa	NR **
TAM-132	Kenya	1.3

Rating evaluation based on EEP review of year 7 reports as follows:

- 1= Relevant to program, functioning, appropriate objectives.
- 2= With some modification will make useful contribution to INTSORMIL objectives
- 3= Raises questions concerning progress, relevance, and likelihood of a significant contribution.

\*\* Specific comments within the report.

### Balance of Domestic and "Host Country" Spending of INTSORMIL Project Funds

According to the budget sheets the overall balance of domestic and "host country" spending is approximately half and half which is just about optimum. However, in some projects, some items designated as a "host country" expenditure do not appear to fit into that classification. It would be necessary to establish whether or not the expen-

ditures of each project correspond to the budget classification.

### Prime Sites/Ecogeographic Zones

INTSORMIL's current program strategy is to operate mainly through prime country sites representative of a major ecological zone/geographic region. At present it has 6 prime sites in Africa and Central America. Given adequate funding, existence of the requirements for conducting research (i.e. training host country personnel, facilities, etc.), and suitable agreements/arrangements to extend research results and services into adjacent areas, a prime site program approach seems a reasonable program strategy to achieve objectives. The External Evaluation Panel concurs with this prime site approach, but notes that the nature and level of INTSORMIL's inputs at the sites may not be the kind and amount needed to achieve and sustain rapid advances in sorghum/millet production and use. The Panel recommends that the Technical Committee and the ME examine this matter with special regard to the instructions in "Guidelines for the Collaborative Research Support Programs," BIFAD/AID, June 21, 1985, pages 8-9.

In regard to the matter of providing the appropriate kind and amount of resources to exploit the prime site program approach, INTSORMIL officials and collaborators may wish to reconsider arrangements whereby two (or more) CRSPs operating in a given host country (or could be a prime site) would share one or several U.S. scientists on long-term assignments. This may be something to explore, should funding for the CRSPs be reduced further. At the present time the Bean/Cowpea CRSP operates in Botswana and Honduras, which are INTSORMIL prime sites.

### The Need for Agricultural Sector, Demand and Trade Analysis Vis-A-Vis Technological Advances in Agriculture.

The need for technological advances of the type sought by INTSORMIL depends, among other things, on population growth, climatic instability, income and its distribution, income demand elasticities for the products involved, alternative sources of income and trade possibilities as a source of food security.

In West Africa and, for that matter, in much of central and south America, agricultural sector, demand and trade studies are beyond INTSORMIL budgets and skills. Even when such studies are available from FAO, IBRD, AID itself, other AID projects and elsewhere, INTSORMIL workers are so involved in doing what they do well -- improving technology -- that they do not have time to use the studies available to determine appropriate adjustments in INTSORMIL's program and to make justifi-

able cases for different INTSORMIL efforts. It follows from this that AID/Washington and the USAID mission have a particular responsibility to examine the different INTSORMIL projects in light of such information as is available from the international community on trends and likely consequences of changes in population, levels and distribution of income, weather instability, trade opportunities, alternative sources of income and the like. Short term surpluses of production over effective demand (even when repeated) should not be permitted to obscure the long term necessity in most third world countries of better producing more food or of earning the income needed to buy food from others. As Drs. Johnson and Gebrekidan have pointed out for Niger and Mali, the situation is somewhat obscure for West Africa in AID and INTSORMIL circles.

### **The Need for Social Science Work in INTSORMIL**

First, INTSORMIL is fundamentally a project in applied biology. As an applied effort, it is multi-disciplinary even to the extent of including the applied rural social sciences in a limited degree. INTSORMIL does not really need scientists -- social or biological -- pursuing their own disciplines for the sake of their disciplines without regard to practical problems involving sorghum and millet production and distribution.

It seems reasonable for INTSORMIL to expect rural social scientists to contribute to farm management or farming systems studies that will help design appropriate technological advances and promote the adoption of those advances once they are attained. It also seems reasonable to expect agricultural economists, rural sociologists and anthropologists to assist in studies of grain acceptability and utilization. In addition to knowing preferences, INTSORMIL needs to be guided by the costs of meeting those preferences in terms of reduced yields and other lost opportunities that consumers will sacrifice in order to satisfy their preferences. This need goes beyond simple market economics to the need to study consumers behaviorally in ways understood by sociologists, anthropologists, institutional economists, social psychologists, and the like. Food quality is more than biology (nutrition), food technology, and preferences.

### **Roles for Private Seed Firms in the Third World**

The record of parastatal, input distribution agencies in the third world is a poor one. However, it should not be concluded that a private firm will always do better. Three cases can be distinguished.

In some instances the benefit of an improved variety or technology can be appropriated by a private firm to a degree which permits the firm to prosper and render good service but not become monopolistic or monopsonistic enough to unduly exploit farmers and/or consumers. Hybrid corn in the U.S. provides an excellent historical example of such an instance.

In other cases, the benefits of a technological advance are so difficult for a private firm to appropriate that a firm cannot render good service and prosper. Yet some such technologies may be socially very desirable and beneficial. Examples include open-pollinated stable varieties and self seeding or self propagating varieties. Such seeds and materials often require public support for their development and distribution as private firms cannot make enough money to do the job.

A third case perhaps best exemplified by a public utility is when the benefits are so easy to appropriate that exploitive monopolies or destructive competition among competing monopolies is likely to develop. This last case (which is relatively rare for agriculture) calls for either public regulation of private sector firms or public agencies.

In the third world, private firms are often precluded from entering the agricultural input and product market on the basis of arguments involving the second and third case even when the first circumstance exists. Accurate determination of which of these three circumstances exists is crucial. No private firms should want to enter the second situation and have no justifiable reason for opposing public sector research and extension activities.

On the other hand, the public sector is typically short of resources including entrepreneurial skills. These shortages render it unwise for the public sector to do what the private sector can do well and cheaper; hence, the first case should be left to the private sector.

The third situation seems to materialize less often in agricultural markets than progovernment, anti market advocates fear. However, it can be significant. For instance one subtle form of monopolistic competition is to discourage public development and dissemination of type II materials in order to preserve markets for type I materials.

### **Movement of Sorghum Germplasm**

An effort to expedite sorghum introduction to this country has received support from the U.S.D.A. Germplasm/Plant Introduction Section as well as from the Sorghum Crop Advisory Committee. St. Croix in the U.S. Virgin Islands seems a natural quarantine area. Aphis, however, has expressed concern in particular about long smut and ergot with seed treatment research

planned at Frederick, MD. Dr. George White, of the plant quarantine group suggests there may be as many as 6000 sorghum accessions waiting clearance. Small quantities have been handled by greenhouse supervised quarantine at various locations but this approach fails to evaluate most collections of any magnitude or reciprocal breeding efforts, such as between PI's and overseas linkages.

In the meantime, the EEP strongly encourages all PI's to use the appropriate and legal channels for importing sorghum and millet into their respective programs. Concern exists for possible seed borne transmission of long smut, ergot, downy mildew and anthracnose. Africa, Asia, Brazil, Australia, southern Russia and Bulgaria all require a quarantine on introduced seed with your past, present, and future support needed to avoid an unfortunate introduction of a new pest or pathotype thereof.

### Summary

Improved agricultural productivity must relate to (1) capital, (2) people, and (3) science. The INTSORMIL CRSP is the only U.S. organized, funded, and directed attempt to improve productivity and utilization of sorghum and millet in LDC's through scientific input. The EEP appreciates frustrations faced by the CRSP as the three components not infrequently are out of balance. Additionally, we recognize that the PI's will always approach

their objectives as moving targets i.e. consumer numbers increasing and productivity moving both up and down with fortunately good upward movement currently being experienced in parts of Africa.

The INTSORMIL CRSP, however, must continue in quest of its objectives to assure that productivity not only shows an upward trend but more importantly that it parallels demand. The EEP sees this opportunity relating to:

1. Higher yielding cultivars e.g. Sureno, Tortillero, Catracho, Hageen Dura 1 or through farming practices which improve productivity.

2. More yield stability e.g. complementary programs of entomology and pathology and again from improved cultural practices.

3. Improved nutritional aspects e.g. the tannin research.

4. Additional land areas under cultivation e.g. the Cerrado of South America and similar low pH soils of Africa as well as solutions to *Striga* control which could reopen vast areas to improved sorghum and millet productivity.

We, the EEP, see these four opportunities receiving guidance from the social sciences and thus, together, INTSORMIL has, is, and should continue to make an even greater contribution.

