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Introduction and Program Review

The 2009 INTSORMIL Annual Report presents the progress and notable achievements by the Sorghum, Millet and Other Grains CRSP during the period of September 30, 2008 through September 29, 2009. These results are an outcome of partnerships between scientists at six U.S. Land Grant Universities (Kansas State University, University of Nebraska, The Ohio State University, Purdue University, Texas A&M University and West Texas A&M University), scientists of the Agricultural Research Service of the U.S. Department of Agriculture at Tifton, Georgia and the National Agricultural Research Systems (NARS) and National Universities in sixteen countries in Central America, West Africa, East Africa and Southern Africa.

Agricultural research provides benefits not only to producers but also to processors and consumers of agricultural products. Agricultural research has continuously shown that it is able to provide improved products of greater quantity and quality, as well as improved health to consumers and broad-based economic growth which goes beyond producers and consumers.

The Sorghum, Millet and Other Grains Collaborative Research Support Program (INTSORMIL CRSP) conducts collaborative research through partnerships between 17 U.S. university scientists and scientists of the National Agricultural Research Systems (NARS), IARCs, PVOs and other CRSPs. INTSORMIL is programmatically organized for efficient and effective operation and captures most of the public research expertise on sorghum and pearl millet in the United States. The INTSORMIL mission is to use collaborative research as a mechanism to develop human and institutional research capabilities to overcome constraints to sorghum and millet production, marketing, utilization and Technology Transfer for the mutual benefit of the Less Developed Sorghum and Millet Producing Countries (LDCs) and the U.S. Collaborating scientists in NARS, developing countries and the U.S. jointly plan and execute research that mutually benefits all participating countries, including the United States.

INTSORMIL takes a regional approach to sorghum and millet research and funds projects in four regions, western, eastern, and southern Africa, and in Central America. INTSORMIL support to these regions promotes the general goals of building NARS institutional capabilities and creating human and technological capital to solve problems constraining sorghum and millet production, marketing and utilization. INTSORMIL's activities are aimed at achieving a sustainable, global impact by promoting economic growth, enhancing food security, and encouraging entrepreneurial activities.

INTSORMIL continues to contribute to the transformation of sorghum and pearl millet from subsistence crops to value-added, cash crops. Because sorghum and millet are important food crops in moisture-stressed regions of the world, they are staple crops for millions in Africa and Asia. In their area of adaptation, sorghum and millet have a distinctly competitive advantage by yielding more grain than other cereals. The development of both open-pollinated and hybrid sorghums for food and feed, with improved properties, such as increased digestibility and reduced tannin content, is contributing to sorghum becoming a major feed

grain in the U.S., Africa and Central and South America. Pearl millet is also becoming an important feed source for poultry in the southeastern United States. Improved varieties and hybrids of pearl millet and improved lines of sorghum can be grown in developing countries, as well as the United States. They have great potential for processing into high-value food products which can be sold in villages and urban markets, where they compete successfully with imported wheat and rice products. In the U.S., pearl millet is sold in niche markets, e.g., heads of pearl millet for bird food and for floral arrangements. These emerging markets, for sorghum and pearl millet, are results of the training and collaborative international scientific research that INTSORMIL has supported both in the United States and collaborating countries.

Although there have been significant advances in the improvement and production of sorghum and millet in the regions in which INTSORMIL serves, population growth continues to exceed rates of increase in cereal production capacity. Thus, there remains an urgent need to continue the momentum of our successes in crop improvement, improved processing and marketing of sorghum and millet, and strengthening the capabilities of NARS scientists to conduct research on constraints to production, utilization and marketing of sorghum and millet.

The INTSORMIL program maintains a flexible approach to accomplishing its mission. The success of INTSORMIL can be attributed to the following strategies which guide the program in its research and linkages with technology transfer entities.

