



EXECUTIVE
SUMMARY



INTSORMIL

Annual Report 1990



**SORGHUM/MILLET
COLLABORATIVE
RESEARCH SUPPORT
PROGRAM (CRSP)**

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

Funding support through the Agency
for International Development

Grant No: DAN 1254-G-SS-5065-00



**Cover Photographs
(top to bottom)**

1. Dr. Gebisa Ejeta examines experimental plots of *Striga* tolerant cultivar 'SRN-39' and *Striga* susceptible local cultivars in Niger. (Photo courtesy of Dr. Darrell Rosenow).
2. INTSORMIL scientists discuss new sorghum variety performance with farmer on steep hillside farm in Honduras. (Photo courtesy of Dr. Darrell Rosenow).
3. Colombian Director of Research, Dr. Manuel Torregroza and INTSORMIL Principal Investigator, Dr. Guillermo Muñoz inspect new ICA/INTSORMIL acid/aluminum tolerant variety 'Sorghica Real 60'. (Photo courtesy of Dr. Bruce Maunder).
4. IER scientists Mdme. Coulibaly, Mr. Temé, Mr. N'Diaye, Mr. Sy and Mr. Traore make field selections in sorghum nursery in Mali. (Photo courtesy of Dr. Darrell Rosenow).

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Fighting Hunger with Research . . . A Team Effort

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**Grain Sorghum/Pearl Millet Collaborative
Research Support Program (CRSP)**

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**Report Coordinators
John M. Yohe, Program Director
and
Timothy T. Schilling, Associate Program Director**

For additional information contact the INTSORMIL Management Entity at:

INTSORMIL
54 Nebraska Center
University of Nebraska
Lincoln, Nebraska 68583-0948

862

Telephone (402) 472-6032

Telex 438087 UN INTPRG LCN

Dialcom 57:CGI025

Fax No. (402) 472-7978

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University of Nebraska
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INTSORMIL Institutions are affirmative action/equal opportunity institutions.

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EXECUTIVE SUMMARY

Introduction and Program Overview

Sorghum and millet are important food and feed crops. They remain the staple crop for millions of people in semi-arid regions of the world. Their unique ability to withstand periods of drought and other adverse edaphic and climatic factors have led to their widespread cultivation and consumption in Africa and Asia. Sorghum and millet are grown in some of the harshest environments and most fragile lands in the world resulting in low and unstable grain production. As population pressure increases in these areas, the need to boost production in environmentally sound ways becomes increasingly urgent.

To increase sorghum and millet productivity, INT-SORMIL was created in 1979 by USAID and operates under the Bureau for Science and Technology. Over the past ten years, INTSORMIL has established a dynamic, multi-institutional and interdisciplinary collaborative research and training program. INTSORMIL links the expertise of 30 U.S. scientists from five American universities with over 100 international scientists in six key sites and 15 other countries. Individual country programs respond to National Agricultural Research Systems' (NARS) requests for research support. INTSORMIL provides technical backstopping, conducts collaborative research, trains national staff and students, and contributes to overall NARS sorghum and millet program operations support. The success of INT-SORMIL can be attributed to five unique features.

- INTSORMIL capitalizes on over 90% of U.S. University sorghum and millet expertise where most basic and strategic research is conducted. This allows us the unique opportunity to support and complement applied field work conducted at NARS by adding an otherwise unknown dimension to the research.
- INTSORMIL is an integrated, interdisciplinary organization encompassing breeding, agronomy, insect and disease management, food quality, economics, and sociology.
- INTSORMIL enhances the capacity of NARS to solve country and region specific problems through collaborative research thus increasing NARS technical and institutional productivity.
- INTSORMIL activities are constraint and NARS driven: identification and alleviation of priority production constraints are achieved in concert with collaborating National Agriculture Research Systems, NARS.

Productivity constraints were identified in concert with Host Country scientists and became the basis by which the program matrix was developed. The matrix was utilized to create and implement a comprehensive interdisciplinary research program. Progress has been made to alleviate the constraints but some problems have not yet been eliminated. The constraints listed below are resolvable impediments to productivity both economically and institutionally.

- Poor and unstable yields due to low and erratic rainfall
- Biotic stresses such as plant disease and insects
- Lack of appropriate value-added crop utilization technologies
- Lack of productive resource efficient germplasm
- Lack of profitable and sustainable production systems
- Need for human resource development
- Need for effective research infrastructures and operations

These and other constraints are addressed in a well planned approach described in a Global Plan which outlines a comprehensive approach to the resolution of the constraints. Our strategy focuses on five technical thrusts, each aimed at increasing productivity:

- Germplasm Enhancement-the development of resource efficient cultivars
- Sustainable production systems-establishment of environmentally sound and financially profitable production systems
- Biointensive plant protection systems-the development of environmentally and economically sound pest control systems
- Crop utilization and marketing-development of shelf stable processed foods with good marketing potential
- National Sorghum and Millet Research Program enhancement-short and long term training for NARS staff, equipment procurement, and overall NARS operations support

INTSORMIL collaborative research programs are directed at alleviating the priority constraints within a collaborating host developing country through interdisciplinary research. American scientists work together with host country scientists to resolve priority constraints. The U.S. Land Grant Universities participating with INTSORMIL are:

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

INTSORMIL collaborates with many different countries and institutions. Of these institutions, INTSORMIL has designated six country/institutions as prime sites for long term collaborative research because of their ecogeographic location, national importance of sorghum and millet, and their desire to collaborate. The INTSORMIL prime sites and institutions are currently as follows:

**The Department of Agricultural Research, DAR,
Botswana
The Institute of Rural Economy, IER, Mali
The National Institute for Agricultural Research,
INRAN, Niger
The Agricultural Research Corporation, ARC,
Sudan
The Secretariat for Natural Resources, SRN,
Honduras
The Institute for Colombian Agriculture, ICA,
Colombia.**

This report summarizes the program effort during the eleventh year of implementation. These eleven years of experience continue to reaffirm the global need for INTSORMIL to improve sustainable and profitable sorghum/millet production systems in developing countries. The report is organized by discipline and project and provides a detailed description of relevant annual activities at the project level. These activities have been summarized by subject and presented in the following pages in summary form.

1990 Activities

Administration and Management

The University of Nebraska (UNL) is the Management Entity (ME) for the Sorghum/Millet CRSP and is the primary grantee of A.I.D. UNL subgrants are made to the participating U. S. Universities for the research projects between individual U. S. scientists and their host country counterparts. Country project funds, managed by the ME and U.S. participating institutions, flow to the country program in support of the research activities at the host country level. The Board of Directors (BOD) of the CRSP serves as the top management/policy board for the CRSP. The Technical Committee (TC), Ecogeographic Zone Council (EZC), External Evaluation Panel (EEP) and A.I.D. personnel advise and guide the ME and the board in areas of policy,

technical aspects, collaborating host country coordination, budget management, and review.

The 1990 year was a very busy but fruitful one for the ME, BOD, TC and EZC. Below are listed several major accomplishments for the year.