**Section III.**

**Appendices**

## Appendix 1

## NIGER PRIME SITE EEP REPORT

Brhane Gebrekidan and Glenn L. Johnson  
November 1986

## I. BACKGROUND

- A. Prime Site: Niger (West Africa)
- B. Project: Niger prime site project and several other associated INTSORMIL Projects in sorghum breeding, entomology, agronomy/physiology, grain quality, and socio-economics.
- C. EEP Reviewers: Brhane Gebrekidan and Glenn L. Johnson
- D. Date: October 19 - 24, 1986
- E. Names of Collaborators:

## Niger (INRAN)

## INTSORMIL Universities

- |                                  |  |
|----------------------------------|--|
| 1. Mousa Adamou, breeding        | 1. John Axtell, Coordinator/<br>breeding/quality |
| 2. John Clark, breeding          | 2. Gebisa Ejeta, breeding                        |
| 3. Boutorou Ouendeba, breeding   | 3. Darrell Rosenow, breeding                     |
| 4. *Isoufou Kapran, breeding     | 4. Fred Miller, breeding                         |
| 5. *Tom Tyler, breeding          | 5. Dave Andrews, breeding                        |
| 6. *Dale Hess, Striga            | 6. Lynn Gourley, breeding                        |
| 7. Mousa Aumarou, cereal quality | 7. Allen Kirleis, grain<br>quality               |
| 8. *S.D. Maiga, entomology       | 8. Jerry Eastin, physiology                      |
| 9. Ousman Youm, entomology       | 9. Frank Gilstrap, entomology                    |
| 10. Mhamane Issa, economics      | 10. John Sanders, economics                      |
| 11. Robert Deuson, economics     |  |
| 12. **Gary Steck, entomology     |  |

\* INTSORMIL graduate student

\*\* INTSORMIL research associate

## F. USAID Mission staff involved with the project:

1. F. Fuller, Project Manager and A/ADO
2. Earnest F. Gibson, ADO
3. G. Coulter, Dept. Director, AID
4. Abbie Fessenden, Program Officer, AID

- G. Grant Dates: INTSORMIL Project Year 4 (83/84) to Year 7 (86/87)

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## II. NIGER PRIME SITE

	<u>Rating (1-9)</u>
Funding	5
Use of budget	1
Equipment Management	1
A. INTSORMIL	3
USAID/NIGER	8
Host Country	4
B. Use of Niger Prime Site Budget (PRF-109) (overall rating 2)	
Salaries	2
Vehicles	2
Equipment	2
Supplies	2
Training	1
Conferences	1
Travel	2
C. Custody and maintenance of vehicles: Sue Clark and Tom Tyler and INRAN are accountable individuals and institution.	1
D. Overall evaluation of INTSORMIL budget utilization for this prime site:	1
E. Audit/Project Management reviews:  Do not know of any.	
F. Problems regarding funding, budgeting, release of funds, procurement:	

It was reported that there was considerable delay for vehicle purchase authorization from AID Washington, D.C. Two vehicles were purchased in two weeks time right after authorization was received from AID Washington, D.C. The fact that project funds are authorized and allocated on a yearly basis makes long term planning very difficult. In the specific case of crop improvement activities long term planning and commitment are essential to achieve the desired results. The total amount of fund allocated for the prime site activities is not adequate at all. If the planned objectives of the prime site collaborative activities are to be realized more fully, additional funds are needed.

There is a problem involving the stability and level of funding for socio-economic research in INTSORMIL. Partly because socio-economic research was widely scattered into a number of inadequately funded areas at previous EEP evaluation, consolidation of socio-economic funding into farming systems (including on-farm trials) and food quality

assessment work was recommended. However, budget cutting instead of consolidation tended to take place with the result that farming systems research has not received much additional emphasis and the quality assessment work is more technical than socio-economic. Higher and more stable funding for farming systems and demand and cost analysis for different qualities of grain are needed.

G. Adequacy of funding to accomplish CRSP objectives:

If the CRSP activities of INTSORMIL are to have significant impacts on sorghum and millet production in West Africa, substantial increases in funds to be spent in the prime site is very much desirable.

See "F" above vis-a-vis socio-economics. It is recognized that INTSORMIL's prime responsibility is with respect to sorghum production and utilization.

H. Adequacy of current policies and procedures:

While it is not clear whose or what policies and procedures are under question here, INTSORMIL faces questions with respect to policies and procedures of both USAID/Niamey and GON vis-a-vis the two food grains -- sorghum and millet. Part of these questions are related to the recent OTA Special Report: Continuing the Commitment: Agricultural Development in the Sahel.

As weather and, perhaps, Sahelian policies have improved in the last two years, supplies of sorghum and millet have increased and their prices have fallen to levels disastrous to producers and a source of difficulty to the governments of countries such as Niger with 91 percent of its labor force in agriculture. The OTA report states:

...While there have been exceptions from year to year and from country to country, data points to a decade characterized by declining per capita food production, stagnant or declining yields of major crops, continuing environmental degradation, and little diminution of the region's high vulnerability to drought. Moreover, a 1985 CILSS study predicts continuing deterioration and recurrent crisis in the Sahel if the trends of the past two decades are not radically reversed....

Experts have tried to attribute the ongoing problems in the Sahel to a continuing succession of years with low and highly variable rainfall. But one of CILSS's goals was to reduce the region's vulnerability to drought--a goal that obviously has not been met successfully. In part, Sahel experts now admit, the gap between expectations and performance is a product of unrealistic original assumptions

and goals... Both Sahelians and donors lacked knowledge about fundamental ecological and socio-economic realities and unrealistically believed that technologies and models of development were available or could be easily transferred and adapted from elsewhere...

It is argued by some on the basis of questionable data and analysis that the present tendency of sorghum and millet growers to out-produce effective demand along with the above OTA report now indicate that INTSORMIL is likely to contribute little and that what it can contribute is unneeded in view of improved sorghum and millet supplies. Alternatively some believe that reliance should be placed on (1) production of irrigated crops (vegetables and rice) and livestock products and (2) regional trade among West African countries as a source of food security.

INTSORMIL administrators are in a poor position to answer these arguments. They need better national and regional (West African) agricultural sector studies than are available. The sector studies previously part of INTSORMIL would not have been adequate. Glenn Johnson's discussions with Henri Joserand indicate that his (Joserand's) analyses are devoted substantially to the monitoring of policy agreements reached between USAID/Niamey and the GON and are not adequate for appraising Nigerian needs for improved grain sorghum and millet cultivars.

Similarly, USAID/Niamey lacks adequate sector studies. The OTA report quoted above indicates a drop in per capita GNP from 1960 and 1982 which even if not "real" does not provide much basis for hoping that income demand elasticities for livestock products and vegetables will increase effective demands for such products in Niger. Population increases rapidly. Income is not being significantly redistributed. The indication is that the demand (such as it is) will continue to be high for grains relative to livestock products and vegetables. This coupled with the dangers of more drought years suggests the prudence of a continual emphasis on the improvement of sorghum and millet technology and on improved price and trade policies more favorable for food grain production and trade. Whether the OTA report is correct about the ineffectiveness of past efforts to increase food grain production and provide drought protection, the INTSORMIL work we observed in Niger provides a basis for expecting significant improvements in sorghum/millet varieties and production technologies as a result of INTSORMIL work.

It would, indeed, be helpful to have better sector studies for both Nigerian and West African agriculture. Glenn Johnson visited both Henri Joserand's project and the agricultural economists at the University of Niamey without

finding the kind of analyses needed. Similarly, the food security project headed up at Michigan State University is of little value for Niger as (1) Niger has been avoided by the administrators of that project in the conviction that the food security project would be competitive with the Joserand project and (2) the food security study does not cover enough West African countries (both Niger and Nigeria are omitted) to provide the basis for a West African regional sector and trade study. It seems evident to Glenn Johnson, as an INTSORMIL EEP member with extensive agriculture sector study experience, that an AID effort is needed to bring together the efforts of Joserand, the MSU food security project and indigenous research capacities at such Nigerian universities as Amadu Bello, Ibadan, Ife and Niger to analyze the West African agricultural sector with emphasis on the food grains, food grain substitutes (mainly root crops), rice livestock and poultry products and vegetables. Production and trade decisions about food grains in West Africa are of long-term life and death significance in West Africa and need to be guided by better analyses than we now have of drought risks including both insuring and ensuring, potentials for technical breakthroughs, prospective changes in per capita real incomes, and demographic changes including the distribution of populations among income classes. Though such analysis is not a proper responsibility to assign to INTSORMIL, it is one that should be met by USAID/Niamey and AID/W before deciding to reduce support for INTSORMIL in Niger, Mali and elsewhere in West Africa.

### III. RESEARCH PERFORMANCE COMPARED AGAINST MAJOR CONSTRAINTS

#### A. Research (overall rating 2)

##### 1. Short and long term expected accomplishments:

Justifiably both short and long term accomplishments are expected in this CRSP. The research underway at this prime site covers sorghum breeding, agronomy, entomology, grain quality, Striga, and socio-economics. Short and long term accomplishments to varying degrees are expected in each of these areas. See discussion under II. H.

##### 2. Design of research objectives/strategies to show measureable accomplishments:

The research objectives and strategies, within the constraints of funds, facilities, and personnel, have been well designed to show measureable results.

3. Dissemination of research results in the host country and in the U.S.:

There has been no research result from this project disseminated and put into use in farmers' fields in the host country. In view of the short life of the project, this is as expected. However, at the level of the research stations a large number (over 1000) of sorghum lines, populations, and hybrids in the form of trials and nurseries have been introduced into Niger and the best ones selected for further use in breeding and trials in Niger.