Developing institutional and human capital: INTSORMIL provides needed support for education of agricultural scientists in both developing countries and the United States. The results of this support include strengthening the capabilities of institutions to conduct research on sorghum and millet, development of international collaborative research networks, promoting and linking to technology transfer activities and dissemination of technologies developed from research, and enhancing national, regional, and global communication linkages. INTSORMIL provides essential support to bridge gaps between developing countries and the United States. A major innovative aspect of the INTSORMIL program is to maintain continuing relationships with scientists of collaborating countries upon return to research posts in their countries after training. They become members of research teams with INTSORMIL and NARS scientists who conduct research on applications of existing technology and development of new technology. This integrated relationship prepares them for leadership roles in their national agricultural research systems and regional networks in which they collaborate.

Conserving biodiversity and natural resources: Results of the collaborative research supported by INTSORMIL include development and release of enhanced germplasm, development and improvement of sustainable production systems and development of sustainable technologies to conserve biodiversity and natural resources. The knowledge and technologies generated by INTSORMIL research also enhance society's quality of life and enlarge the range of agricultural and environmental choices available both in developing countries and the United States.

INTSORMIL promotes the conservation of millet and sorghum germplasm, resource-efficient cropping systems, integrated pest management strategies that conserve natural control agents and cultivars with improved nutrient and water use efficiencies and evaluates the impacts of sorghum/millet technologies on natural resources and biodiversity.

Developing research systems: Collaboration in the regional sites, in countries other than the United States, has been strengthened by employing multi-disciplinary research teams composed of U.S. and NARS scientists focused on unified plans to achieve common objectives. INTSORMIL scientists provide global leadership in biotechnology research on sorghum and pearl millet. The outputs from these disciplinary areas of research are linked to immediate results. INTSORMIL uses both traditional science of proven value and newer disciplines such as molecular biology in an integrated approach to provide products of research with economic potential. These research products, which alleviate constraints to production and utilization of sorghum and pearl millet, are key elements in the battle against hunger and poverty because they provide means for economic growth, generation of wealth, and improved health. New technologies developed by INTSORMIL collaborative research are extended to farmer's fields and to processors and marketers of sorghum and millet products in developing countries and the United States through partnerships with NGOs, research networks, national extension services and the private sector. In addition, economic analyses by INTSORMIL researchers play a crucial role in enabling economic policymakers to more intelligently consider policy options to help increase the benefits and competitiveness of sorghum and pearl millet as basic food staples and as components of value-added products.

Supporting information networking: INTSORMIL research emphasizes working with both national agricultural research systems and sorghum and millet networks to promote effective technology transfer from research sites within the region to local and regional institutions and small farmers. Technology transfer is strengthened by continued links with regional networks, International Agricultural Research Centers, and local and regional institutions. Emphasis is placed on strong linkages with extension services, agricultural production schemes, private and public seed programs, agricultural product supply businesses, and nonprofit organizations such as NGOs and PVOs, for efficient transfer of INTSORMIL-generated technologies. Each linkage is vital to development, transfer, and adoption of new production and utilization technologies. The ultimate goal is to provide economic and physical well-being to those involved in the production and utilization of these two important cereals, both in developing countries, and the United States.

Promoting demand-driven processes: INTSORMIL economic analyses are all driven by the need for stable markets for the LDC farmer and processor. Thus, these analyses focus on prioritization of research, farm-level industry evaluation, development of sustainable food technology, processing and marketing systems. INTSORMIL seeks alternate food uses and new processing technologies to save labor and time required in preparation of sorghum/millet for food and feed, and to add value to the grain and fodder of the two crops. Research products transferred to the farm, to the livestock industry, and to processors and marketers of sorghum and millet are aimed

at spurring rural and urban economic growth and providing direct economic benefits to producers and consumers. INTSORMIL assesses consumption shifts and socioeconomic policies to reduce effects of price collapses, and conducts research to improve processing for improved products of sorghum and millet which are attractive and useful to the consumer. Research by INTSORMIL agricultural economists and food scientists seeks to reduce effects of price collapse in high yield years, and to create new income opportunities through diversification of markets for sorghum and pearl millet. INTSORMIL socioeconomic projects measure impact and diffusion and evaluate constraints to rapid distribution and adoption of introduced, new technologies.