- Developed Grant Extension Proposal for the next five years of INTSORMIL activity. The Proposal outlined the INTSORMIL five year strategic plan and was approved at the optimal funding levels contingent on the availability of funds in USAID.
- Organized and implemented an important workshop on sorghum/millet protein quality at Purdue University. This workshop was highly esteemed for assessing current state of the art and orienting future quality protein work in sorghum.
- Presented CRSP activities to U.S. Congressional, World Bank, Environmental, AID, and USDA delegations in Washington. This initiative should result in higher visibility and recognition among important domestic and international groups.
- Successful at securing a \$100,000 local currency buy-in from the Host Country/USAID Mission in Sudan. These funds will be used exclusively to complement the INTSORMIL core country budget for collaborative sorghum and millet research. Much thanks goes to the AID mission and Dr. Gebisa Ejeta, the INTSORMIL Sudan Coordinator.
- Developed INTSORMIL Five Year Calendar with dates of all INTSORMIL major activities to provide more orderly and efficient annual planning. In addition, annual EEP reviews have been incorporated in order to keep the panel abreast of project activities and to allow input from the EEP on a yearly basis as required by USAID guidelines.
- Funded, organized and hosted a major sorghum and millet workshop in Sudan. The workshop was well attended with participants from over 15 countries.
- Instrumental in the development of the CRSP Council, an integrated CRSP initiative that addresses the global concerns of agricultural production and sustainability, natural resource conservation, and environmental quality. The CRSP Council unites the resources and capabilities of the eight CRSPs, effectively creating a powerful international research network to service and support USAID missions and regional offices.

- Granted an additional \$100,000 by USAID/S&T to be used in behalf of all eight CRSP programs for developing "Cross CRSP" activities.
- Negotiated U.S. \$558,000 buy-in from USAID Egypt Mission. This three year buy-in will activate INTSORMIL projects in pathology and agronomy in collaboration with Egyptian scientists.
- Initiated and awarded \$25,000 grant from USAID/S&T to co-sponsor Sorghum Utilization Symposium with ICRISAT. The Symposium highlights current state of the art technologies and focuses on future research directions.

Training

Training of host country scientists contributes to the capability of each host country research program to stay abreast of environmental and ecological changes which alter the balance of sustainable production systems. The strengthening of host country research institutions contributes to their capability to predict and be prepared to combat environmental and ecological changes which affect sorghum and millet. A well balanced institution will have to be prepared to prioritize and blend its operational efforts to accomplish the task of conserving and efficiently utilizing its natural resources.

During 1990 covered by this report, 118 students from over 37 different countries were enrolled in an INTSORMIL advanced degree program. Over 80% of these students are from countries other than the U.S. which shows the emphasis placed on international development. INTSORMIL also places importance on training women which is reflected in the fact that 20% of all INTSORMIL graduate participants are women.

Twenty students were fully funded by INTSORMIL in 1990 and 19 others were partially supported through INTSORMIL research grants. An additional 60 students were funded from other sources yet conducted research on INTSORMIL projects. Finally, INTSORMIL has placed and managed 19 students with reknown professors in areas outside of INTSORMIL disciplines under a subgrant from ICRISAT.

Total student numbers remained constant with that of 1989 which was an increase of 17% compared to 1988. However, the number of INTSORMIL funded students has declined from 47 to 20 as compared to 1987. This decrease is partially due to an equivalent increase in the number of students supported through other sources. An even more significant factor is that budget flexibility for supporting training under INTSORMIL projects has been greatly re-

duced because of inflationary pressures. None of the 30 INTSORMIL project budgets have been increased in the last five years.

The second phase of the SADCC/ICRISAT/INTSORMIL program was signed in 1989 and will run through September 15, 1993. The second phase calls for a two fold increase in volume and activity. An additional 60 scientists from the SADCC region have been identified and will be processed for training in the next two years. Increased emphasis has been given for the disciplines of food technology, economics, forages, and agroclimatology. INTSORMIL engaged the services of Ms. Terri Steadman to manage the increased graduate student volume. As of June 30, 1990 INTSORMIL has processed a total of 48 SADCC students encompassing nine SADCC countries.

Networking

Established networking activities have continued with ICRISAT, SADCC/ICRISAT, SAFGRAD, ICRISAT Sahelian Center, ICRISAT West Africa Sorghum Program, East Africa ICRISAT, ICRISAT/CIMMYT and CIAT. There has been excellent collaboration with each of these programs in cosponsoring workshops and conferences, for coordination of research and long term training.

INTSORMIL has collaborated with TROPISOILS in Mali and in Peru with extremely good results. Collaboration among CRSPs is essential for providing a broad systems approach to addressing many of the natural resource constraints that now face us. INTSORMIL was awarded a \$100,000 grant to initiate and foster inter-CRSP approaches to sustainable agricultural development.

Current Country Specific Activities

Botswana

The major constraint in Botswana is that of inadequate and poorly distributed rainfall. During the time INTSORMIL has been involved with research in Botswana there has been a drought seven of eight years. INTSORMIL is working with the Department of Agricultural Research, DAR, to develop macro and micro water encatchment systems. These systems, when used in conjunction with soil management techniques have been proven to double yields of sorghum in dry years. INTSORMIL also provides high quality, adaptable germplasm to the sorghum and millet breeding program and collaborates with the country's pathology and entomology components.

Progress was made in identifying resistance to the sugarcane aphid in sorghum lines. Resistant x susceptible crosses indicated that resistance is simply inherited and controlled

by a single completely dominant gene. Different virulence within the Botswana and between the Botswana and Zimbabwe sources of aphids suggests different biotypes exist among the populations.

Material from Texas A&M University collaborative nurseries demonstrated that good anthracnose resistance was available in introduced and improved local germplasm. Anthracnose virulence appears to differ from that occurring in India and the U.S. and may even differ within the SADCC region. Charcoal stalk rot, ergot, and other diseases were also characterized.

Dr. Naraine Persaud, INTSORMIL soil physicist continued work on the Botswana national tillage trials. Results from this research have shown that tillage performed as early as possible with the inception of rains can conserve sufficient moisture and give better rain use efficiencies. Addition of phosphorous furthered response and gave excellent yield increases.

Botswana students trained through SADCC/ICRISAT/INTSORMIL, INTSORMIL, and USAID/BOTSWANA educational/research programs are Lucas Gakale, Louis Mazhani, Chris Manthe, Dollina Malepa, Elijah Modiakgotla, Michael Mogorosi, Baikabile Motlalo, and Boi Sebolai. These scientists are providing an excellent scientific core staff to DAR. Currently there are four students being trained by INTSORMIL and others have been identified for future training.

Honduras

INTSORMIL works in conjunction with the National Research Institution, Recursos Naturales, the Pan American Agricultural School, EAP and The Soil Conservation Program, LUPE. Research is focused on the development of high yielding sorghum varieties and hybrids for the two major agroecological zones of Honduras. The program effectively integrates the disciplines of pathology, entomology, food quality, agronomy and economics into a powerful technology generating unit.

Two varieties, Sureño and Catracho, were developed and released through the program and recent impact studies show these technologies provide farmers with a real 15% net farm income increase and a 58% income increase if price policy was designed to avoid price collapse in good years.

Extensive on-farm testing of the new INTSORMIL varieties indicates that they produce higher grain yields than traditional maicillo criollos varieties. Data from 47 sites showed an increase over local cultivars with traditional practices of 23% and 38% respectively. The magnitude of their yield advantage increased considerably when seed was

treated with a systemic insecticide and when seed treatment was combined with 60Kg/ha nitrogen. Sureño has been accepted quite well in southern Honduras, with one survey indicating 28% of the farmers had tried it, and 48% of those have adopted it.