The selected promising lines and hybrids show high yield potential, drought resistance, and Striga tolerance. Continued work along this line is expected to result in developing varieties and/or hybrids suitable for farmer production in Niger within the next few years.

a. Improved cultivars, laboratory tests, methods and technical reports released for public use:

Although no cultivars, laboratory tests, and methods have been released for public use, a large number of scientific reports, delivered and published in various places, have been released by this CRSP. The most recent document on this specific site is the INRAN/INTSORMIL/NCRP Sorghum and Millet Workshop Proceedings of October 1985.

b. Germplasm utilization in the U.S. and in Niger:

Breeders in Niger now have a large array of selected sorghum germplasm because of this CRSP and they are actively using them in their sorghum improvement efforts. Sorghum germplasm from Niger, especially those which are heat, drought and acid soil tolerant are being utilized in the sorghum breeding programs of the participating U.S. universities.

c. Seed production, status of the industry:

No information.

d. Workshops:

Collaborators in this CRSP have participated in a wide range of workshops and networking activities. Specific to this project is the Niger workshop mentioned under (a) above.

e. Research findings on the needs of the small farmer:

The research findings in cultivar development, agronomy, grain quality and local food preparation investigations, entomology, Striga, and socio-economic studies at the farm level are all relevant to and address the needs of the small sorghum farmer directly.

As a long-term student of farm management, Glenn Johnson was much encouraged by the on-farm trial and food grain quality assessment work.

f. Understanding of U.S. counterpart scientist of LDC needs:

The U.S. scientists most intimately involved in this prime site project have a good grasp and understanding of LDC needs. The research priorities and emphasis they have collaboratively developed with their counterparts in the LDC reflect such understanding because the problems being researched on are clearly consistent with the priorities of the host country.

#### IV. TRAINING PERFORMANCE (Rating 1)

In this project it is somewhat difficult to separate training sponsored by the INTSORMIL CRSP because it is very closely tied to the Purdue Niger Cereals Research Project.

A. In the U.S. and host country:

Eight M.S. and Ph.D. graduate students are partially or in whole being supported or supervised through the activities of this project. They are all working on thesis problems relevant to the needs of Niger. All such research projects have received prior approval of INRAN before they were implemented.

B. Numbers completed:

No degree training completed. However, a Nigerian chemist (Moussa Oumarou) has spent several weeks at each of three INTSORMIL universities undergoing short term training and orientation on cereal quality laboratory techniques and has returned home.

C. Cumulative training totals through 1986:

Eight as indicated above.

D. Returned trainees:

Moussa Oumarou is the only returned trainee and is on the job.

V. INSTITUTIONAL DEVELOPMENT - STRENGTHENING THE NATIONAL PROGRAM  
(Rating 3)

The institutional development and the strengthening of the Nigerian national program in sorghum and millet is done primarily through visits and consultations of U.S. scientists, graduate students research in Niger, and participation in joint research planning. Training is needed to improve the level of proficiency of host country scientists which explains why a number of Nigerians are currently in training at INTSORMIL universities. Much of the current collaborative research underway in Niger is between graduate students and INTSORMIL professors with much of the research being done on site in Niger. In view of the shortage of highly trained manpower in Niger this approach is practical and desirable. The two U.S. workers on site are Dr. Gary Steck (entomologist) and Mr. Tom Tyler (plant breeding graduate student). Both of these individuals seem to be well accepted by host country nationals and are effective in their respective area of research. Gary Steck is on short term assignment to Niger and Tom Tyler will be in Niger until the completion of his M.S. thesis in sorghum breeding.

The goal of this CRSP is to establish an active collaborative research relationship and to contribute to the alleviation of hunger and malnutrition. This is certainly a long term goal. A realistic time frame to get to the stated goal will take about 15 to 20 years. Long term commitment of all participating parties is essential to attain the stated goals.

DECOR is the social science part of INRAN. Farming systems and/or farm trials work is being well institutionalized by Deuson, Shapiro and Sanders though socio-economic resources for farming systems and grain quality evaluation are not adequate despite cutbacks in other socio-economic research by INTSORMIL. As pointed out above, INTSORMIL work in Niger needs to be guided by sector analysis, demand studies and regional trade studies done in other projects and agencies.

VI. PLANNING OF THE PROGRAM RESEARCH COLLABORATION (Rating 2)

- A. The work plan for this prime site has been developed with the involvement of the TC, EZC, ME. The preparation of the work plan for 1986 was done at the level of the prime site coordinator and at the level of the participating INTSORMIL scientists and the host country collaborators. The major part of the plan was prepared during INTSORMIL project year No. 5. In most parts of the project there was sufficient collaboration between INTSORMIL and host country scientists at the planning stage. Therefore, the project reflects the joint views of the collaborating scientists. Based on actual experience in Niger, new components, such as the head bug complex and the stem borer investigations, have been

added to the overall project. In general, the budget and the work plan are related. The work plan is reviewed internally within the project and adjustments made as appropriate.

The program planning and collaborative effort of this CRSP has not found ways of getting needed results of sector, demand and regional trade analyses from other agencies (AID itself, other AID projects such as the University of Michigan Project or the Michigan State University Food Security Project, the University of Niamey, FAO, IBRD and the like). The social science dimensions of food quality assessments are crucial to INTSORMIL but relatively neglected.

B. The work plan is reviewed internally within the project and adjustments made as appropriate. (Rating 1)

C. Work plan for 1987: (Rating 1)

There are no major changes in the existing work plans for 1987. A couple of initiatives which may materialize in 1987 are the placing of a sorghum breeder in Niger and the initiation of an expanded in-country plant physiology program. The level of research in the U.S. and Niger are expected to stay at the 1986 level.

D. Networking/Collaboration (Rating 1)

Most of the participating INTSORMIL scientists (Axtell, Gebisa, Kirleis, Abbott, Sanders, Gilstrap, Teetes, Rosenow, Andrews, Eastin) have visited Niger from 1-3 times each for a total of 20 man-weeks. In addition the chair of the INTSORMIL Board of Directors (Thomas) and A/Director of the ME (Yohe) have visited the project site. Collaborating Nigerian scientists (Adamou, Oumarou, Maiga) have visited U.S. project sites. U.S. and Nigerian scientists have also come together in the workshop organized through this project. Overall the networking and collaboration activities of this project have been excellent.

## VII. GENERAL (Rating 2)

A. Balance between research and training. (Rating 2)

B. Balance of domestic to overseas research. (Rating 2)

- C. Interest, involvement, and support of the USAID Mission. (Rating 3)

See comments on need for more macro economic analysis vis-a-vis INTSORMIL under II. H above.

- D. Relationship to the USAID Mission. (Rating 2)

Can it be improved? Yes, vis-a-vis macro analysis of need for INTSORMIL.

- E. Domestic and international linkages: (Rating 1)

An in-country sorghum and millet workshop in which INTSORMIL and Nigerian scientists participated was organized. Exchange visits of INTSORMIL scientists to Niger and collaborating Nigerian scientists to the U.S. as well as West African countries have been made. Such visits have strengthened linkages among the scientists.

- F. Cost effectiveness of the program. (Rating 1)

Since this project is so closely linked to the Purdue NCRP and other INTSORMIL projects it is very much cost effective and is doing so much more than what the level of funding would indicate. This will be documented latter after getting needed data from ME.

- G. Institutionalization of the host country component. (Rating 2)

This project operates in cooperation and collaboration with INRAN, the national institute for agronomic research, and the host country component is satisfactorily institutionalized. All the components of the project operating in Niger are considered as part of the national sorghum research program and as such form an integral part of INRAN's research activities.

#### VIII. PROSPECTS AND POTENTIAL (Rating 2)

- A. Project problems:

The lack of Nigerian researchers with sufficient academic training and experience to participate fully in the collaboration in the spirit of the CRSP appears to be a problem. The current emphasis on training should rectify this problem within the next few years. Currently and justifiably, much of the collaboration involves INTSORMIL scientists and their graduate students working on sorghum problems of interest to Niger. It would be useful and desirable if INTSORMIL scientists that visit frequently and

spend substantial time in French speaking West Africa were to have communicating level of French language proficiency.

B. Project successes/achievements:

For the relatively short time this project has been underway a number of significant achievements have been realized. A comprehensive collaborative research program most of which is done on site in Niger is fully operational. A successful workshop was organized in 1985 and the proceedings published. A number of Nigerians are undergoing graduate training in INTSORMIL universities under the collaborating INTSORMIL scientists. In plant breeding, a wide array of useful and selected sorghum germplasm has been introduced and these are being actively utilized in the Nigerien breeding program. The potentials of hybrid sorghum are being investigated both from the production and the tuwo (traditional dish) preparation point of view. The hybrids being investigated have Tx 623 and P954066 as female parents. Some of the hybrids seem to have good potential for Niger. Hageen Dura-1 has been found promising for production in Niger but makes poor quality tuwo. In cereal quality, evaluations have been standardized and a number of traditional and improved local varieties have been characterized for Nigerian tuwo both at the laboratory and the village home level. These standardized procedures will be useful in evaluation of all forthcoming promising lines and hybrids for tuwo in Niger. A sorghum quality laboratory manual for use in West Africa has been prepared by the INRAN Cereal Quality Laboratory. In entomology, the sorghum head bug complex and stem borers species identifications have been done, the biology and alternate host situations of these insects as well as loss assessment investigations are still underway. In the Striga experiments, the variety SRN 39 has been found most tolerant under the very heavy Striga pressure conditions of the Konnie area of Niger. The widely recognized Striga tolerant varieties such as N13, Framida, IS9830, and Dobs have been essentially wiped out by the Konnie strain of S. hermonthica. The recently identified powerful germination stimulant for Striga, sorgoleone, by L. Butler's laboratory at Purdue promises exciting new possibilities for tackling the Striga menace in Africa. In the socio-economics research, whole farm modeling utilizing data generated by INRAN/NCRF is underway.