The INTSORMIL program addresses the continuing need for development of technologies for agricultural production, processing and utilization of sorghum and pearl millet for both the developing world, especially the semiarid tropics, and the United States. There is international recognition by the world donor community that National Agricultural Research Systems (NARS) in developing countries must assume ownership of their development problems and move toward achieving resolution of them. The INTSORMIL program is a proven model that empowers the NARS to develop the capacity to assume ownership of their development strategies, while at the same time resulting in significant benefits to the U.S. agricultural sector. These aspects of INTSORMIL present a win-win situation for international agricultural development as they strengthen developing countries' abilities to solve their problems in the agricultural sector while providing benefits to the United States.

Administration and Management

The University of Nebraska (UNL) hosts the Management Entity (ME) for the Sorghum/Millet and Other Grains CRSP and is the primary recipient of the Leader with Associates Cooperative Agreement from USAID/Mali. UNL makes sub-awards to the participating U.S. universities and USDA/ARS for research projects between U.S. scientists and their collaborating country counterparts. A portion of the project funds managed by the ME and U.S. participating institutions supports regional research activities. The Board of Directors (BOD) serves as the top management/policy body for the CRSP. USAID personnel serve as a voting member of the Board and provides advice and guidance to the ME and the Board in areas of policy, technical aspects, collaborating country coordination, budget management and review.

Education

During the period of 2008-2009, there were 40 students from 28 different countries enrolled in an INTSORMIL advanced degree program and advised by an INTSORMIL principal investigator. Approximately 73% of these students came from countries other than the U.S. The number of students receiving 100% funding by INTSORMIL in 2008-2009 totaled 3. An additional 37 students received partial funding from INTSORMIL. INTSORMIL places high priority on training of women. During the period 2008-2009, 48% of all INTSORMIL graduate participants were female.

Another important category of education which INTSORMIL supports is non-degree research activities, namely postdoctoral research and research of visiting scientists with INTSORMIL PI's in the United States. During this year, 10 host country scientists improved their education as either postdoctoral scientists (2) or visiting scientists (8). Their research activities were in the disciplines of agronomy, breeding, food science and pathology. These scientists came to the United States as postdoctoral scientists or visiting scientists from El Salvador, Egypt, India, Burkina Faso, Malawi, Croatia, Turkey, Zambia and the USA. In addition to non-degree research activities there were 724 participants (342 male and 382 female) who were supported by INTSORMIL for participation in workshops and conferences.

Networking

The Sorghum/Millet CRSP global plan for collaborative research includes workshops and other networking activities such as newsletters, publications, exchange of scientists, and exchange of germplasm. The INTSORMIL global plan is designed for research coordination and networking within ecogeographic zones and, where relevant, between zones. The Global Plan:

- Promotes networking with IARCs, NGO/PVOs, regional networks (ASARECA, ECARSAM and others) private industry and government extension programs to coordinate research and technology transfer efforts.
- Supports INTSORMIL participation in regional research networks to promote professional activities of NARS scientists, to facilitate regional research activities (such as multi-location testing of breeding materials), promotes germplasm and information exchange and facilitates impact evaluation of new technologies.
- Develops regional research networks, short-term and degree training plans for sorghum and pearl millet scientists.

Established networking activities have been accomplished with ICRISAT in India, Mali, Niger, Kenya, Ethiopia, Uganda and Tanzania; Central America and with CORAF and ASARECA/ECARSAM in Africa and SICNA and the U.S. National Grain Sorghum Producers Association for the purpose of coordinating research activities to avoid duplication of effort and to promote the most effective expenditure of research funds. There also has been efficient collaboration with each of these programs in co-sponsoring workshops and conferences, and for coordination of research and long-term training. INTSORMIL currently cooperates with ICRISAT programs in east, southern and West Africa.

Regional Activities and Benefits

West Africa

The West Africa Regional Program now encompasses five countries of the Sahelian region – Burkina Faso, Mali, Niger, Nigeria, and Senegal.