Improved local sorghum breeding lines performed very well in yield trials and the most promising have been advanced to extensive on-farm trials. These on-farm trials have revealed that the improved maicillo lines yielded slightly better than the traditional maicillo with traditional cultural practices. Some of the improved maicillos had grain and tortilla quality equal or superior to the local cultivars. The tan plant lines were particularly good for tortilla quality.

Hybrid maicillos have shown a large yield advantage over local maicillos varieties. Breeding for hybrid maicillos has become a priority breeding objective.

Research on grain quality research indicates that sorghum grain with certain traits can produce tortillas of comparable quality to those of maize. Important traits were found to be white grain with an absence of pigment or staining, grain with little or no grain mold or weathering, grain with a thick pericarp to facilitate pericarp removal, and grain which retains a light color in the presence of alkali. Development of high yielding, food type sorghums with these grain quality traits should have direct and significant application not only to Honduras, but to other countries in South and Central America

Diseases of sorghum in Honduras have been identified, and their importance determined through incidence, severity, and loss assessment studies. Diseases of major importance are downy mildew, MDM, grain mold, acremonium wilt, and foliar diseases such as gray leaf spot, rust, zonate, and oval leaf spot.

Studies on biological control of the fall armyworm and stem borers have been completed, and an exotic parasite effective in controlling stem borers was mass reared and released in Honduras and El Salvador and apparently has become established at low numbers, in both countries.

Six Honduran and Central American students have been trained, with most conducting their research in Honduras. Several Central American researchers have been involved in short term training missions to the U.S.

Colombia

The INTSORMIL program in Colombia has effectively engendered the support of the National Agricultural Research Institute, ICA, Colombian Universities, Private companies, CIAT, and Extension Organizations to form a

dynamic program on sorghum improvement. Program focus has been on the adaptation of sorghum varieties to the acid and aluminum saturated soils of the savannah region.

Two varieties, Real-40 and Real-60, were recently released from the program and have been accepted by growers as reflected by the documented demand for seed. These varieties have the potential to allow over 200,000 hectares of acid savannah soils to be utilized for sorghum production where other crops can not grow.

Selections were made in the different ecosystems from 500 F₄ lines sent by MSU-104. These short-stature lines have good yield capacity and are being evaluated in regional trials.

Twenty F₂ populations from Mississippi were screened in both vega and savanna environments. Promising breeding material was identified and is available for future work. The lines selected have short stature and good yield potential.

Mali

INTSORMIL works with the National Research Institute, IER, and uses a strong interdisciplinary approach to sorghum and millet improvement as mandated by the very complex nature of the constraints in both sorghum and millet production in Mali. The Mali program has focused on the development of sorghum varieties with acceptable food quality, headbug/mold resistance, drought tolerance and nutrient-use efficiency. Several seedling establishment screening techniques have been developed and are being used by the breeding programs.

Germplasm from U.S. breeders and the sorghum conversion program has been incorporated into the Malian breeding programs. Testing in Texas and Mali has demonstrated that the drought response in Mali is similar to the drought response in west Texas.

Sorghum and millet postharvest technology systems in Mali were documented in 1979 and strategies for evaluating the quality of cereals, especially sorghum, for thick porridge (tô) were devised. Mini tests for evaluating milling and tô properties were developed and currently are used in the laboratory. Equipment for the new Food Technology Laboratory was provided and personnel were provided short term training programs in the U.S.

Sorghum dehulling properties were defined by combined village trials in Mali and laboratory work in the U.S. This research showed that sorghum with hard endosperm and thick pericarps is definitely required for efficient traditional hand pounding.

The severity and persistence of the adverse effect of head bugs on food quality of introduced sorghums was first generally recognized in Mali. Head bugs reduced sorghum and milling yields and gave tô, a local thick porridge, with unacceptable texture and keeping properties.

Seven improved sorghum lines, Malisors, from the Malian program have been released. Malisor 84-7 has shown some advantages in multiple cropping systems and appears to be the only improved sorghum with head bug resistance. As such, it will be used extensively in sorghum breeding in Mali, and all across West Africa where head bugs are a very serious constraint. These improved types in general have improved yields and good food quality properties.

Progress has been made to determine factors affecting the "soils problems" in Mali through joint INTSORMIL/TROP-SOILS collaboration. Some "dune varieties" of millet originating in Niger are tolerant.

A method of screening large numbers of sorghum and millet lines for early generation selection for seedling stage drought resistance using a charcoal pit has been adapted and is used.

Parboiling can convert sorghum and millet into acceptable products. A processed food product called 'sori' was developed to add value to sorghum grain produced at the farm level and is in the early stages of consumer acceptance testing. If acceptable, 'Sori' has the potential to offset shifting consumer preference to imported, more convenient grains, especially rice and wheat, which drain foreign exchange.

INTSORMIL has provided short term and graduate training for several key Malian scientists. Scientists trained in food technology, pathology, breeding, physiology and agronomy have returned to Mali and collaborate in the program. Seven graduate students are currently training in INTSORMIL universities to provide personnel to continue the programs. The programs include agronomy, breeding, physiology, economics and soils.

Technical assistance to develop the Cinzana station, to map the soils, and obtain detailed physical and chemical analysis of the soil profiles has been provided. Equipment and short term consultants were supplied to establish and install sprinkler systems and screening procedures for drought tolerance and research at Cinzana.

Niger

In collaboration with the Institute of National Agronomic Research, INRAN, INTSORMIL has developed strong programs in the areas of breeding, pathology, entomology, and

food technology. The program has developed an effective laboratory screening technique for *Striga* resistant sorghums. This method could be important to resolving the problem of the parasitic weed, *Striga*, in Africa and India.

Innovative disease screening techniques were developed in collaboration with INRAN and are being employed in several other countries. Dr. Omer El Hilu from ARC/Sudan, working with Richard Frederiksen and John Clark continues to explore an initiative to set up an All Africa Long Smut Disease Nursery. This nursery will serve to screen all advanced breeding material for Long Smut, a major disease of sorghum in Africa.

Field research in farm production economics has made important contributions to the INRAN economics and on-farm testing programs. Research is now underway on the biological control of the major insect pest of millet, the millet girdler.

Significant advances have been made in the breeding program at INRAN, primarily on sorghum, as a result of collaboration with INTSORMIL. Intercrossing of adapted exotic germplasm with local Nigerian varieties has yielded useful selections that are currently under regional evaluation.

A hybrid sorghum breeding program initiated at INRAN in collaboration with INTSORMIL has also made useful contributions. Issoufou Kapran, working with Gebisa Ejeta, identified five experimental sorghum hybrids with excellent adaptation and yield potential in Niger. These hybrids yielded much higher than local varieties both under rainfed (149%) and irrigated (161%) locations in Niger.

Experiments are in progress by Dr. Paresh Verma and Dr. Jerry Eastin which will provide information needed to optimize water-use efficiency of the millet/cowpea intercropping systems. Once the water extraction patterns of the two crops and the optimum shade level needed to maximize photosynthesis but minimize transpiration for maximum water-use efficiency in cowpea are known, we will be able to alter the time of cowpea planting and hence shading level, to increase overall production of the intercropping system.

Sudan

The INTSORMIL program in Sudan has worked closely with the Government's Agricultural Research Corporation, ARC, to build a strong national program for its most important staple crops, sorghum and millet. The ARC/ICRISAT/INTSORMIL hybrid, 'Hageen Dura-1' was released in 1984 and is grown on over 15,000 hectares in the irrigated Gezira. This technology is in its initial stage of diffusion and has already shown a high rate of return to society of 32%.