C. Progress of the program:

The program is progressing satisfactorily. See other parts of this report for discussion of the socio-economic aspects of INTSORMIL's Niger program.

D. Overall outlook:

The overall outlook for the activities of this prime site appears bright especially in view of the heavy emphasis on training and the comprehensive range of sorghum research initiated at the site.

IX. FOLLOW-UP ACTIONS/SUGGESTIONS FOR PROJECT IMPROVEMENT; REVIEWERS COMMENTS AND RECOMMENDATIONS

- A. Millet Research. It was repeatedly mentioned both by INRAN and USAID Niger that INTSORMIL was not sufficiently involved in pearl millet research in Niger. Since pearl millet is the most important crop of Niger it is understandable why this issue is of concern both to INRAN and USAID. It would be very much desirable if INTSORMIL would draw upon the available and appropriate expertise in the U.S. and get involved more in pearl millet research in Niger.
- B. INTSORMIL/ICRISAT in Niger. It is clear that both ICRISAT and INTSORMIL consider Niger as the country of focus in their West African initiatives. Obviously, ICRISAT, through its Sahelian Center in Niger, is operating at a much larger scale than INTSORMIL. Currently there are 17 professional staff at the ICRISAT Sahelian Center (ISC). There was some concern expressed, especially by USAID Niger, about possible duplications of effort between the two organizations. However, at this time there is very little duplication because ICRISAT's concentration in Niger is on pearl millet and that of INTSORMIL is on sorghum. If INTSORMIL plans to work on millet it must be in areas complementary to ICRISAT's efforts. In view of the shortage of high level trained manpower in agricultural research in Niger and the subsequent limitations in the absorptive capacity of INRAN for truly Nigerien scientists to INTSORMIL scientists collaboration, it was pointed out, especially by USAID Niger, that the ISC may offer better opportunities for a more meaningful collaboration than INRAN. However, in the various areas of sorghum research, the ISC does not have much to offer now. Regardless of this fact, in the long run it appears much better for the national program of Niger if collaboration is between its national scientists and INTSORMIL scientists. Such a collaboration helps them develop their own capabilities and make them self-reliant.
- C. Plant pathology. There is very little involvement of INTSORMIL in plant pathology research in Niger. Everywhere we visited in this trip, we have noticed long smut as a major disease. TX623 was especially susceptible to the disease. INRAN has expressed concern about the severity of this disease which is also serious in much of the lowland semi-arid areas of the rest of Africa. The Sudan, through

INTSORMIL collaboration, does some work on long smut. It would be very much desirable if INTSORMIL would initiate work on this disease in Niger and also facilitate collaboration between the Sudan and Niger on research on this important but neglected disease.

- D. Striga. This parasitic weed is a serious problem on both sorghum and pearl millet not only in Niger but in most areas of Africa growing these crops. The INTSORMIL initiated work on Striga is good and should contribute to the overall effort of tackling this problem Africa-wide. The sorgoleone work at Purdue is a unique development. Further effort should be made to explore the practicality of this chemical for Striga control. ICRISAT/IDRC have been working for a number of years on Striga in Burkina Faso. Further efforts are necessary to link up closely the ICRISAT and INTSORMIL Striga work in West Africa.
- E. Sorghum Breeding. Much has been done by the INTSORMIL CRSP to introduce a wide array of selected sorghum germplasm into Niger. The sorghum breeding approach is a comprehensive one in that it covers both hybrid and variety development. Some of the advanced lines from the pedigree selection at Konnie looked outstanding agronomically with excellent grain quality. The hybrid sorghum work is justified because it does complement the variety development effort. Hybrid sorghum should have good future potentials in Niger especially in view of the projected USAID support to small scale irrigated crop production. Much of the breeding work depends on making crosses and generation advance for Niger in the U.S. and conducting the selection and evaluation phases in the host country. This is a good and an effective mechanism for collaboration. The breeding work should continue to be the core of the Niger prime site program.
- F. USAID and agricultural research in Niger. The major source of agricultural research support to Niger traces to USAID and much of this is in cereals research as it should be. USAID Niger has been talking about shifting priorities from cereals in favor of diversification primarily because of the current grain surplus and low prices in Niger. The surplus situation is certainly temporary resulting from the favorable rains of the past two seasons. The years of inadequate rainfall and poor crop harvests in the Sahel are sure to come again. In the long run, continued support to cereals research is indispensable to improve and stabilize cereal production in Niger. The INTSORMIL CRSP has certainly a significant role to play in this effort.
- G. Seed Industry. For political as well as practical reasons, most countries would prefer to have their own seed schemes for their important crops. For West Africa, the Pioneer seed company based in Ivory Coast is proposing to sell seeds

throughout the region. A letter distributed by the company to the USAID missions of the region seems to suggest that they are prepared to develop and/or introduce seeds needed in the region. Regardless of the involvement of a multinational seed industry in West Africa it would be very essential to continue to support the national programs in their crop improvement efforts.

- H. Collaboration. Because of the limited availability of high level trained manpower in Niger, a point of concern raised was whether Nigeriens are sufficiently involved in the design and priority identification of research. This is a legitimate concern because the central concept of the CRSP is collaboration. Under the circumstances we are satisfied that Nigeriens collaborated at all levels starting from design to implementation of the current projects. When the trainees on-board return to INRAN, collaboration is expected to improve with the Nigerien collaborators taking more of the initiative in problem identification.
- I. Funds for in-country collaborators. One of the main factors limiting the effectiveness of a collaborative activity is the lack of resources and funds for the collaborator in the host country. Often a relatively small amount of funds allocated for this purpose is very much cost effective and can go a long way in achieving the overall goals of the CRSP. In the case of Niger, particularly when a number of trainees are expected to return to their home country, it is highly recommended that some amount of the project funds be ear-marked for in-country spending by the collaborators for the CRSP projects. This is in addition to appropriate equipment purchases.
- J. Linkages between prime and collaborative sites. A number of the problems being researched on at the prime site are relevant for and applicable to the conditions of a number of other INTSORMIL countries in Africa. It would be desirable if further efforts are made to strengthen linkages between the prime site and other collaborating countries, particularly in West Africa. One way of strengthening linkages would be to include all INTSORMIL collaborating national scientists in workshops like the one held in Niger in 1985. The excellent headbug work in Niger can be extended to Mali and could be another good basis for collaboration between Niger and Mali.

- K. Overall impression. The INTSORMIL scientists and the prime site coordinator are to be commended highly for having initiated and mobilized the appropriate INTSORMIL talent and resources to concentrate on the sorghum research problems of Niger. This shift of emphasis and focusing on the real problems of a developing country such as Niger is a much appreciated development. Although there is much more to be done in Niger and similar other African countries in sorghum and millet research, we believe that the INTSORMIL CRSP is on the right track at this prime site and we have no doubt that they will contribute significantly in improving and stabilizing sorghum and millet production in the region. Our overall impression for this site is excellent.
- X. OVERALL PROJECT RATING (2).

**MALI COLLABORATIVE SITE EEP REPORT**

Brhane Gebrekidan  
November 1986

**I. BACKGROUND**

- A. Collaborative Site : Mali (West Africa)  
 B. Project : Mali collaborative site project and several other associated INTSORMIL projects in breeding, agronomy/physiology, and grain quality.  
 C. EEP Reviewer : Brhane Gebrekidan  
 D. Date : October 24-29, 1986  
 E. Names of Collaborators :  
     Mali (IER)  
     1. Moussa Traore, IER/INTSORMIL Coordinator, physiology  
     2. Oumar Niangado, breeding  
     3. Issaka Konate, breeding  
     4. Miriam Haidara, grain quality  
     5. Salamitu Coulibaly, grain quality  
     6. Mamadou Doumbia, soils  
     7. Adama Coulibaly, agronomy  
     INTSORMIL Universities  
     1. Lloyd Rooney, Coordinator, grain quality  
     2. Darrell Rosenow, breeding  
     3. Charles Sullivan, physiology  
     4. Art B. Onken, soils  
 F. USAID Mission staff involved in the project  
     1. S.K. Reddy, Project Officer, USAID  
     2. James Jackson, ADO, USAID  
 G. Grant Date: 1984 to 1987

**II. MALI COLLABORATIVE SITE**

**RATING (1-9)**

Funding	3
Use of budget	1
Equipment management	1
A. INTSORMIL (\$36,100 for 84/85; \$46,250 for 85/86; \$50,000 for 86/87)	3
NE-16/NE-123 (\$13,960 for 85/86 and \$17,500 for 86/87)	1
USAID/MALI	1
Host Country	3

- B. Use of Mali Collaborative Site budget  
(overall rating 1)
- |                           |   |
|---------------------------|---|
| salaries                  | 2 |
| vehicles                  | 1 |
| equipment                 | 1 |
| supplies                  | 1 |
| training                  | 1 |
| conferences/consultations | 3 |
| travel                    | 1 |
- C. Custody and maintenance of vehicles and equipment - Moussa Traore is accountable individual and IER is the responsible institution 1
- D. Overall evaluation of INTSORMIL budget utilization for the Mali site 1
- E. Audit/Project management reviews:  
Do not know of any
- F. Problems regarding funding, budgeting, release of funds, procurement:

Project fund transfers from the University of Nebraska are often too slow. The fact that the INTSORMIL fiscal year is from July to June 30 has been mentioned as a serious problem for proper timing of fund transfer. Since the crop season starts in June, Mali would like to have funds transferred well before planting time. It is recommended that appropriate measures be taken to rectify this problem. Comment on problems of yearly budget allocation made under Niger II (F) apply her also.