Multi-agency, multi-disciplinary teams of agronomists, entomologists, food scientists, plant breeders, plant pathologists, poultry scientists, extension educators, and others from Burkina Faso, Mali, Niger, Nigeria, and Senegal are developing, evaluating,

and transferring technologies to improve production and marketing of sorghum and pearl millet and manage *Striga* in West Africa. The West Africa regional program with collaboration among scientists at Institut D'Economie Rurale in Mali, Institut National de la Recherche Agronomique du Niger, INERA and IRSAT in Burkina Faso, Institut Sénégalais de Recherches Agricoles and ITA in Senegal, University of Maiduguri in Nigeria, universities in the U.S., volunteer organizations, and private industries are contributing to INTSORMIL objectives to facilitate markets; improve food and nutritional quality to enhance marketability and consumer health; increase stability and yield through crop and natural resources management; develop and disseminate information on stresses to increase yield and quality; enhance stability and yield through genetic technologies; and better the lives of people dependent on sorghum and pearl millet.

The collaborating scientists are using seed multiplication, on-farm testing, and exchange of varieties of sorghum and millet with the goal of disseminating the best cultivars in combination with fertilizer and other crop management options such as legumes in crop rotations and crop protection options. They also are identifying storage disease and insect pests and control measures to manage grain harvesting and storage practices. They are developing base populations of cultivars of sorghum and millet with known adaptation, stability, and acceptability through multi-environment experiments and resistance to pests and drought. They are using conventional and/or marker-assisted recurrent selection to generate adapted dual-purpose varieties, open-pollinated varieties, and hybrid parental lines for targeted environments.

Food utilization, processing and marketing research collaboration is being coordinated from Senegal. This involves coordination of “Increasing farmers and processors’ incomes via improvement in sorghum, pearl millet, and other grain production, processing, and marketing systems.” The processing and marketing sub-project involves food scientists from Burkina Faso, Niger, and Nigeria, and poultry scientists from Niger. The Niger project focuses on processed food and animal-feed markets and their expansion through development of good-quality, competitive millet- and sorghum-processed products and greater use of sorghum in poultry feed.

The overall goal is to enhance urban markets for hybrid and improved sorghum and millet cultivars, where farmers can sell their surplus grain and thus be able to purchase production inputs that enhance production. Emphasis is also being placed on development and transfer of improved technologies to farmers, NGOs, food processing and marketing entrepreneurs, and consumers with emphasis being placed on processed products that contribute to development of markets for sorghum and millet. Technologies for production of breads and other products based on sorghum, and millet were transferred; local processing groups were assisted by disseminating new processing technologies and in initiating businesses; and sorghum and millet are being characterized as “functional foods” for health. The goal was to have competitive composite flour and other products in the marketplace. For animal feed, use of sorghum in poultry feed in West Africa is being validated and education provided on availability of low-tannin varieties and aflatoxin-free grain, with the goal to increase the use

of sorghum for poultry.

Horn of Africa

The Horn of Africa Regional Program now encompasses four countries- Tanzania, Uganda, Kenya and Ethiopia.

Sorghum and millet constraints in the region continue to be low productivity and limited markets for the grain produced. Major production constraints include water deficits, stem borers, nitrogen deficiency, *Striga*, weeds and *Quelea quelea* (birds). Farm household interviews in Tanzania show a low rate of adoption for production technologies, often due to lack of knowledge and availability of technologies (e.g., seed of improved varieties) or market instability and seasonal price fluctuations. The market limitations are perpetuated by a general lack of reliable quality grain production. Storage and transport infrastructure deficiencies compound the product/market disconnect. The INTSORMIL regional project team continues to address these constraints from developing production technologies, extending these to farmers in the region and exploring new market outlets for sorghum and millet while enhancing and protecting profits for all involved in the supply chain. Studies of the sorghum based clear beer value chain in Tanzania is an excellent example of this holistic approach. The study included interviews with sorghum farmers, traders, transporters, processors, distributors and warehouse owners. There has been a modest increase (4%) of sorghum based product in the clear beer industry in the region over the last two years of the study. The study concludes that continued growth in the sorghum beer industry depends on potential demand of the buyers, consistent and high quality grain from farmers, adequate transportation and storage infrastructure, profitability for all chain members and trust and contract enforcement mechanisms. This study validates the INTSORMIL objectives for regional development.