ARC in collaboration with INTSORMIL food utilization scientists, developed a composite flour using 30% sorghum and 70% wheat which can reduce wheat imports thus economizing precious foreign exchange.

United States

INTSORMIL research is performed at all participating universities. INTSORMIL investigators routinely evaluate international material for disease and insect susceptibility which is beneficial to all sorghum producers, U.S. and international. Much of the U.S. research conducted utilizes "upstream", hi-tech approaches to solve "downstream", farm level problems. Other research is being performed to alleviate constraints in the U.S. that are very similar to those in the developing world.

Drought is a world-wide constraint to the sorghum producers. INTSORMIL workers at Texas A&M, Purdue, and the University of Nebraska have begun to study drought effects from physiological, biotechnical, and genetic perspectives utilizing drought tolerant germplasm from Africa. Breakthroughs from stateside efforts will be readily transferable to other countries since germplasm sources are similar.

Recent economic studies have revealed that funds appropriated for INTSORMIL research have resulted in dividends that exceed initial expenditures several fold through the use of technologies generated by the program utilized for U.S. agriculture.

Future Directions

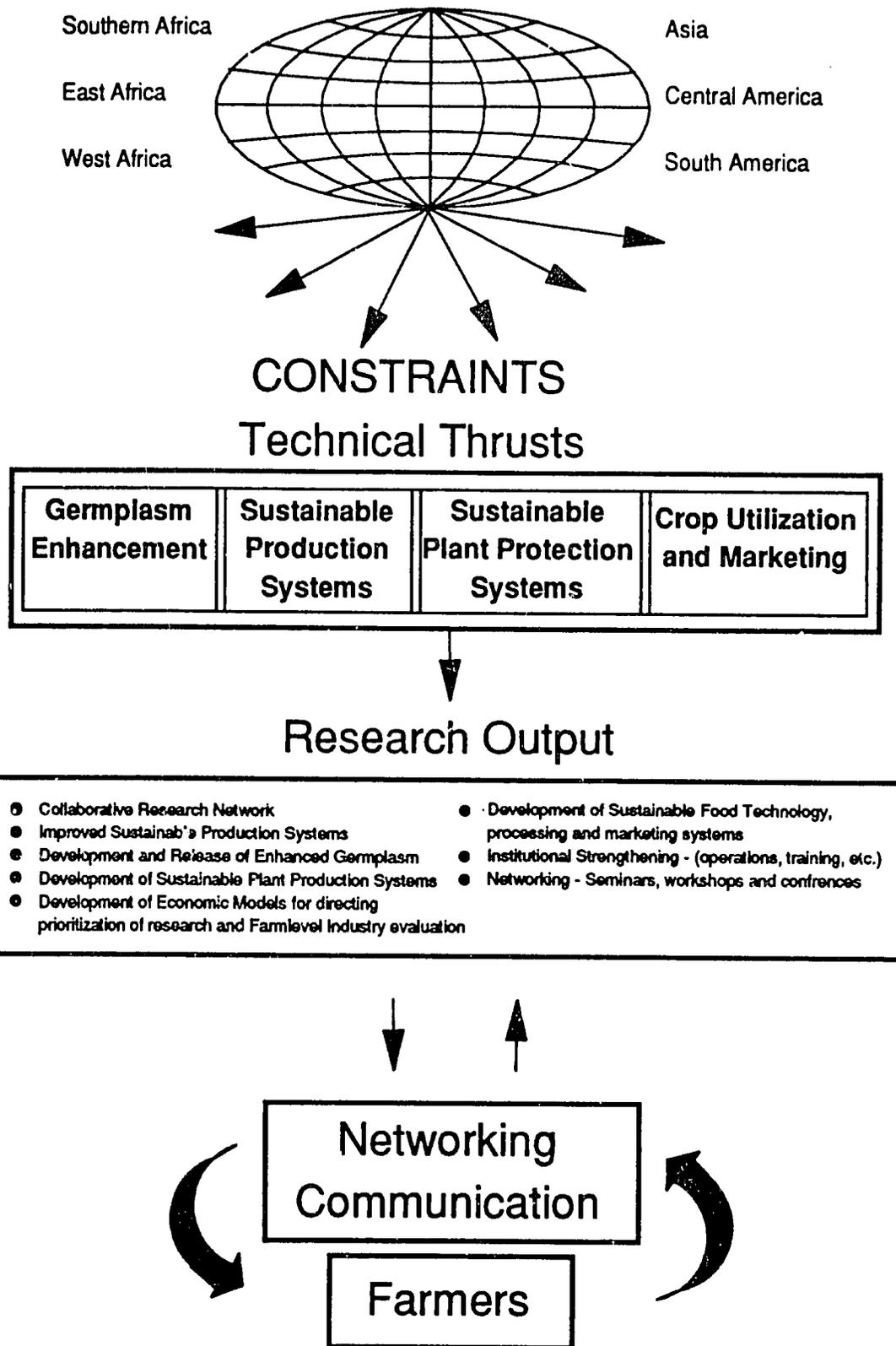
Over the past 12 years the INTSORMIL program has developed an effective research network on grain sorghum and pearl millet which is bringing about improved production and utilization of these crops in the developing world. The research in each of the collaborative countries has grown and the operational needs of the programs are now exceeding the resources of the program. It is also recognized that these programs must be nurtured until they become self sustaining and can move into a different phase of collaboration. New research emphasis must be given to sustainable production and utilization systems which conserve natural resources and at the same time utilize those resources efficiently and effectively. In order to address these concerns, greater emphasis and resources are needed to address the following concerns:

- Sustainable millet production and protection systems.
- New sorghum/millet food product development.
- Development of stable marketing systems for sorghum/millet.

- *Striga* control
- Quela bird control
- Biotechnology for understanding the host/pathogen gene relationships, disease/insect control, *Striga*, nutritional quality, and other abiotic stresses.
- Communications for developing materials for technology dissemination. This includes development of materials to enhance technology dissemination between host country research and extension programs.

