Central America (El Salvador, Nicaragua)

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Collaborative Program

Vision Statement

The following vision statement was developed during the past year. "INTSORMIL collaboration will support national research programs' efforts to develop dynamic, competent institutional research programs which contribute to productivity, economic growth, natural resource conservation and improved diets for grain sorghum producers, processors and consumers. Scientists in the region will work as regional, multi-institutional, multi-disciplinary teams collaborating with extension services, NGOs, international research centers, PCCMCA, the private sector and scientists from U.S. land grant universities to increase productivity, profitability, economic growth, conservation of natural resources, and food security for producers, processors and consumers of sorghum".

Institutions

Active INTSORMIL collaboration in Central America is occuring primarily among the following institutions: Centro

Nacional de Technología de Agropecuaria y Forestal (CENTA), El Salvador; Instituto Nicaragüense de Tecnología Agropecuaria (INTA), Nicaragua; Universidad Nacional Agraria (UNA), Managua, Nicaragua; Kansas State University, Mississippi State University, Texas A&M University; and the University of Nebraska. In addition, INTSORMIL has a current MOU with the Universidad Nacional Autónoma de Nicaragua (UNAN), Leon, Nicaragua, and maintains ties with the Escuela Agrícola Panamericana (EAP), Honduras based upon past collaboration. During early 2003 contacts were initiated by the Dirección de Ciencia y Tecnología Agropecuaria (DICTA) in Honduras, and it is hoped to sign a Memorandum of Understanding and initiate collaborative research with DICTA late in 2003.

Organization and Management

In 1999, INTSORMIL shifted program emphasis in Central America to El Salvador and Nicaragua. Scientists from collaborating institutions met and developed a research plan for the 2000 -2001 years with collaborative projects in plant breeding, utilization, plant protection (entomology and plant pathology), and agronomy. On February 27-28, 2002 scientists met to present two-year research results and develop priorities for collaborative research for 2002-2006. In Oct 2002, the research directors of collaborating institutions met to develop a regional training plan for sorghum research programs.

Financial Inputs

Primary financial support for the program is from the INTSORMIL Central America Regional Program budget, which was $105,000 during the past year.The four collaborative research projects (plant breeding, utilization, plant protection, and agronomy) were budgeted at $8,000 to $21,000 each based upon output in 2001-2002 and activities proposed for 2002 - 2003, with the balance maintained at the INTSORMIL Management Entity to cover regional expenses. These regional expenses included expenses associated with the Central America Research Directors meeting, equipment purchases and administrative travel.

Collaboration

INTSORMIL's Central America program has collaboration with many non-governmental organizations mainly in validation of new sorghum varieties on-farm, and formal collaboration with national extension services, and it has served as a catalyst for Central American grain sorghum research and technology transfer. Collaborative relationships have been established with a number of universities in El Salvador and Nicaragua, and undergraduate students often complete thesis research on INTSORMIL-supported experiments. In addition, René Clará Valencia coordinated the regional grain sorghum yield trials conducted by the PCCMCA, and provided technical assistance for seed production to the private seed company Productoras de Semillas in Guatemala. A strong collaborative relationship has been developed between INTSORMIL's regional sorghum research program and ANPROSOR, the Nicaraguan grain sorghum producers association, which has assisted in identifying research priorities and has collaborated with a number of research studies since 2002. Regional scientists have formal collaboration with the CIRAD-CIAT project on participatory plant breeding for sorghum (and upland rice), and ICRISAT provides germplasm for breeding use as requested.

Sorghum Production/Utilization Constraints

Grain sorghum is the third most important crop in Central America (El Salvador, Guatemala, Honduras, and Nicaragua) after maize and beans. The area devoted to grain sorghum in 2000 was 252,544 ha^{-1} with an average grain yield of 1.5 Mg ha^{-1} (FAO, 2001). During the last decade sorghum grain yield in Central America increased due to improved technology (including improved cultivars and hybrids, herbicides, insecticides, planting date, minimum tillage, seed treatments and fertilizer) available to producers.