- G. Adequacy of funding to accomplish CRSP objectives:

The current levels of funding appear adequate especially with the active support of USAID Mali through the US AID-PSTC grant (\$150,000 over three years) for Moussa Traore and the substantial equipment purchases through NE-123 (Sullivan). The crop improvement area may require additional funding.

- H. Adequacy of current policies and procedures:

There was no special problem encountered.

### III. RESEARCH PERFORMANCE COMPARED AGAINST MAJOR CONSTRAINTS

#### A. Research (overall rating 2)

1. Short and long term expected accomplishment: Both short and long term accomplishments are expected. The research underway in the collaborative site covers mainly sorghum physiology/agronomy, food quality, and breeding in each of which long and short term accomplishments are expected.

2. Design of research objectives/strategies to show measureable accomplishments: These have been well designed to show measureable accomplishments.

3. Dissemination of research results in the host country and in the U.S.: There has been no research result from this project disseminated and put into use in farmers' fields in the host country. The project has not been operating long enough to expect such results. A number of promising sorghum lines are now available at the level of the research station and these are expected to go out for farmer use in the foreseeable future.

a. Improved cultivars, laboratory tests, methods, and technical reports released for public use: A number of technical reports have been released in association with this project.

b. Germplasm utilization in the U.S. and in Mali: Malian sorghum breeders now have a large array of selected germplasm because of this project. Guineense sorghums from Mali have been introduced into U.S. INTSORMIL universities because of this project and a number of them which have good drought and heat resistance have been put into the sorghum conversion program.

c. Seed production, status of the industry: A national seed production and distribution scheme operates under the IER. In sorghum the main varieties under current multiplication are CE-90-16-3, CSM 219, Gadiaba, SH1 D3, SH2 D2 and Tiemarifing, none of which traces to this project.

d. Workshops: None was organized by this project. However, scientists involved in this project have participated in a number of workshops and networking activities since 1985.

e. Research findings on the needs of the small farmer: The research findings of agronomy/physiology, food quality, and crop improvement are relevant to the needs of the small farmer in Mali.

f. Understanding of U.S. counterpart scientists of LDC needs: There are no U.S. scientists assigned to this project to the host country on a long term basis. However, those visiting frequently and are most closely associated with the project have a good understanding and grasp of LDC needs.

#### IV. TRAINING PERFORMANCE

##### A. In the US. and Host Country:

One Ph.D. trainee has been supported through this project. Three M.S. students are training at Texas A&M University with partial support from this project.

##### B. Numbers completed:

One Ph.D. trainee has completed his studies at Nebraska and returned to Mali at the beginning of this year.

##### C. Cumulative training totals through 1986:

Four as indicated above.

##### D. Returned trainees:

Moussa Traore (Ph.D. Nebraska) is the only returned trainee that is currently on the job.

#### V. PLANNING OF THE PROGRAM RESEARCH COLLABORATION (Rating 1).

A. In general, comments under VI(A) of the Niger part of this report apply to Mali also.

B. The work plan is reviewed internally within the project and adjustments made as appropriate (Rating 1).

C. Work plan for 1987 (Rating 1). The work plan for 1987 calls for continuation and expansion of the current activities. More equipment for physiology research are to be acquired through NE-123. The US AID-PSTC grant is expected to be received and work initiated in 1987. Work on acid soil and aluminum toxicity is to continue. The sorghum drought screening and breeding work will continue. The food quality laboratory will be equipped through INTSORMIL funds.

- D. **Networking/collaboration:** Most of the INTSORMIL participating scientists (Onken, Rooney, Rosenow, Sullivan, Esabel, Ejeta, Teetes) have visited Mali from 1-3 times. In addition, Directors of the ME (Vollmar and Yohe) have visited Mali. Collaborating Malian scientists (Haidara, Konate, Coulibaly, Traore, Sanogo, Niangado, Keita) have visited U.S. project sites. Networking and collaboration with Niger, Senegal, and Burkina Faso need to be strengthened.

VII. GENERAL (Rating 1)

- A. Balance between research and training. (Rating 2)
- B. Balance of domestic to overseas research. (Rating 2)
- C. Interest, involvement, and support of the USAID Mission. (Rating 1)
- D. Relationship to the USAID Mission. (Rating 1)
- E. Domestic and international linkages. (Rating 2)  
Exchange visits of a number of INTSORMIL scientists to Mali and collaborating Malian scientists to the U.S. have been satisfactorily done. Such visits have contributed significantly to strengthening linkages.
- F. Cost effectiveness of the program. (Rating 1)  
This project is closely associated with the USAID/ICRISAT/MALI sorghum program and TROPISOILS and it is very much cost effective.
- G. Institutionalization of the host country component. (Rating 1)  
This project operates in cooperation and collaboration with IER, the national institute for agricultural research, and the host country component is satisfactorily institutionalized. All the components of the project operating in Mali are considered as part of the national program and as such form an integral part of IER's research activities:

VIII. PROSPECTS AND POTENTIAL (Rating 2)

- A. **Project problems:**  
There are no significant project problems at this site except for delay of fund transfer from the University of Nebraska to IER. If possible, French language knowledge for INTSORMIL scientists traveling frequently to Mali and staying there for extended periods would be desirable.

B. **Project successes/achievements:**

A comprehensive collaborative research program most of which is done in Mali is fully operational. A Ph.D. trainee has completed his studies and is back on the job in Mali and coordinates INTSORMIL activities. He has obtained a substantial grant from USAID for expanding the physiology research in Mali. Three Malians are still on training in Texas. A wide array of sorghum germplasm has been introduced to Mali through this project and they are actively being utilized in research. Of the food type sorghums introduced, Sureno and Dorado, appeared particularly outstanding both in agronomy and grain quality. Just as in Niger, Hageen Dura-1 has been good agronomically in Mali but was found unacceptable because of headbugs and grain mold. Laboratory procedures for seedling screening of a large number of sorghum breeding lines for resistance to drought and heat stress (charcoal pit technique) have been adapted and are in use at the IER.

C. **Progress of the program:**

The program is progressing satisfactorily.

D. **Overall outlook:**

The overall outlook for the activities of this collaborative site appear very bright especially in view of the relatively good high level trained manpower already available in Mali. Additionally there are three undergoing training in Texas. Mali is now one of the best sites for CRSP activities.

IX. **FOLLOW-UP ACTIONS/SUGGESTIONS FOR PROJECT IMPROVEMENT: REVIEWER'S COMMENTS AND RECOMMENDATIONS.**

Most of the comments made under Niger in section IX apply for Mali also.

A. **Millet research:** Same comments as Niger IX (A).

B. **INTSORMIL/ICRISAT in Mali:** The issue of duplication between the activities of INTSORMIL and ICRISAT did not come up in any of our discussions. The ICRISAT/USAID/Mali sorghum and millet program has served INTSORMIL in much the same way as INRAN has in Niger. The significant contribution of Dr. John Scheuring, who has now left ICRISAT, was emphasized by IER. There was an indication at the time of our visit that ICRISAT may choose Mali as the regional center for their West African sorghum program. If this materializes, it would be essential for INTSORMIL to work closely with ICRISAT/MALI so that their activities would continue to complement each other.

- C. Plant pathology and entomology: The long smut disease of sorghum is also of concern to Mali as Niger but there is very little work being done on it. INTSORMIL's work on this disease, whether based in Niger or Mali, should be planned to serve both countries. Duplication of work on this disease in the two countries does not appear justified to me. The strong head bug complex work in Niger should serve Mali also. USAID/Mali has indicated that the IPM work is being phased out and that they would like to see INTSORMIL continue some of the sorghum and millet entomology and pathology work. That is a suggestion worth a follow-up.
- D. Striga: At this time there is not much that Mali is doing on this problem. INTSORMIL is concentrating on Striga in Niger. It is recommended that the INTSORMIL/Niger Striga work be strengthened and expanded so that it cover Mali's concerns also. It would be essential to coordinate the Striga research activities of ICRISAT/Burkina Faso and INTSORMIL/Niger and also Mali as a testing site.
- E. Sorghum breeding: A strong breeding program should be the core of the INTSORMIL/Mali CRSP. Since the departure of John Scheuring there appears to be a weakness in the Malian sorghum breeding program. I understand that ICRISAT is to place a new sorghum breeder in Mali. If this materializes, it would be essential for INTSORMIL to link up closely with the new breeder as well as the young Malian sorghum breeders. It is recommended that efforts be made to strengthen the Malian sorghum breeding program. It was obvious that there was not a strong initiative in hybrid sorghum in Mali. It is recommended that the Niger hybrid sorghum work use Mali as a testing site to explore the potential of hybrids in Mali.
- F. Plant physiology: This is certainly the strongest discipline at this site essentially because of Dr. Moussa Traore returning after his INTSORMIL training at Nebraska under Dr. Charles Sullivan. He has received and continues to receive a wide range of plant physiology laboratory equipment from Sullivan's NE-123 project and in addition he has the new USAID grant. The plant physiology work is to continue on drought and heat tolerance. With this substantial support, all concerned hope and expect useful plant physiology work to be done in Mali. It is very important to link up closely the planned physiology work with breeding and practical agronomy work so that the effort will result in improved sorghum and millet production in Mali and hopefully elsewhere in West Africa. The plant physiology area is certainly one in which Mali can provide leadership and support Niger. In view of the development of such a strong program in this discipline in Mali I do not see the justification for initiating a similar program in

Niger now. Niger does not have the trained manpower for this purpose.