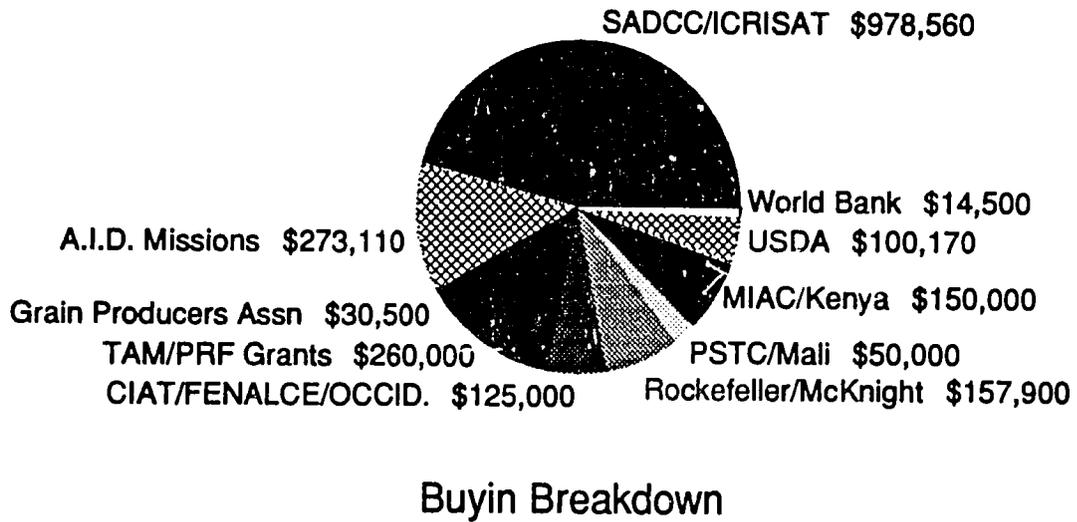
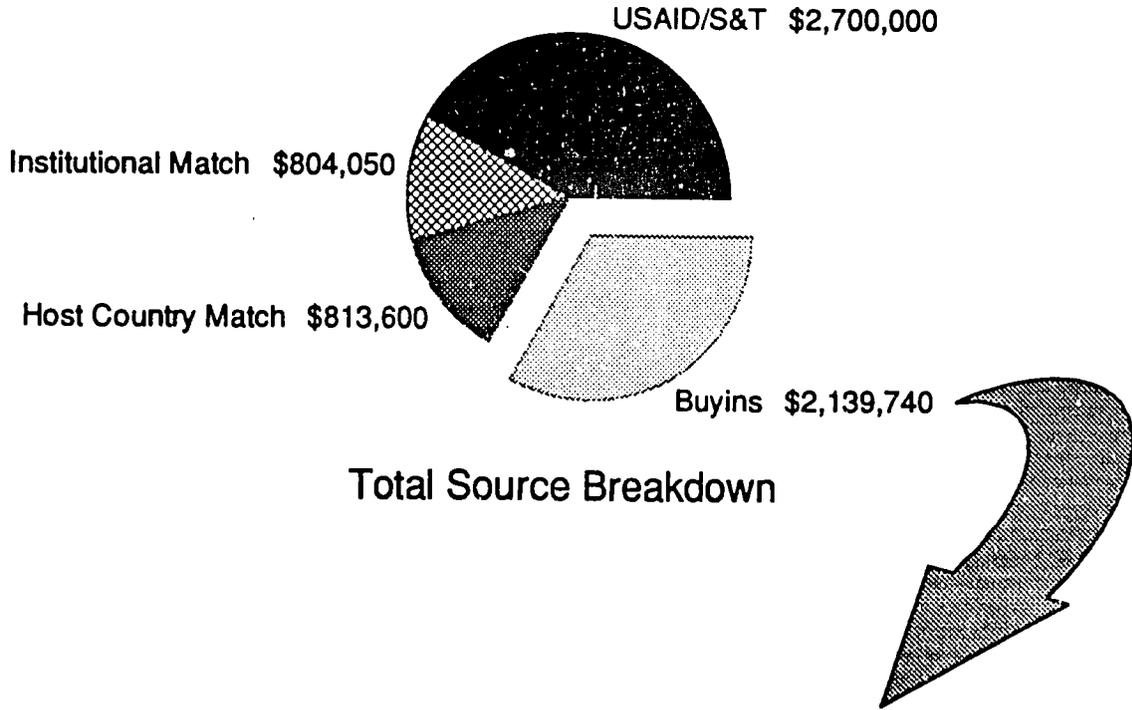
The new directions build upon the necessity to approach constraints to production and utilization from an ecological setting. INTSORMIL has organized its whole program approach around protection and enhancement of biological diversity, integrated pest management, sustainable production systems, and sustainable product utilization and marketing systems. The four global technical thrusts of the program are germplasm enhancement, sustainable production systems, sustainable plant protection systems, and crop utilization and marketing. A fifth global thrust is host country program enhancement.