Although not all planned activities for Year 3 of the individual projects comprising the Horn of Africa regional program were accomplished during 2009, there are clear indications that progress is being made in the region. Production technology development continues through breeding of *Striga* resistant sorghum hybrids, testing and optimization of agronomic practices adaptable to the region. Sorghum and millet constraints are then further addressed through analysis of technology adoption, detailed value chain studies, monitoring of market forces on commodity prices and new product development. The regional program reflects well the major objectives of supply chain/market development, IPM, genetic enhancement and building partnerships. Through all these activities, students who are being trained provide the human capacity for development in the host countries.

Southern Africa

The Southern Africa Regional Program now encompasses four countries – Zambia, Mozambique, South Africa and Botswana.

The Southern Africa regional program is composed of 12 research projects directed by 14 scientists representing 8 agencies in 4 countries. Eight U.S. based principal investigators collaborate with the regional scientists. Countries and agencies represented are the Botswana College of Agriculture; the Mozambique National

Agrarian Research Institute; in South Africa the University of the Free State, the ARC-GCI (pending acceptance of MOU), the University of Pretoria, and the Medical Research Council, and in Zambia the Zambia Agricultural Research Institute and the University of Zambia. The scientists represent the disciplines of agronomy (1), breeding (3), socio-economics (2), entomology (3), food science (1), and pathology (1). A regional planning meeting to identify and guide 2006-2011 activities developed the following problem statement: Food security and incomes of sorghum and millet farmers in southern Africa remain low and productivity is constrained by a lack of appropriate technologies and farmer linkages with input and output markets. Enhanced collaboration among stakeholders will facilitate technology transfer, adoption, and improved productivity. Market incentives will drive technology adoption and productivity improvements. Regional scientists were selected for the 2006-2011 program with the expectation each has expertise to contribute to achieving the goal of improving sorghum and millet for the farmers and end-users. Individual work plans are developed using a format similar to that for U.S. investigators. Each scientist is expected to specify where activities fall within the regional plan and to provide performance indicators and outputs. Progress listed in the individual annual reports should be used to evaluate progress and performance. Each collaborating scientist brings to INTSORMIL individual collaborators including Future Harvest Centers, NGOs, and other governmental or private organizations. Each also has other grant funds - other donors, grants and commodity organizations - that provide reciprocal leveraging of resources. Technical backstopping and logistical, material and additional operational support is provided by the U.S. collaborators.

The goal of the collaborative program is to develop and transfer technology for increased production and use of pearl millet and sorghum. Component projects conduct research specific to the project goals but which has implications to research in other projects. Projects interact to develop new technology and the interaction will increase as additional opportunities and funding become available. The local scientists are encouraged to collaborate across country boundaries.

Central America

The Central America Regional Program now encompasses two countries - El Salvador and Nicaragua.

The INTSORMIL regional programs are designed to support national research programs in efforts to develop dynamic, competent institutional research programs which contribute to productivity, economic growth, natural resource conservation and improved nutrition of people in the region. By accessing available expertise and infrastructure in the region, support from INTSORMIL is designed to facilitate and promote interaction between national programs, NGOs, international research centers, private sector and scientists from the U.S. land grant universities to achieve the goals of improving productivity, profitability, economic growth and food security for producers and consumers as well. Historically, the Central American Regional Program has been a robust and active program. Given the new INTSORMIL program, the Central American program is in the process of re-organization including but not limited to development of new program priorities and

project development.

The INTSORMIL program in Central America continues to produce results based on the long term activities in the region. Research in plant breeding, agronomy, pest management and utilization have created varieties and hybrids with improved yield potential and management programs to capitalize on that potential followed by the development of end uses for the products that are produced. Support of extension programs provides the conduit to educate producers and end users on the effective use of these materials.