Small-scale Central American farmers are burdened with low productivity and limited land resources. Intercropping provides a means to increase total productivity per unit land area and reduce the risk of dependence on one crop. The dominant cropping system is maize intercropped with maicillos criollos (called millón in Nicaragua). These tropical grain sorghums are three to four meters tall, drought tolerant, and photoperiod sensitive. The grain is used as human food and a feed grain for livestock, and the stover is used for livestock forage. Although maicillos criollos produce low yields, they are planted on approximately 67% of the grain sorghum area in Central America.

The limited grain yield response of traditional maicillo criollo varieties to management practices is a primary constraint to increased production. Soil and water conservation, improved production practices and soil fertility management, and increased genetic potential of both maicillos criollos and other sorghum varieties is essential to obtain economical yield increases. To date, increased grain sorghum production, yield and area are due primarily to utilization of improved cultivars (hybrids and varieties) other than maicillos criollos.

Alternative uses for sorghum grain need to be developed to encourage sustainable economic growth in semi-arid areas in Central America. White-grain, tan-plant colored grain sorghum cultivars are well adapted to Central American human food and livestock feed systems. Innovative processing systems, like extrusion and flaking, are needed to increase starch digestibility and maximize net energy intake for livestock feed. A lack of milling equipment for production of grain sorghum flour limits adoption of the use of grain sorghum flour for baked products. Human consumption needs to be promoted, especially in tortilla products, extruded snacks and flour substitution through use of superior grain-quality sorghum cultivars. Use of grain sorghum cultivars for forage, or dual use for both grain and forage are important to small producers.

Research Accomplishments and Planning

Sorghum Research Reporting and Planning Workshop

The workshop was held on February 27 - 28, 2002 and attended by thirty-six participants sponsored by INTSORMIL, five sponsored by INTA, and several administrators from INTA, UNA and ANPROSOR. INTSORMIL helped support a special issue of the scientific journal *La Calera* Vol 3 (February 2003) which included published articles based upon 11 of the reports, and two other reports were published in *La Calera* Vol 2.

Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos y Animales (PCCMCA) [Cooperative Central American Program for Crop and Animal Improvement] Annual Meeting

Regional coordinators and 6 collaborating scientists participated in this annual meeting April 28 - May 2, 2003. Thirteen out of 15 oral papers on grain sorghum were presented by INTSORMIL collaborators, and the meeting provided a forum for broadening contacts with programs in other countries and with the private sector. In addition, it was useful for regional planning of the 2003 growing season research and technology transfer plans.

Research Directors Meeting

A regional research directors meeting was held Oct. 3, 2002 in Managua, Nicaragua with the goal to prioritize degree education and short-term training needs of sorghum research programs in Central America. Degree training priorities were in the areas of food science and plant breeding. In addition, plant pathology was a high priority in Nicaragua and entomology in El Salvador. Much effort has been made to identify potential candidates for graduate study, and one has started a Ph.D. program in plant pathology at Mississippi State. In addition, a student for a Ph.D. program in entomology at Mississippi State will start English language training in August 2003 with a goal of enrollment in a Ph.D. program in Jan. 2004.

The research directors determined a short-term training priority list of experimental design, statistical data analysis and scientific communication as the highest priority, and the Universidad Nacional Agraria (UNA) in Nicaragua is planning such a course in late 2003. Other short-term training needs identified were plant breeding, and utilization of sorghum for forage. CENTA has agreed to prepare training in these two areas for 2003 and 2004.

Meeting with CENTA Board of Directors

At the request of CENTA, the Regional Coordinators met with the CENTA Board of Directors on April 28. Presentations on INTSORMIL programs worldwide and in Central America were made, followed by discussion of present activities and future opportunities. The CENTA Board of Directors suggested that INTSORMIL increase contacts with snack food companies and with the Ministry of Economics micro-enterprise efforts, and that board members would assist with efforts to obtain USAID Mission funds to increase degree education and degree training efforts.