- G. Food quality: The construction of the new food technology laboratory is near completion at Sotuba. Well trained personnel are available for the laboratory. IER has requested equipment for this laboratory through INTSORMIL funding and some have been budgeted. It is recommended that INTSORMIL participate fully in equipping and using the facilities.
  - H. USAID and agricultural research in Mali: The issue of diversification and reduced emphasis on cereals research did not come up in Mali as it did in NIGER. On the contrary, USAID/Mali is very much supportive of cereals research. They are behind the current Malian sorghum improvement program. They were instrumental in facilitating the USAID-PSTC \$150,000 grant for Dr. Moussa Traore. They have emphasized the point that success stories have to be told or even better demonstrated to maintain their support.
  - I. Seed industry: Same comments as Niger IX (G).
  - J. Collaboration: To fully collaborate in the spirit of the CRSP, Mali has a much better high level trained manpower base than Niger in physiology, food quality, and to a lesser extent breeding. The Malian scientists have excellent motivation and interest to do collaborative research.
  - K. Funds for in-country collaborators: In general the flow in INTSORMIL funds for Mali in-country spending have been satisfactory. Again, the new USAID-PSTC grant is going to improve the situation even more. The breeding activity may require additional support.
  - L. Linkages between prime and collaborative sites: In addition to the suggestions made in the sections above, the comments under Niger IX (J) on this issue apply for Mali also.
  - M. Overall impressions: The overall favorable impression expressed under Niger IX (K) apply for Mali also. The Mali site coordinator(s) and all the INTSORMIL scientists and their Malian collaborators involved in this work are to be commended for initiating and operating a good CRSP.
- X. OVERALL PROJECT RATING (1).

## HONDURAS PRIME SITE EEP REPORT

## I. Background

- A. Prime/Collaborative Site: Honduras
- B. Project Title: Sorghum Breeding in Honduras
- C. EEP Reviewer: Clarence Gray, Ricardo Bressani, Bruce Maunder
- D. Date: December 7-11, 1986
- E. Name and Title of Collaborators:
- ESCUELA AGRICOLA PANAMERICANA  
 Ing. Roni Munoz, Asst. Prof., Dept. of Agronomy  
 Dr. Keith Andrews, Project Integrated Pest Management  
 CENTER FOR AGRICULTURAL TECHNOLOGY (CENTIA)/EL SALVADOR  
 Ing. Rafael Reyes, Entomologist Coordinator, Sorghum Prg.  
 UNIVERSITY OF EL SALVADOR, EL SALVADOR  
 Ing. Leopoldo Serrano, Entomology Dept.  
 ICRISAT/MEXICO  
 Dr. Compton Paul, Agronomist  
 Agr. Rene Clara, Breeder  
 MINISTRY OF NATURAL RESOURCES  
Tegucigalpa  
 Dr. Leopoldo R. Alvarado, Head, Dept. of Agric. Research  
Choluteca  
 Ing. Rigoberto Nolasco P, Coordinator, National Sorghum  
 Program  
 Dr. Francisco Gomez, Breeder, National Sorghum Program  
Comayagua  
 Ing. Miguel A. Soler, Regional Director  
 Ing. Lindolfo Fernandez, Agronomist, Sorghum Program  
Olancho  
 Ing. Humberto Mejia, Agronomist, Sorghum Program
- INTSORMIL Collaborators Present
- Dr. Glen J. Vollmar, Program Director  
 Dr. Darrell Rosenow, Breeder, Country Coordinator, TAM-122  
 Dr. Dan Meckenstock, Breeder, TAM-131  
 Dr. Lloyd Rooney, Cereal Quality, TAM-126  
 Ing. Ronaldo Sequeira, Entomologist, TAM-125
- Additional INTSORMIL Collaborators
- Dr. Fred Miller, Sorghum Breeder, TAM-121  
 Dr. Gary Peterson, Sorghum Breeder, TAM-123  
 Dr. Richard Frederiksen, Sorghum Pathologist, TAM-124  
 Dr. Frank Gilstrap, Sorghum Entomologist, TAM-125  
 Dr. Henry Pitre, Sorghum Entomologist, MS-105
- F. USAID Mission Staff Involved with the Project and Qualifications: Richard Owens, CRSP Liaison, RDO  
 Richard Peters, Chief RDO
- G. Grant Dates: September 1, 1981 to present

- II. Funding/Use of Budget/Equipment Management for Honduras Prime Site (Rating 1-9): 3  
 Difficult to make judgment based on information given-based on progress - 3.

A. Levels and Sources for 1985, 1986 and 1987 (projected)

	1984-85	1985-86	1986-87
INTSORMIL (AID)			
TAM-121 Miller	7,500	7,500	7,500
TAM-122 Rosenow	12,000	12,000	14,000
TAM-123 Peterson	8,500	14,800	17,300
TAM-124 Frederiksen	20,000	15,000	8,000
TAM-125 Gilstrap	12,000	19,000	19,000
TAM-126 Rooney *	77,000	72,000	85,000
MSU-105 Pitre	22,000	28,000	28,000
TAM-131 Meckenstock (Honduras)	135,000	124,875	135,000
USAID/HONDURAS	30,000	50,000	127,500
Totals	324,000	343,175	441,300

- \* Much of this spent in Mexico on sorghum tortilla quality with direct application to Honduras.

B. Use of TAM-131 Budget - budgets and expenditures by categories for 1985 and 1986.

	1985	1986
1. Salaries		65,037
2. Vehicles		15,000
3. Equipment		10,000
4. Supplies		14,956
5. Training		
6. Conferences		
7. Travel		6,000
8. Other (overhead)		<u>12,655</u>
Total		123,648

C. Custody and maintenance of vehicles, equipment and other nonexpendable CRSP-purchased property.

1. Inventory records: TAM Research Foundation, Ministry of Natural Resources, Escuela Agricola Panamericana
2. Accountable individuals and institutions: Ministry and TAM-131.

D. Overall evaluation of INTSORMIL budget utilization as directed to this Prime Site: Satisfactory

E. Audit/Project management reviews.

1. Date, by whom, and findings and follow-up:  
Yes, by AID which resolved problem
2. If no audit, has one been requested: \_\_\_\_\_

- F. Problems regarding funding, budgeting, release of funds, procurement and other -- in U.S. and Host Country: None
- G. Adequacy of funding (to accomplish CRSP objectives) by CRSP participants: Dr. Francisco Gomez will not be adequately funded based on planned 1987 AID direct support.
- H. Adequacy of current policies and procedures (especially regarding follow-up on use of funds and commodities):  
Need more information.

III. Research Performance -- Compared against Major Constraints Identified in the Global Plan. Consider the following points:  
(Rating 1-9) 2

A. Research

1. For the research in progress in the Host Country are short term and long term accomplishments expected, when and what effect on food production: Short term was release of non-photoperiod sensitive varieties (2) and a hybrid (1). Hopefully extension will properly promote and distribute seed. This will increase quantity of coarse grain for food or feed.
2. Have research objectives/strategies been designed to allow project opportunity to show a measureable accomplishment over set periods of time: Yes at least for short term goals.
3. Have research results been disseminated and put into use in the Host Country and in the U.S.:
  - Seed production of Sureno, Catracho, Tortillero
  - release of diatraea parasite for biological control
  - serum bottle chemical applicator
 The above are basically for Honduras at present but could apply to other CA countries.
  - a. Improved cultivars, laboratory tests, methods, technical papers, reports and state of the art bulletins released for public use: See above
  - b. Germplasm utilization both domestically and in the host country: Excellent
  - c. Seed production, status of a seed production industry, if any: Recursos Naturales and private sector.
  - d. Contributions to and participation in international sorghum/millet networks, e.g. IARCs and others: Strong
  - e. How do the research findings address the needs of the small farmer: Improved yield and more crop stability plus inexpensive control methods.
  - f. How would you rate U.S. counterpart scientists understanding of LDC's needs, domestic and agricultural policy, and cropping statistics: Are average or mixed rating.

IV. Training Performance (Only CRSP sponsored training in 1986)  
(Rating 1-9) 2

- A. Numbers and kind in process in the U.S., Host Country and elsewhere: 3 - F. Fernandez, M. Castro, C. Trambanion
- B. Numbers and kind completed -- U.S. and Host Country: 3 - F. Gomez, Ronaldo Sequeira, G. Wall
- C. Cumulative training totals - through 1986: 6
- D. Evidence of working trained researchers back into country programs: F. Gomez with Recursos and on job training for Serrano, Reyes, of El Salvado.