Associate Award

In 2007 INTSORMIL received a three year (September 29, 2007 – September 30, 2010) \$250,000/year award “Transfer of Sorghum, Millet Production, Processing and Marketing Technologies in Mali” from the USAID/EGAT/AG/ATGO/Mali. The project was based on successful activities through the INTSORMIL West Africa Regional Project and was designed to rapidly move sorghum and millet production technologies onto farmers’ fields, link farmers’ organizations to food and feed processors and commercialize processing technologies so as to enhance markets and to significantly expand the existing project, especially into the northern areas of Mali. The award allowed INTSORMIL to significantly increase its impact in Mali by (1) expanding to new sites with more concentration in the poorer northern Tombouctou region where food insecurity is a severe problem for the small scale farmers who depend on sorghum and millet for their daily diet, (2) upscaling the research and (3) upscaling the technology transfer component. The Cooperative Agreement was modified in 2008 to provide four year funding at \$1,250,000 per year (2008-2009 to 2011-2012) to expand all activities and to develop institutional capacity by adding a degree and short term training component to the Cooperative Agreement.

The Cooperative Agreement consists of four components: 1) Production - Marketing activities led by John Sanders, Purdue University Marketing Economist; 2) Food Processing Technology and Training activities, led by Bruce Hamaker, Purdue University Cereal Chemist, 3) Décrue Sorghum (post water recession sorghum planted at the edges of the Niger River and Lakes after the rainy season has ended) production activities led by Vara Prasad and Scott Stagenborg, Kansas State University Agronomists and 4) Academic Training led by Jess Lowenberg -Deboer, Purdue University. Activities are conducted in collaboration with IER.

Significant progress was achieved in 2009 through meeting Project objectives as set forth in the workplan:

- Network establishment to enhance partnership development with relevant stakeholders and to develop stronger farmers’ groups so as to enhance their marketing power.
- Facilitate adoption of production and marketing technologies to improve the productivity of sorghum and millet and increase farmer incomes.
- Develop alternative markets (human food and livestock and poultry feed) for sorghum and millet.
- Develop sorghum production technology for the “culture de décrue” system

- Upscaling the sorghum and millet seed production industry in collaboration with other agencies.
- Disseminate technology via workshops, field days and media (communications/ publications/website).
- Build institutional (IER) technology development and transfer capacity through long term (academic) training and short term training of farmers’ groups and food processor entrepreneurs.

Network Establishment

Décrue sorghum - Partnerships have been developed through visits to Mali and include, INTSORMIL PIs, IER scientists, USAID /EGAT Team, local administrators of the Lake Faguibine revitalization program in Goundam and farmers from two villages surrounding the lakes Bintagoungou and Mgoudou. Participation in the USAID/Mali Mission Partner’s meeting in Bamako, December 2009 provided an opportunity to develop additional partnerships to increase impact in the Tombouctou Region. In 2010, collaboration with the Direction Regionale Agriculture (DRA), Mopti and the ONGs (Non-Governmental Organizations = NGOs) ACAS, Gao; RGCOP, Tombouctou; and CONFIGES will be initiated to conduct demonstration plots on improved décrue sorghum technologies.

Production-Marketing - A strong network had already been established prior to the initiation of this project. That network involves, IER, USAID, ICRISAT, Sasagawa2000, ULPC Dioila, AMEDD, INTSORMIL PIs and the food processors; Mam Cocktail, Beau Céréale, Sahélienne de l’Alimentation, Musola Jama Sewa, DANAYA Céréales, La Maraîchère, Corbeille and UCODAL. Participation in the USAID/Mali Mission Partner’s meeting in Bamako, December 2009 provided the opportunity to increase the network. Collaboration with AMEDD and IICEM

(USAID’s Integrated Initiatives for Economic Growth in Mali) in 2010 is expected to triple the land area and number of collaborating farmers.