Plant Breeding

Research Methods

The plant breeding programs in both El Salvador and Nicaragua are striving to identify adapted grain sorghum lines with good agronomic and utilization characteristics for development either as photoperiod-sensitive (for relay intercropping systems with sorghum planted into the existing maize crop) or insensitive varieties for grain production or dual use as grain and forage. Photoperiod-insensitive lines may also serve as parents for hybrids. During 2002-2003, the Nicaraguan program took regional leadership for the hybrid development program, while El Salvador took regional leadership for the photoperiod sensitive variety program. Once potentially superior lines are identified, then preliminary yield trials are conducted followed by on-farm verification trials and ultimate release. The breeding programs are constantly evaluating new sources of germplasm identified in the region, from INTSORMIL breeding programs in the United States, and from ICRISAT. Each year, grain sorghum hybrid tests have been conducted in three to seven countries in Central America. Collaborative ties have been made with Dr. Gille Trouché, CIRAD-CIAT project, with focus on a participatory sorghum breeding program in Nicaragua.

Research Results

Regional PCCMCA trials were conducted for four sorghum hybrids from Christiniani Burkard, Sefloarca and Prosemillas, a common check hybrid and a local check hybrid at 6 locations in El Salvador, Guatemala and Nicaragua. No hybrid differences in grain yield, plant height or days to flowering were found.

Plant breeding programs in El Salvador and Nicaragua are evaluating photoperiod sensitive sorghum varieties (maicillos criollos and millón) for relay intercropping systems with maize, and in some cases, with dry beans. In El Salvador the varieties 85-SCP-805 and ES-790 produced yields approximately 25% higher than the mean in both 2001 and 2002 (Table 1) and have been shown to have high nitrogen use efficiencies (see project report UNL 213). They have been selected for on-farm validation testing in 2003. Future research will emphasize transfer of the varieties 85-SCP-805, 86-EO-226 and ES-790 to hillside farmers in relay intercropping systems with maize, and evaluate the new potential varieties EIME 119, EIME 178 and PRE-EIME 112 on-farm in relay intercropping with maize. In Nicaragua, selection for improved photoperiod-sensitive varieties started in 1998. In 2002, two evaluation trials were conducted at high-yield and low-yield locations in the Las Segovias re-

Table 1. Yield of best photoperiod-insensitive and photoperiod-sensitive grain sorghum varieties, and check varieties tested in El Salvador, 2001 and 2002.

Photoperiod-Insensitive			Photoperiod-Sensitive		
Variety	2001	2002	Variety	2001†	2002
	T/ha			T/ha	
Soberano (Check)	5.86ab	5.41a	EIME 119	5.14ab	4.09a
ICSV LM-89513	5.72ab	5.21a	85-SCP-805	5.90a	4.06a
ICSV LM- 90520	5.86ab	5.18a	ES-790	5.85a	4.03ab
ICSV LM- 90538	7.86a	5.13ab	PRE-EIME 178		3.62abc
ICSR-939	5.69ab	4.99ab	86-EO-226	4.80abc	3.60abc
RCV (Check)	5.63ab	4.84ab	PRE-EIME 112	4.29abc	3.42abc
ICSV LM-89537	5.67ab	4.82ab	PRE-EIME 169	3.42 bc	3.37abc
ICSV LM-93076	5.69ab	4.79ab	PRE-EIME 163		3.32abc
ICSV LM-93077	6.25ab	4.73ab	PRE-EIME 182		3.28abc
ICSV LM-93075	5.53ab	4.47ab	PRE-EIME 180	3.10 c	3.26abc
ICSV LM-92512	5.71ab	4.41ab	EIME 113		3.03abc
ICSV LM-89544	6.31ab	4.40 b	Local Check	5.36a	2.73 bc
Mean	5.27	4.86		4.32	3.00
C.V. (%)	20.8	7.3		17.1	18.6

† Lack of values in 2001 indicate that this variety is a new selection from the nursery, and was not included in the evaluation in 2001.

gion with 13 or 17 photoperiod sensitive varieties. The varieties PREEIME 119 and PREEIME 117 with yields greater than 3100 kg ha^{-1} in one trial and PREEIME 217 with yields greater than 5000 kg ha^{-1} in another appear to be most promising. Based upon previous years' results, the varieties ES-790, 86-EO-226 and EIME 113 are in validation trials on-farm in 2003. In both countries, there is a population-based improvement effort to utilize the broad base of photoperiod-sensitive germplasm present in Central America.