V. Institutional Development, i.e., Strengthening Host Country Sorghum/Millet Research and Improved Systems (Rating 1-9): 3

- A. Site improvements during period of 1984-85: Addition of EAP in Honduras, ICTA in Guatemala, excellent progress.
- B. Level of proficiency and past accomplishments of Host country collaborators: Good
- C. If U.S. worker is on location, determine his/her role, acceptance by host country nationals, planned longevity and evaluate the ability/effectiveness of that individual: Very good acceptance with one exception; will stay for indefinite period; has gotten a strong program going plus developed in country support for program.
- D. What are the CRSPs goals and how long will it take to get there: Increase sorghum production and utilization with emphasis on improved maicillos criollos but will be two or more years before seed distributed to local farmers. Will need more on farm testing. Good disease resistant and better yield potential material available.

VI. Planning of the Program/Research Collaboration (Rating 1-9):  
5

- A. Work plan for 1986
  - 1. TC, EZC, or ME guidance/approach of any: Partial, but more needed.
  - 2. How prepared:
  - 3. Who prepared, how much collaboration: F. Gomez, L. Alvarado, R. Nolasco, F. Fernandez, D. Rosenow, and D. Meckenstock.
  - 4. When prepared: January/May
  - 5. Are the budget and work plan related: Yes in that budget supports equipment, labor and supplies needed to conduct research.
- B. Work Plan Review
  - 1. Is the work plan reviewed and adjustments made, who is notified, ME, TC, EZC: Not to any significant degree at least with notification.

- C. Plans for work development for 1987.
  - 1. Research in host country and the U.S.: Insect screening, downy mildew evaluation, nutritional quality.
  - 2. Expected change from the 1986 program: Special projects with EAP
- D. Networking/collaboration
  - 1. Frequency of communication between collaborators including number of site visits/year: daily to weekly
  - 2. Do collaborators ever visit U.S. project sites: Yes

VII. General (Rating 1-9) 2

- A. What is the balance between research and training: 80/20
- B. What is the balance of domestic to overseas research activities: 50/50
- C. Evaluate the interest, involvement and support of the USAID Mission: Strong - note their counterpart funding.
- D. What is the relationship to the USAID Mission? Can it be improved: Good communication.
- E. Evaluate the domestic, international linkages and cooperation and collaboration: Generally outstanding, including ICRISAT.
- F. Evaluate the cost effectiveness of the program, especially regarding level of activity vs funding level: Satisfactory.
- G. Evaluate the institutionalization of the Host Country component--provide evidence: Recursos much stronger because of INTSORMIL.

VIII. Prospects - Potential

- A. Project problems--present and future effects: Zamanano relationship to CRSP
- B. Project successes/achievements--present and in prospect: Parasitic control of diatrea, insecticide applicator, cropping systems, new varieties/hybrid.
- C. Progress of the program: On target
- D. Overall outlook: Very strong research support for many small markets, could effect El Salvador the most if outreach successful.

IX. Follow-up Actions/Suggestions for Project Improvement:  
See separate attached sheets.

X. Overall Program Rating (1=best, 5= average, 9=poor) 3

### Botswana Prime Site EEP Report

Dates: March 26-30, 1987

EEP: Dr. Brhane Gebrekidan  
Dr. Bruce Maunder

INTSORMIL Board: Dr. Kurt Feltner

INTSORMIL M.E.: Dr. John Yohe

INTSORMIL Investigators Present:

Prof. David Andrews  
Dr. Doug Carter  
Dr. Lynn Gourley  
Dr. Richard Vanderlip  
Dr. Van Withee

Other PI's Active in Botswana:

Dr. George Teetes  
Dr. Gary Peterson  
Dr. Larry Claflin  
Dr. Gary Odvody  
Dr. Max Clegg  
Dr. E.T. Kanemasu (past)  
Dr. W.M. Ross (past)

Expenditures: INTSORMIL KSU-107

	<u>1984</u>	<u>1985</u>	<u>1986 (year 7)</u>
Salaries	15,614	70,289	70,040
Vehicles	--	13,055	--
Equipment	--	21,824	5,185
Supplies	8,746	10,632	11,114
Travel	9,718	10,412	9,411
Other-overhead	5,861	18,972	19,370
Total	39,939	145,184	115,120

Year 8 total budgeted: 124,875

Other PI input to Botswana as a percent of their project budget (est.):

David Andrews  
Richard Vanderlip  
George Teetes

Larry Claflin  
Max Clegg

## Summary of Discussions

### I. Agricultural Technology Improvement Project (ATIP)

- A. Dr. David Norman, Leader - Doug Carter, INTSORMIL agronomist
- B. MIAC project, begun in 1982
- C. Funded at \$12.9 million for first 5 years
- D. Extended to 1990
- E. Purpose: improve capacity of Ministry research and extension program to develop and effectively extend farming system recommendations relevant to the needs of the small farmer.
- F. ATIP was to contribute by strengthening ARS research and extension by implementing farming systems approach which included INTSORMIL staff position.
- G. ATIP needs INTSORMIL support for agronomic technology.
- H. With 100,000 ha sorghum only produced in 1985/86 20,000 tons but country requires 200,000 metric tons of coarse grain. Millet is only grown on 20,000 ha. Average yield sorghum is 200 kg/ha.
- I. Drought and heat along with stand establishment appear to be major limiting factors for sorghum production in Botswana.
- J. Technology must be responsive to the above expected constraints.
- K. Research at Mahalapye, Francistown, and Sebele.

### II. US/AID

- A. John Hummon - Director of Mission
- B. John Roberts - Assistant Director
- C. Paul Daly - Agricultural Development Officer
- D. Botswana considered strategically significant country.
- E. Staff strongly supports INTSORMIL involvement and need for continued input.
- F. Country is headquarters of SADCC and SACCAR organization.
- G. Discussed possible sources of funding outside INTSORMIL for soil physicist position.
- H. May have PL480 pulas (local currency) for in country technical assistance.

### III. US Embassy

- A. Johnnie Carson - charge de'Affairs
  - 1. Supported AID comments
  - 2. Appeared encouraging for strengthening of agricultural research

#### IV. Agricultural Research Service (ARS)

- A. David Gollifer, Director, and William Stewart-Jones, Chief of Arable Crop Research
1. Supportive of training opportunities provided by INTSORMIL relevant to arable agriculture.
  2. Appreciate reorientation of existing INTSORMIL research towards water conservation and harvesting.
  3. Strong plea for additional INTSORMIL research regarding need for soil physicist.
  4. Suggest they be advised of PI visits in ample time for optimum coordination and staff collaboration. Often visits too short. Also, visitor may stress his own interests more than country interests.
  5. Stressed need to better integrate INTSORMIL resources into the ARS system.
  6. Advised their desire for more education of in country scientists before going overseas for training.
- B. Dr. Lucas Gakale, Soil Fertility (trained under Clegg).
1. Rotation experiments of cereal-legumes.
  2. Appears to have limited association with INTSORMIL.
  3. Likely to have leading role in future agronomic developments.
- C. Louis Mazhani, Breeder (sorghum, millet, maize)
1. Works closely with David Andrews, Bill Ross.
  2. Benefits from INTSORMIL irrigation equipments (for 1 hectare)
  3. Impressed EEP by his objectives, understanding, collaboration, and enthusiasm.
  4. Maintains Botswana germplasm collection.
  5. Needs more financial assistance for literature and equipment e.g. dryer.
  6. Our discussions with him suggest local scientists should play major role in project planning.
  7. Requests PI visitors spend more time with resident scientists.
  8. Not overly impressed by ICRISAT germplasm.
- D. Chris Manthe, Entomology
1. Good student of INTSORMIL's Dr. Teetes.
  2. STRong individual helpful in negotiations with South African pest control people.
  3. Doesn't appear to have a major insect problem but has interest in yellow sugarcane aphid.
  4. Other problems may be boll worm, stem borer, head bugs, midge.

## E. Baikabile Matalaote

1. Dr. Starr recently visited on nematodes.
2. May look or is looking at charcoal rot.
3. Will probably look for more collaboration.
4. Could help Mazhani incorporate mildew resistance in Segalone.

## F. K. Monageng

1. Intercropping sorghum/cowpeas with micro-catchment of water.
2. Has additional station management responsibility.

## G. David Harspool

1. Impressive individual with considerable fabricating talent for animal drawn machinery.
2. Carried his equipment to field e.g. for ridge planting.
3. Local manufacturing of some equipment.
4. Developed run-off measuring devices.

## H. Charlie Riches

1. Weeds but emphasis on Striga.
2. Varietal screening - interesting technique.
3. Unfortunately leaving project soon.
4. May have some material for breeding.

## I. Charlie Bernhardt

1. Operator seed multiplication unit (SMU) which:
  - a. produces foundation seed
  - b. does seed testing
  - c. regulatory work-certification
  - d. contracts with farmers
  - e. processes (conditions) seed
  - f. distributes seed
2. Handles sorghum, maize, cowpeas, millet, sunflower, groundnuts (future).
3. Distributed 6,348 tons of seed in 1986/87 with 5,792 free/556 sold of which 5,434 were sorghum.
4. Has cold storage for "best available" parent stocks but will buy and distribute commercial run seed when supplies so require.
5. Back-up when supply limited must come from neighboring countries e.g. Zimbabwe or South Africa.
6. Equipment requires 24 hour operation to meet timing deadlines and may be of questionable quality.