INTSORMIL GLOBAL PLAN



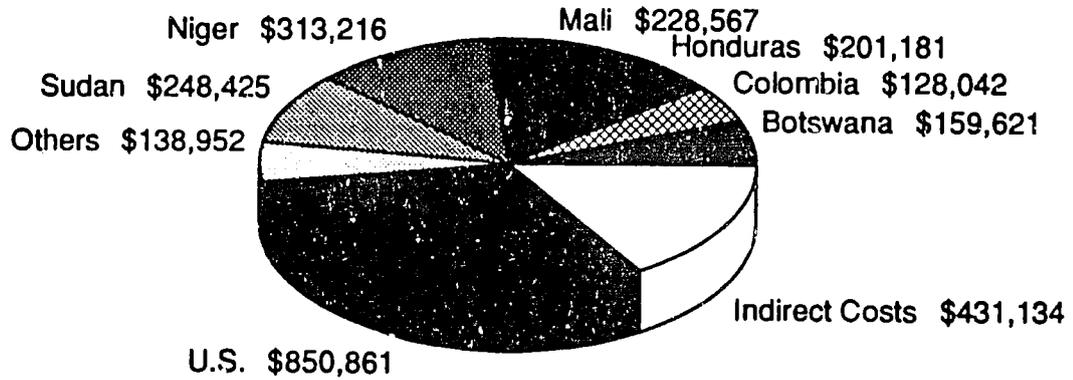
INTSORMIL Source of Funding

Total Year 11 Source - \$6,457,390

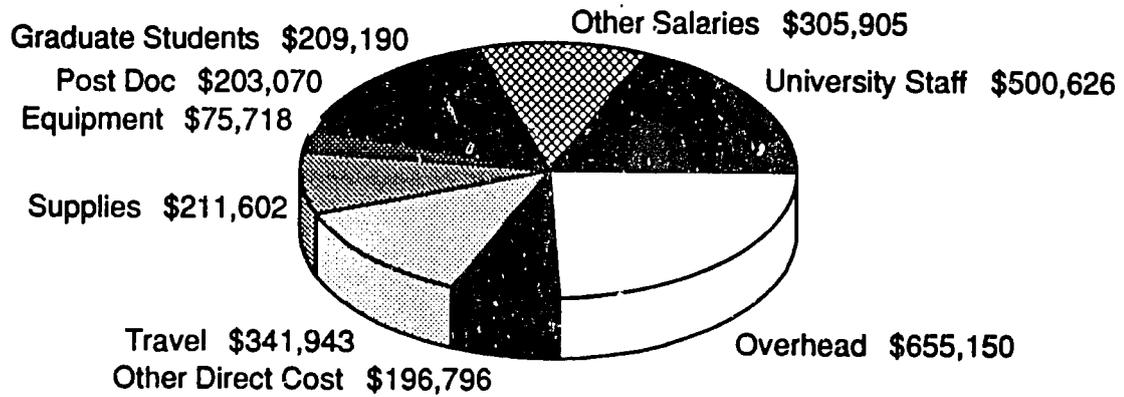


INTSORMIL Budget Analysis

Year 11 - \$ 2,700,000

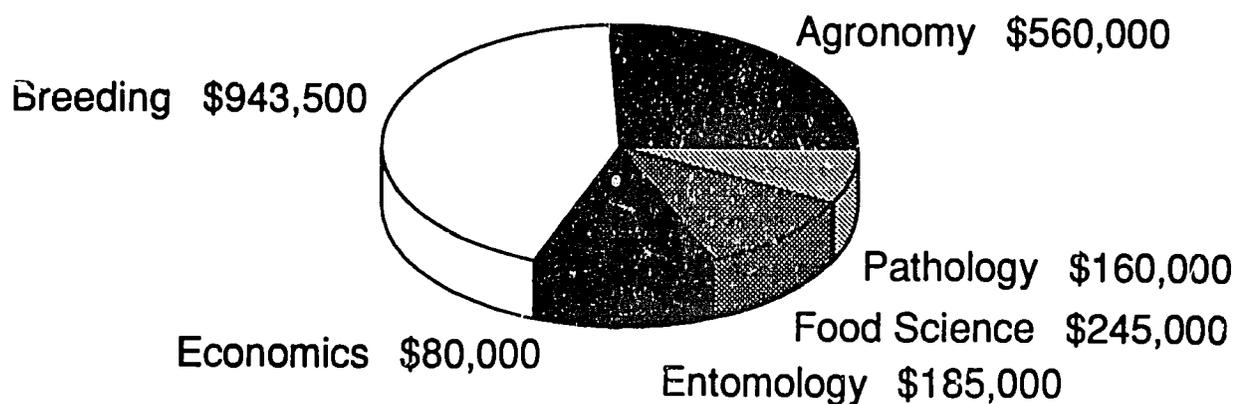


By Country



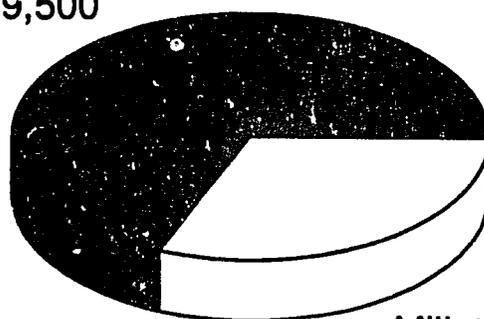
By Line Item

INTSORMIL FY90 Budget Analysis



By Discipline

Sorghum - 69% \$1,859,500



Millet - 31% \$840,500

By Crop

Table 1. A.I.D.-Grant Contribution to Sorghum/Millet CRSP for Years 1 (FY80) through 11 (FY90) for all Collaborative Research and Management Entity.

Budget Line Items	FY 80-85 Years 1-6	FY 86-89 Years 7-10	FY 90 Year 11	FY 80-90 Totals
Salaries & Benefits	\$ 7,604,987	\$ 5,068,822	\$ 1,168,776	\$ 13,842,585
Equipment & Facilities	1,292,255	586,778	48,218	1,927,251
Travel	1,862,258	1,270,062	301,943	3,434,263
Other Direct Costs	1,018,921	1,253,510	357,126	2,629,557
Technical Assistance	341,290	49,500	7,500	398,290
LDC Pass Through	2,160,955	1,095,525	170,000	3,426,480
Indirect Costs	3,869,334	2,707,503	646,437	7,223,274
Total	\$ 18,150,000	\$ 12,031,700	\$ 2,700,000	\$ 32,881,700

Table 2. A.I.D.-Grant Contribution to Sorghum/Millet CRSP for all Collaborative Research, U.S. Institutions (Florida A&M University, University of Arizona, Kansas State University, University of Kentucky, Mississippi State University, University of Nebraska, Purdue University, Texas A&M University), and the Management Entity.

Budget Line Items	FL	AZ	KS	KY	MS	NE	PR	TX	Institutional Total	ME Budget	ME TA-LDC	Total Grant
Years 1-6 (FY 80-85) A.I.D. Grant - AID/DSAN/XII-G-0149												
Salary & Benefits	85,270	191,675	896,270	287,013	828,186	1,622,402	1,224,363	1,833,520	6,968,699	636,288		7,604,987
Equipment & Facilities	35,500	41,529	134,655	4,600	34,968	159,889	129,863	726,750	1,267,754	24,501		1,292,255
Travel	14,500	27,523	276,950	136,390	177,094	233,533	216,753	435,559	1,518,302	343,956		1,862,258
Other Direct Costs	7,500	5,670	142,027	55,271	112,537	148,359	217,751	242,370	931,485	87,436		1,018,921
Technical Assistance												
LDC											341,290	341,290
Indirect Costs	35,106	58,283	397,575	165,476	447,465	762,315	661,080	894,215	3,421,515	447,819	2,160,955	2,160,955
TOTALS	\$ 177,876	\$ 324,680	\$ 1,847,477	\$ 648,750	\$ 1,600,250	\$ 2,926,498	\$ 2,449,810	\$ 4,132,414	\$ 14,107,755	\$ 1,540,000	\$ 2,502,245	\$ 18,150,000
Years 7-10 (FY 86-89) A.I.D. Grant - AID/DAN-1254-G-SS-5065-00 (July 1, 1985 - June 30, 1989)												
Salary & Benefits			594,305	100,954	433,160	858,939	1,077,689	1,387,114	4,452,161	616,661		5,068,822
Equipment & Facilities			84,109	800	69,922	160,752	95,802	165,710	577,095	9,683		586,778
Travel			152,113	27,684	109,996	161,409	277,872	328,988	1,058,062	212,000		1,270,062
Other Direct Costs			103,566	17,213	111,557	148,684	249,458	378,237	1,008,715	130,595		1,161,310
Technical Assistance											22,000	
LDC											49,500	49,500
Discontinued Projects and Grad Student Support											1,095,525	1,095,525
Indirect Costs			262,932	54,999	215,115	451,441	639,929	710,026	2,334,442	373,061	92,200	92,200
TOTALS			\$ 1,197,025	\$ 201,650	\$ 939,750	\$ 1,781,225	\$ 2,340,750	\$ 2,970,075	\$ 9,430,475	\$ 1,342,000	\$ 1,259,225	\$ 12,031,700
Year 11 (FY 90) A.I.D. Grant - AID/DAN-1254-G-SS-5065-00 (July 1, 1989 - June 30, 1990)												
Salary & Benefits			159,792		99,424	185,245	246,348	331,567	1,022,376	146,400		1,168,776
Equipment & Facilities			6,706		9,425	10,085		19,500	45,718	2,500		48,218
Travel			13,500		22,000	37,900	75,651	76,892	225,943	76,000		301,943
Other Direct Costs			13,394		37,200	53,841	116,920	104,771	326,126	31,000		357,126
Technical Assistance											7,500	7,500
LDC											170,000	170,000
Indirect Costs			56,606		50,451	92,929	171,081	191,270	562,337	84,100		646,437
TOTALS			\$ 250,000		\$ 218,500	\$ 380,000	\$ 610,000	\$ 724,000	\$ 2,182,500	\$ 340,000	\$ 177,500	\$ 2,700,000
GRAND TOTALS	\$ 177,876	\$ 324,680	\$ 3,294,502	\$ 850,400	\$ 2,758,500	\$ 5,087,723	\$ 5,400,560	\$ 7,826,489	\$ 25,720,730	\$ 3,222,000	\$ 3,938,970	\$ 32,881,700

Table 3. Management Entity Office Budget Details.

Budget Line Items	FY 80-85 Years 1-6	FY 86-89 Years 7-10	FY 90 Year 11	Totals FY 80-90 Years 1-11
Salaries & Benefits	\$ 636,288	\$ 616,661	\$ 146,400	\$ 1,399,349
Equipment & Facilities	24,501	9,683	2,500	36,684
Travel	339,956	191,000	66,000	596,956
International			23,000	
Domestic			10,000	
Board of Directors			11,000	
Technical Committee			11,000	
Ecogeographic Zone Committee			11,000	
P.I. Conference		16,000		16,000
Consultants	6,600	18,000	4,000	28,600
Other Direct Costs	84,836	117,595	27,000	229,431
Indirect Costs	447,819	373,061	84,100	904,980
Total	\$ 1,540,000	\$ 1,342,000	\$ 330,000	\$ 3,212,000
External Evaluation Panel			10,000	10,000
ME Total Costs	\$ 1,540,000	\$ 1,342,000	\$ 340,000	\$ 3,222,000

Table 4. Sorghum/Millet CRSP Summary of Non-Federal Matching Contributions by U.S. Institutions - Grant Years 1 (FY 80) through 11 (FY 90).