Evaluations of photoperiod-insensitive varieties continues in both countries. In El Salvador, none of the best potential varieties produced a superior yield in 2001 or 2002 compared to the best local check variety (Table 1). Therefore, future efforts will bring in new genetic material with greater potential to increase grain yield. In addition, more emphasis will be given to kernel size and weight, kernels per panicle, and tolerance to foliar diseases. In Nicaragua, several evaluation trials for white and red grain were conducted to select lines for potential release as varieties. Also, a nursery of African lines forwarded by Texas A & M University has been evaluated. At present, the variety INTA-CNIA is being released for high-yield environments, and the varieties INTA-Trinidad and INTA-Ligera for low rainfall zones. Recently the white grain varieties Macía (locally called 'Africana'), CENTA-RCV (El Salvador) and (TXP)-12, and the red grain varieties (SR17)-10-2-2-2, (SR-16)-10-1-1-3 and (SR-6)-1-5-1-1 have been selected for on-farm validation trials.

Forage hybrid research using inbred lines from ICRISAT and Texas A & M University continued with both yield and quality evaluation of hybrids (Table 2). The lower-forage- yielding lines tended to have higher forage quality, but the best hybrids listed in Table 2 were selected based upon yield and quality. These hybrids will be tested on-farm to obtain animal response data, and the inbred lines will be increased in preparation for release in 2004 or 2005.

Sureño was developed with INTSORMIL collaboration in Honduras. In El Salvador, Sureño has been named CENTA S-3

Table 2. Yield and quality of best forage sorghum hybrids tested in El Salvador in 2002.

Hybrid	Yield (Green Weight)†	Total Digestible Nutrients	Net Energy (Lactation)	Acid Detergent Fiber (ADF)	Neutral Detergent Fiber (NDF)	Protein in NDF
	T/ha	%	Mcal/kg	%	%	%
ICSA 275 * TX-2784	195.5	59.3	1.29	62.0	37.0	5.1
ICSA 613 * TX-2784	193.8	59.1	1.29	65.4	37.3	5.2
ICSA 541 * TX-2784	181.2	58.9	1.28	63.3	37.5	4.4
ICSA 264 * TX-2784	190.3	55.4	1.16	64.5	42.0	3.9
ICSA 264 * TX-2785	176.3	60.0	1.32	60.1	36.1	4.8
ICSA 606 * TX-2784	176.7	59.3	1.29	64.0	37.0	4.5
HF-895 (Check)	150.3	55.7	1.30	60.2	41.6	5.3

† Dry weight was approximately 23% of the green weight.

Table 3. Summary of validation trials for CENTA S-3 (Sureño) for silage production at the milk to early dough growth stage in El Salvador, mean of 19 trials in 2002.

Variety	Days to Cutting	Plant Height	Yield		Lipid	Carbohydrates	Protein
			Green Biomass	Dry Matter			
		cm	T/ha		%		
CENTA S-3	74	234	50.7	37.4	2.3	81.1	10.1
CENTA S-2 (Check)	84	257	41.0	30.5	1.6	80.3	9.9

and was validated against the best available sorghum variety for silage production. Validation tests indicated that CENTA S-3 has 10% greater yield and better nutritional value than CENTA S-2 (Table 3). Cattle producers are asking for seed of CENTA S-3, and private industry has initiated production of 25 metric tons of seed to plant 1400 ha of this sorghum variety in 2004.