#### V. Traditional Farm near Gabarone (Matshwani Maano)

- A. Water conservation and harvesting project with Doug Carter
- B. Observed 3 sorghum varieties - Segalone, Town, and unknown brown from contract farmer in South Africa.
- C. Considerable population variability but no thinning
- D. Very low yield - 600 kg from 7-8 ha
- E. Above average farmer - responsive to suggestions
- F. Sorghum experimental plot

#### VI. Sebele Farm

- A. Mortlock research on millet stand establishment with Dr. Vanderlip as major professor.
- B. Seed size was primary variable - no significant results.
- C. Double plowing (Carter) significantly improved yield by absorbing more water vs traditional broadcast-plow system.
- D. Wide row experiment designed to collect water into the row (Carter)
- E. Rotation studies (Lucas) already harvested
- F. Observed ICRISAT sorghum and Mazhani irrigated nursery which includes increase of Botswana germplasm collection.

#### VII. Mahalapye Visit

- A. One of ATIP research sites.
- B. Cooperates with Carter for various inputs.
- C. We observed double plowing experiment - already harvested.
- D. Visited water harvesting project with above average sorghum production partially harvested - saw drying and storage observation. Also, groundnut, millet, maize planting experiment.
- E. Strong discussion by Siebert on production potential, components of grain yield gap analysis, and research methodology.
- F. Government policy encourages extensive plowing by contractors from S.A. - most seed supplied by government - weeds often become major problem.

G. Seed distribution often relies on purchase from available on farm supply and appears to be somewhat loosely handled.

VIII. Commercial Farmers - 2% - rest (98%) are small farms - these 2% account for 35% of total production.

#### XI. Observations and Recommendations

1. EEP has for some time felt a strong need for a prime site review of Botswana which essentially completes all prime sites since global plan was established. Past trip reports, project reports, and presentations had given us concern as to the effectiveness and accomplishment of INTSORMIL inputs into Botswana. We also questioned the opportunity for extension of research to neighboring countries with South Africa well developed and Zimbabwe a leading country from a seed technology/varietal development standpoint as well as having a major ICRISAT sorghum improvement effort there.
2. Our five day visit, however, has given us an opportunity to better understand the Botswana internal situation as well as the out-of-country support programs. We realized a positive outlook for various reasons e.g.
  - a. USAID/Botswana shows strong interest and support for INTSORMIL assistance as experienced by the John Hummond presentation which gave us a strong orientation. Certainly Paul Daly, ADO, showed a strong interest in our visit with conversation on three days plus participation in our Mahalapye field tour. Paul showed interest in locating a means for additional support funds and asked for suggestions regarding the seed situation.
  - b. The strategic position of Botswana to South Africa being 90-95% dependent on them for supplies including both food and hard goods, as well as the relation to SADCC countries. The need for more self sufficiency, however, must be a major concern when one considers the place of the diamond industry in relation to a social or welfare state.
  - c. Both INTSORMIL and ATIP seem mutually supportive of the others need for a satisfactory level of accomplishment. This good working relation undoubtedly is making each more effective.
  - d. We suspect that the very elementary research on basic agronomic practices related to drought can very well be applicable to other African countries where drought is a constraint -- pretty well all inclusive.

e. INTSORMIL should benefit by taking advantage of maintaining a close relationship with the SADCC and SACCAR activities based in Botswana.

3. The aim of INTSORMIL being able to build a strong collaborative program, we would encourage a closer relationship to ARS staff. We do, however, encourage their staff to request such support as opposed to an attempt to pressure them with extensive externally recommended projects. More advance time and forward planning should be given to visits by PI's with as much orientation in advance as possible. Also, ARS staff as well as AID mission and ATIP need an opportunity for planning and especially taking advantage of the PI's talents.
4. We agree to the unanimous request for a soil physicist to investigate soil/water relations. This PI would:  
determine factors influencing infiltration rates  
look into changes of the cultivated soil zone  
interrelate with ATIP and ARS staff and graduate students.

We strongly recommend a short term (one month) consultant to investigate opportunities and need for the position. He hopefully could suggest the best possible candidate who preferably should have adequate experience to give significant and immediate input. Dr. Bob Stewart, director of the Bushland Station, Amarillo, seems a logical candidate for the short term as he can additionally make immediate suggestions helpful for projects prior to the next "rainy season."

5. Doug Carter should be listed as a PI with KS 107 but receive increased project planning in conjunction with Van Withee, also a project PI, Vanderlip, Norman, and key ARS staff as suggested by the director.
6. We would encourage some short term projects which can be adopted and used to illustrate progress to support the longer term approaches. These highly visible but perhaps more simplistic results or accomplishments can give strong impetus to continued or increased support.
7. We strongly support the fundamental agronomic approach to problems of the small farmer as opposed to a more specialized research effort.
  - a. Obviously all research must concentrate on drought/heat with stand establishment interrelated.
  - b. The re-direction into water harvesting and conservation was recognized by the EEP.

8. We encourage continued close cooperation between Mazhani and Andrews in all aspects of plant breeding with this collaboration hopefully an example for other disciplines wherever possible.
9. The talents of Harspool in the design of animal drawn equipment should be a positive asset for various INTSORMIL collaborative projects.
10. At current country yield levels agronomic inputs (cultural practices) along with needed varietal improvements seem most productive and offer the best opportunity for improvement as compared to more basic science (disciplines).
11. We strongly urge and appreciate the continuity of staffing and thus the opportunity for the completion of projects.
12. We only had limited contact with the seed multiplication unit and additionally it is out of the responsibility of INTSORMIL. We did offer to suggest specialists for such input and will make specific comments to Paul Daly.

We appreciate the courtesies extended to us by all involved during our visit. Continuation of active INTSORMIL collaboration appears most desirable.

## COMMENTS ON MY VISIT TO BURKINA FASO

Brhane Gebrekidan

From October 29 - 31 I was able to visit three main locations in Burkina Faso, a) Bobo Dioulasso (Farako Ba), the main cereals improvement research station of the country, b) Kamboinse, the station where ICRISAT's Burkina Faso sorghum and millet work is centered, and c) Ouagadougou, the coordinating headquarters of SAFGRAD. In each location I was able to discuss sorghum and millet research and INTSORMIL's role with appropriate staff.

At Farako Ba, I met Dr. Da San San, sorghum breeder and national cereals program leader of Burkina Faso. He was trained under Dr. L. Rooney at Texas A&M University. He provides an excellent opportunity for CRSP activities. At this time, he does not seem to have an active program contact with INTSORMIL. He could be a good contact person in Burkina Faso in an effort to link up the Niger, Mali, and Burkina Faso INTSORMIL efforts. At Farako Ba, based on past ICRISAT work on Striga, the variety Framida, which has been found tolerant to Striga in Burkina Faso is in extensive agronomic tests. This variety was found very susceptible in Niger. It is important to exchange these apparently contradictory findings within the region. At Farako Ba, ICRISAT has a sorghum pathologist (Dr. Thomas). It would be useful to link up with him if INTSORMIL follows up the long smut work in Niger and/or Mali. IITA/SAFGRAD (Dr. Mario Rodriguez) is doing extensive research on agronomy with emphasis on soil and water conservation and nutrient and water use efficiency. Both Niger and Mali can benefit from this work. Burkina Faso has worked over the years on the advantages and practicality of tied ridges as micro-catchment basins for water conservation for crop use. The INTSORMIL socio-economics project PRF-105 is suggesting tied ridges to be a major component of an improved package of technology to be economically evaluated at the farm level in Niger. Tied ridges are used widely in many of the agronomic experiments in Burkina Faso. Linkages with Burkina Faso should be important for the PRF-105 project.

At Kamboinse, ICRISAT has its main activities on sorghum and millet research. The main base for ICRISAT's Striga work in Africa is at Kamboinse where Dr. Ramaiah, the Striga breeder, is located. I had discussions with Dr. Ramaiah and informed him of the differential Striga responses of SRN39 and Framida showing in Niger. It would be important for the Niger INTSORMIL Striga work to cooperate closely with Ramaiah. At Kamboinse also ICRISAT has had a number of years of work on traditional sorghum food preparation, particularly tuwo. It is important to link the food technology work on sorghum going on in Niger, Mali, and Burkina Faso. Since tuwo is the main food in each of these countries it would be useful to maintain close contact and exchange of information among the researchers involved in the three countries.

In my visit to the SAFGRAD headquarters in Ouagadougou I met Dr. Taye Bezenuh, the Director of Research for SAFGRAD. The emphasis of this organization in the years to come will be on networking and strengthening national programs in crops research in the semi-arid zones of sub-Saharan Africa. SAFGRAD has good linkages with most countries in which INTSORMIL is also interested. It would therefore be useful for INTSORMIL to maintain good linkages with SAFGRAD.

The opportunity for INTSORMIL collaboration and useful linkages are good in Burkina Faso. It would be desirable if INTSORMIL would get involved more actively in Burkina Faso.