U.S. Institution	Years (1-10) FY 80-89	Year 11 FY 90	Years 1-11 Totals
University of Arizona	\$ 149,310	\$	\$ 149,310
Florida A&M University	23,898		23,898
Kansas State University	1,107,360	95,086	1,202,446
University of Kentucky	215,649		215,649
Mississippi State University	734,369	34,250	768,619
University of Nebraska	1,415,936	141,350	1,557,286
Purdue University	1,391,490	193,003	1,584,493
Texas A&M University	2,570,591	243,523	2,814,114
Total	\$ 7,608,603	\$ 707,212	\$ 8,315,815

Year 11 INTSORMIL Training Participants

Name	Country	University	Discipline	Advisor	Degree	Gender	Funding*
Coulibaly, Adama	Mali	KSU	Agronomy	Vanderlip	MSC	M	I
Kabambe, Vernon	Malawi	KSU	Agronomy	Vanderlip	MSC	M	S
M'Khaitir, Yahya O.	Mauritania	KSU	Agronomy	Vanderlip	MSC	M	O
Maliro, Charles	Malawi	UNL	Agronomy	Clegg	PHD	M	S
Mohamed, Mirghazi	Sudan	UNL	Agronomy	Clegg	PHD	M	I
Sebolai, Boingotla	Botswana	UNL	Agronomy	Clegg	MSC	F	S
Bagayoko, Minamba	Mali	UNL	Agronomy	Mason	MSC	M	P
Kasalu, Helen	Zambia	UNL	Agronomy	Mason	MSC	F	S
Sinfi, Seyni	Niger	UNL	Agronomy	Maranville	MSC	M	O
Toure, Abdoul	Mali	UNL	Agronomy	Maranville	MSC	M	I
Adamou, Moussa	Niger	MSU	Breeding	Gourley	PHD	M	O
Gutierrez, Osman	Venezuela	MSU	Breeding	Gourley	MSC	M	O
Montgomery, Libby	US	MSU	Breeding	Gourley	MSC	F	O
Muza, F. Ronald	Zimbabwe	MSU	Breeding	Gourley	MSC	M	S
Ortegon P., Jesus	Mexico	MSU	Breeding	Gourley	PHD	M	O
Saadani, Hamis	Tanzania	MSU	Breeding	Gourley	PHD	M	S
Zake, Vincent	Uganda	MSU	Breeding	Gourley	PHD	M	O
Mushonga, Joseph	Zimbabwe	PRF	Breeding	Axtell	PHD	M	O
Peters, Paul	US	PRF	Breeding	Axtell	PHD	M	O
Botorou, Ouendeba	Niger	PRF	Breeding	Ejeta	PHD	M	O
Grote, Ed	US	PRF	Breeding	Ejeta	PHD	M	O
Klingler, John	US	PRF	Breeding	Ejeta	MSC	M	I
Vogler, Renee	US	PRF	Breeding	Ejeta	MSC	F	I
Dahlberg, Jeffrey	US	TAM	Breeding	Miller	PHD	M	P
de Franca, Geraldo	Brazil	TAM	Breeding	Miller	PHD	M	P
Kanyenji, Ben M.	Kenya	TAM	Breeding	Miller	MSC	M	P
Khizzah, Bill W.	Uganda	TAM	Breeding	Miller	PHD	M	P
Nunes, Maria Eugenia	Mozambique	TAM	Breeding	Miller	MSC	F	S
Ombakho, Geroqe	Kenya	TAM	Breeding	Miller	PHD	M	O
Tenkouano, Abdou	Burkina Faso	TAM	Breeding	Miller	MSC	M	P
Toure, Aboubacar	Mali	TAM	Breeding	Miller	PHD	M	P
Gilbert, Mike	US	TAM	Breeding	Rosenow	PHD	M	P
Gorman, Chris	US	TAM	Breeding	Rosenow	MSC	M	I
Isbell, Verne	US	TAM	Breeding	Rosenow	PHD	M	P
Walulu, Richard	Kenya	TAM	Breeding	Rosenow	MSC	M	P
Doumbia, Mamadou	Mali	TAM	Breeding	Peterson	PHD	M	P
Chirwa, Rowland	Malawi	UNL	Breeding	Andrews	PHD	M	S
Chungu, Chibwe	Zambia	UNL	Breeding	Andrews	BSC	F	S
Mazhani, Louis	Botswana	UNL	Breeding	Andrews	PHD	M	S
Mwaka, F.P.	Zambia	UNL	Breeding	Andrews	MSC	M	S
Traore, Karim	Mali	UNL	Breeding	Andrews	MSC	M	O
Ahmed, Mohamed	Sudan	PRF	Economics	Sanders	PHD	M	I
Coulibaly, Ousmane	Mali	PRF	Economics	Sanders	PHD	M	I
Habash, Mohamed	Syria	PRF	Economics	Sanders	PHD	M	I
Lopez-Pereira, Miguel	Honduras	PRF	Economics	Sanders	PHD	M	I
Nichola, Tennassie	Ethiopia	PRF	Economics	Sanders	PHD	M	I
Ramaswamy, Sunder	India	PRF	Economics	Sanders	PHD	M	I
Shapiro, Barry	US	PRF	Economics	Sanders	PHD	M	O
Lopez, Julio	Honduras	MSU	Entomology	Pitre	MSC	M	I
Portillo, Hector	Honduras	MSU	Entomology	Pitre	MSC	M	I
Bayoum, Imad	Lebanon	TAM	Entomology	Tectes	PHD	M	O
Jimenez, Nora	Colombia	TAM	Entomology	Tectes	MSC	F	O
Jost, Douglas	US	TAM	Entomology	Tectes	MS	M	O
Magallenes, Ricardo	Mexico	TAM	Entomology	Tectes	PHD	M	O
Manthe, Chris	Botswana	TAM	Entomology	Tectes	PHD	M	S
Musonda, Ephraim	Zambia	TAM	Entomology	Tectes	MSC	M	S
Pendleton, Bonnie	US	TAM	Entomology	Tectes	PHD	F	O
Rojas, Edgar	Costa Rica	TAM	Entomology	Tectes	MSC	M	O