Food Processing - The processing component has strong linkages with a wide array of stakeholders in Mali. This includes IICEM (expertise in value-chains and markets), The Malian Food Processors Association (FENATRA), Women Food Processors Association (GIE), PCDA (World Bank Financed with expertise in cereal technology), Catholic Relief Services and a group of food processing entrepreneurs.

Technology Adoption and Farmer Incomes

Five new technologies were introduced by the Production-Marketing component. The number of farmers (and hectares) under the Production-Marketing component doubled in 2009 from 500 in 2008 to 1,000 in 2009 (Year 2). Projections are to increase the number of farmer cooperators using the improved technologies and marketing strategies from 1,000 in 2009 to 3,000 in 2010. Income gain due to the increased yields ranged from 43-121%. Training of farmer associations (cooperatives etc.) in the Production-Marketing Project began in 2008. This approach was expanded to several new villages in 2009. The farmers’ organizations have been acquiring identities as successful economic units. They buy inputs, store and sell the grain. Repayment rates for the inputs have

been very high, generally over 95%. Grain price increase due to the marketing strategy was 31%.

Alternative Market Development

Extensive progress was made in developing new markets for sorghum as a poultry feed. There appears to be significant potential for the use of sorghum as a poultry feed in Mali and other West African countries. Food processing incubator units were installed in IER Mopti and Sotuba and in several entrepreneurial groups. Entrepreneurial units in Mopti, Bandiagara and Gao are now fully mechanized for processing of decorticated and milled products. IER technologists have trained personnel at each of seven entrepreneurial units and several workshops have been conducted. Training at workshops included 1) Entrepreneur unit operation, 2) Management, 3) Engaging the market and 4) Financial matters.

Décrue System Production Technology

Management practices evaluated in farmers' fields and compared to farmer's cultural practices include varieties, planting date, plant density, row spacing, fertilizer levels and seed treatment. Practices that increase yield were identified. Planting date had a significant effect on germination and plant population. Thirty three sorghum cultivars were evaluated by farm women in a participative selection. The women chose the cultivar 'Niatichama' as the cultivar with the best grain quality. The men also selected 'Niatichama' among the top three cultivars for production.

Sorghum and Millet Seed Production

Partnerships were developed to promote the production of sorghum and millet seed of high yielding and good grain quality varieties suitable for human food and poultry feed. The Production-Marketing component is collaborating with WASA and farmer seed producers in Garasso and Kaniko to produce quality seed. Farmers' received training in seed production, including hybrid seeds and marketing concepts. Training will be expanded to additional sites in Year 3. Activities conducted by IER décrue scientists include cultivar collections and testing to identify most suitable cultivars for the region.

Dissemination of Technology

In June a workshop was conducted for food processing entrepreneur partners at IER/Mopti on the topic: "Primary education of technologies of processing of high quality, competitive millet and sorghum products, the fundamentals of quality management and packaging, and contracting farmers for high quality grains." A second workshop was conducted in late summer in Gao. The workshop topic was "Marketing and management of a unit of local cereal transformation." The Production-Marketing and Décrue components held field days to promote production technology. Articles describing the project were placed on the INTSORMIL website <<http://intsormil.org>> under "ME Presentations" (PowerPoint presentations) and quarterly and annual reports were added under "Mali Award Reports." An article describing the project was placed on the USAID/Mali Mission's website under "Partners."

Institutional Capacity Building

A subcontract for training was awarded to Purdue University with funding starting April 1, 2009.

Five candidates were identified by IER and recommended for MSc degree training in the USA.

All candidates first enrolled in English Language Training Program at the Indiana Center for Intercultural Communication (ICIC) in Indianapolis before taking up their graduate studies. The IER scientists are: Aly Ahamadou (Ag Economics- Purdue), Mamadou Dembele (Ag Economics- Purdue) Bandiougou Diawara (Agronomy-Kansas State University), Fatimata Cisse (Food Science-Purdue) and Sory Diallo (Agronomy-Kansas State University).