Name	Country	University	Discipline	Advisor	Degree	Gender	Funding*
Roque, Javier	Mexico	TAM	Entomology	Tettes	PHD	M	O
Thindwa, Harriet	Malawi	TAM	Entomology	Tettes	PHD	F	S
Siame, Anthony Bupe	Zambia	PRF	Food Quality/Util	Butler	PHD	M	S
Weerasuriya, Yohan H.	Sri Lanka	PRF	Food Quality/Util	Butler	PHD	M	O
Aboubacar, Adam	US	PRF	Food Quality/Util	Kirleis	MS	M	O
Leonard, Dawn	US	PRF	Food Quality/Util	Kirleis	MSC	F	I
Mohammed, Selma	Sudan	PRF	Food Quality/Util	Kirleis	PHD	F	O
Shull, Jeanette	US	PRF	Food Quality/Util	Kirleis	PHD	F	I
Watterson, Julia	US	PRF	Food Quality/Util	Kirleis	PHD	F	O
Almeida-Dominguez, H.D.	Mexico	TAM	Food Quality/Util	Rooney	PHD	M	P
Bello, Tony	Nigeria	TAM	Food Quality/Util	Rooney	PHD	M	P
Clegg, Chally	US	TAM	Food Quality/Util	Rooney	MSC	M	I
Corujo, Juan	Spain	TAM	Food Quality/Util	Rooney	MSC	M	P
Gous, Franz	South Africa	TAM	Food Quality/Util	Rooney	PHD	M	O
Islas-Rubio, Alma	Mexico	TAM	Food Quality/Util	Rooney	MSC	F	P
Mrema, Greyson	Tanzania	TAM	Food Quality/Util	Rooney	MSC	M	S
Wright, Lee	US	TAM	Food Quality/Util	Rooney	MSC	M	P
Young, Robert	South Africa	TAM	Food Quality/Util	Rooney	PHD	M	O
Chaisrisook, Chulee	Thailand	KSU	Pathology	Claflin	PHD	F	O
Darnetty	Indonesia	KSU	Pathology	Claflin	MSC	F	O
Farrokhi-Nejad, Reza	Iran	KSU	Pathology	Claflin	PHD	M	O
Qhobela, Molapo	Lesotho	KSU	Pathology	Claflin	PHD	M	S
Xu, Jin-Rong	China	KSU	Pathology	Claflin	PHD	M	O
Zvoutete, Petuos	Zimbabwe	KSU	Pathology	Claflin	MSC	M	S
Casela, Carlos	Brazil	TAM	Pathology	Frederiksen	PHD	M	O
Esele, Peter	Uganda	TAM	Pathology	Frederiksen	PHD	M	O
Mansuetus, Anaclet	Tanzania	TAM	Pathology	Frederiksen	MSC	M	S
Naidoo, Gnanamba!	South Africa	TAM	Pathology	Frederiksen	PHD	F	O
Oh, B.J.	Korea	TAM	Pathology	Frederiksen	PHD	M	O
Guthrie, Phil	Great Britain	TAM	Pathology	Odvody	PHD	M	I
Kunene, Innocentia	Swaziland	TAM	Pathology	Odvody	PHD	F	S
Mtisi, Ester	Zimbabwe	TAM	Pathology	Odvody	PHD	F	S
Alexander, John	US	TAM	Pathology	Toler	PHD	M	O
Mahuku, George	Zimbabwe	TAM	Pathology	Toler	MSC	M	S
McClellan, Eddie	US	TAM	Pathology	Toler	PHD	M	I
Theu, Matthew	Malawi	TAM	Pathology	Toler	PHD	M	S
Gandoul, Gandoul I.	Sudan	UNL	Physiology	Eastin	MSC	M	P
Kubik, Keith	US	UNL	Physiology	Eastin	PHD	M	P
Zavala-G., Francisco	Mexico	UNL	Physiology	Eastin	PHD	M	P
Coulibaly, Sidi Bekaye	Mali	UNL	Physiology	Sullivan	MSC	M	O
Dione, Siriba	Mali	UNL	Physiology	Sullivan	MSC	M	I

* I = Completely funded by INTSORMIL

P = Partially funded by INTSORMIL

S = SADCC/ICRISAT funded

O = Other source

Year 11 SADCC/ICRISAT Training Participants

Name	Country	University	Discipline	Advisor	Degree	Gender
Chitengue, Jone	Angola	Viscosa	Breeding	Vieira	MSC	M
Jose, Joao	Angola	Viscosa	Breeding	Cardosa	MSC	M
Mogorosi, Michael	Botswana	UNL	Agronomy	Mason	BSC	M
Sebolai, Boingotlo	Botswana	UNL	Biometrics	Clegg	MSC	F
Mazhani, Lou is	Botswana	UNL	Breeding	Andrews	PHD	M
Manthe, Chris	Botswana	TAM	Entomology	Teetes	PHD	M
Malepa, Dollina	Botswana	UNL	Plant/Soil	Walters	PHD	F
Maraka, Makoala	Lesotho	UNL	Agronomy	Walters	MSC	M
Mofolo, Moea	Lesotho	UNL	Agronomy	Sorensen	BSC	M
Mothokho, Neo	Lesotho	UNL	Agronomy	Lewis	BSC	M
Qhobela, Molapo	Lesotho	KSU	Pathology	Clafin	PHD	M
Moletsane, Nyakallo	Lesotho	PRF	Economics	Farris	MSC	F
Kabambe, Vernon	Malawi	KSU	Agronomy	Vanderlip	MSC	M
Msiska, Felix	Malawi	MSU	Agronomy	Hodges	MSC	M
Maliro, Charles	Malawi	UNL	Agronomy	Clegg	PHD	M
Chirwa, Rowland	Malawi	UNL	Breeding	Andrews	PHD	M
Thindwa, Harriet	Malawi	TAM	Entomology	Teetes	PHD	F
Theu, Matthew	Malawi	TAM	Pathology	Toler	PHD	M
Luhanga, Jeffrey	Malawi	MSU	Seed Tech	Andrews, C.H.	PHD	M
Pereira, Luiz	Mozambique	UNL	Agroclimatology	Weiss	MSC	M
Brito, Rui	Mozambique	CSU	Agronomy	Dumford	PHD	M
Nunes, Maria E.	Mozambique	TAM	Breeding	Miller	MSC	F
Nxumalo, Edgar	Swaziland	SHS	Agronomy	Lane	MSC	M
Kunene, Innocentia	Swaziland	TAM	Pathology	Odvody	PHD	F
Matowo, Peter	Tanzania	KSU	Agronomy	Pierzwnski	PHD	M
Mdolwa, Samuel	Tanzania	KSU	Agronomy	Moshier	BSC	M
Felix, Joel	Tanzania	PRF	Agronomy	Vorst	BSC	M
Mgema, William	Tanzania	UNL	Agronomy	Clark	MSC	M
Saadani, Hamis	Tanzania	MSU	Breeding	Gourley	PHD	M
Gutazi, Athman	Tanzania	KSU	Entomology	Reese	MSC	M
Mrema, Greyson	Tanzania	TAM	Food Science	Rooney	MSC	M
Mansuetus, Anaclet	Tanzania	TAM	Pathology	Fredriksen	MSC	M
Hikeezi, Doreen	Zambia	KSU	Agronomy	Kropf	BSC	F
Kasalu, Helen	Zambia	UNL	Agronomy	Mason	MSC	F
Chungu, Chibwe	Zambia	UNL	Breeding	Andrews	BSC	F
Muuka, Ferdinand	Zambia	UNL	Breeding	Andrews	MSC	M
Musonda, Ephraim	Zambia	TAM	Entomology	Teetes	STT	M
Sisame, Anthony	Zambia	PRF	Food Science	Butler	PHD	M
Muza, Figuhr	Zimbabwe	MSU	Breeding	Gourley	MSC	M
Mahuku, George	Zimbabwe	TAM	Pathology	Toler	MSC	M
Matisi, Esther	Zimbabwe	TAM	Pathology	Frederiksen	STT	F
Zvoutete, Petros	Zimbabwe	KSU	Pathology	Clafin	MSC	M