Future Directions

Prices of many basic foods skyrocketed in 2008 resulting in a major food crisis that affected millions of poor people throughout the world. The causes of the crisis are many and complex. An increasing demand for food and energy at a time of low food stocks, poor harvests and weak credit have led to record prices for oil and food.

Without appropriate interventions, the food crisis is not likely to resolve itself. In determining the proper response we must take into consideration that "Food crop prices were expected to remain high in 2009 and then start to decline as supply and demand respond to high prices; however, they are likely to remain well above the 2004 levels through 2015 for most food crops. Forecasts of other major organizations (FAO, OECD and USDA) that regularly monitor and project commodity prices are broadly consistent with the projections. It is unlikely that demand will decline markedly in the future so in order to lower prices supply must be increased. Increasing agricultural production will require input from developing countries, international organizations, and donors.

The new Sorghum, Millet and Other Grains CRSP was authorized and funded by USAID effective October 1, 2006. Strategies under this new CRSP have maintained INTSORMIL's highly productive momentum, built on its record of success, and continues to work toward accomplishing a whole new set of goals. INTSORMIL's new vision to improve food security, enhance farm incomes, and improve economic activity in the major sorghum, millet and other grains-producing countries in Africa and Central America is proving to be successful as indicated in this report. The CRSP is demonstrating international leadership in leading efforts to promote profitable markets for sorghum, pearl millet and other grains by working with agencies that identify and develop markets, assess economics, and facilitate the evolution of a production-supply chain and by expanding markets that deliver quality grain to end users. Future strategies will maintain the new CRSP's highly productive momentum, continue building on the old CRSP's record of success, and accomplish a new set of goals.

During the past 29 years, INTSORMIL has educated more than one thousand scientists through degree programs, visiting scientist experiences, postdoctoral training, workshops, and conferences. About one-third of those trained are from the U.S. and two-thirds are from developing countries. The bridges built by this training are crucial to maintain scientific and peaceful linkages between the United States and developing countries. The collaborative research supported by INTSORMIL continues to produce benefits for both developing countries and the United States. Food production, utilization and marketing in both developing countries and the United States are strengthened by INTSORMIL. The health benefits of the two nutritious cereals, sorghum and millet, are enjoyed by millions of people. Sorghum is a significant element in the food chain of the United States, being a key feed for livestock. So what is the future for collaborative, international sorghum and millet research supported by INTSORMIL? The future is bright.

There continues to be a need for highly qualified researchers for these two crops both in developing countries and the United States. INTSORMIL fulfills a unique role in providing postgraduate training (M.S. and Ph.D. level) to meet this need. As the demand for water in cities continues to put greater pressure on the use of water for irrigated crop production, sorghum and millet, which are for the most part rainfed, will gain increased importance in meeting the caloric needs of developing countries, particularly in the semiarid tropics, and needs of the livestock feed industry in the United States. Recent INTSORMIL research on the nutritional benefits of sorghum and millet forms a strong base for future research to enable the commercialization of nutritionally

superior sorghum. Based on its achievements, the INTSORMIL team is well positioned to contribute even more effectively to ending hunger and raising incomes. With the increasing strength of scientific expertise in developing countries, INTSORMIL is now able to more effectively reduce constraints to production and utilization of sorghum and millet to the mutual benefit of developing countries and the United States. Advances in sorghum and millet research over INTSORMIL's 29 years and the training of sorghum and millet scientists in the United States, Africa and Central America by INTSORMIL now enables these scientists from developing countries and the United States to jointly plan and execute mutually beneficial collaborative research. These collaborative relationships are key components to INTSORMIL's success and will continue as fundamental approaches to meeting the INTSORMIL mission. In the future, INTSORMIL will target NARS collaborative ties that reflect regional needs for sorghum and/or millet production. These ties are in the sorghum and millet agroecological zones of western, eastern, and southern Africa, and Central America. By concentrating collaboration in selected sites, INTSORMIL optimizes its resources, builds an enhanced scientific capability on sorghum and millet, and creates technological and human capital that has a sustainable and global impact.