In Nicaragua, research on developing grain sorghum hybrids was initiated. Sorghum hybrids originating from CENTA (El Salvador) and Texas A & M University were evaluated. The inbred lines used to produce these hybrids will be evaluated, and seed will be increased in 2003. In addition, male-sterile lines were evaluated for yield, adaptation and potential for use in producing hybrids. The CENTA hybrids ICSA613*99CA2519, ICSA613*86-EO-361, and ICSA613*96CD635 were the best, producing yields of 7.0 to 7.6 T/ha grain yield, while the Texas hybrids A8PR1057*6BRON167, A8PR1051*TX430, A0PR59*5BRON159, and A0PR1053*TX430 produced acceptable yields between 5.9 and 6.5 T/ha. The inbred lines ICSA-613, 86-EO-361, 99CA2519, 96CD635, 99CA2519, A8PR1057, A8PR1051, A0PR59, A0PR1053, 6BRON167, 5BRON159 and Tx430 are being evaluated in 2003. The male-sterile inbred lines ICS-275, ICS-333, ICS-361, ICS-541 and TX-629 were selected as being well adapted to Nicaraguan growing conditions, and seed is being increased in 2003.

Entomology and Plant Pathology Research

Research Methods

Farmer surveys and evaluation of the All Disease and Insect Nursery (ADIN) were used in El Salvador and Nicaragua in 2000 and 2001 to identify the pests more commonly occurring in grain sorghum fields to help guide future research. M.S. thesis research on sorghum midge was conducted in Nicaragua and published in *Tropical Agriculture, La Calera* and in an extension bulletin. Alternate methods for control of sorghum midge and leaf-footed bugs on sorghum panicles was conducted in 2002. In El Salvador, studies were conducted on economic thresholds of fall armyworm infestation during the whorl stage, timing of spraying for control of sorghum midge, and the ADIN and producer fields were evaluated for the most commonly occurring insects. Plant pathologists used fungicide applications in their research to determine economic yield losses from fungal diseases. Two meetings organized by UNA, INTA, CIRAD-CIAT and ANPROSOR were held in May 2003 with 70 farmers from the Pacific Region of Nicaragua to learn about the main sorghum production constraints in Nicaragua.

Research Results

Producer surveys and evaluation of ADIN in 2001-2003 found that most prevalent diseases were anthracnose and gray spot (*Cercospora)* in Nicaragua, and rust *(Puccinia* species) in El Salvador, and the most prevalent insect pests were fall armyworm *(Spodoptera* species) and midge in both countries. The pink scavenger caterpillar was observed to infest sorghum panicles in 2002. Insecticide treatments were found to be more effective than barrier crops for midge control in sorghum, while biological treatments produced inconclusive results which merit further study. Infestation with fall armyworm from 0 to 80% during the whorl growth stage had no effect on sorghum yield in both 2001 and 2002, indicating that sorghum plants can recuperate from early season damage. Timing of insecticide spraying between 10 and 50% flowering and no insecticide application produced similar yield indicating that natural infestation was not at an economic threshold.

Evaluation of ADIN studies in Nicaragua confirmed anthracnose and gray spot to be the major diseases in Nicaragua, and differences among sorghum lines on susceptibility to these two diseases varied. The lines BTX-378, 96GCPO, B143 and LG-35 were very susceptible while R9113, 98PR1057, 90EON343 and 91BE7414 had less than 10% infestation. In El Salvador, application of the fungicide Cycosin and elemental sulfur during vegetative growth had no effect on reducing incidence of fungal pathogens. Application during grain fill reduced incidence of *Gloeocercospora, Collectotrichum, Helminthosporium* and *Puccinia*, but had no effect on grain yield. Six sorghum varieties were evaluated for susceptibility to rust which showed large differences, with 'punta de lanza' and 'sapo' (photoperiod sensitive varieties) having less than 15% incidence and the sorghum line 88B943 having over 75% incidence.

In Nicaragua, farmer meetings identified felt needs for training in integrated pest management of grain sorghum, especially with diseases, and agronomic management. In addition, fertilizer management (particularly rates and application timing), weed control and additional utilization options beyond being a

poultry feed. They indicated a need for a simple grain sorghum production manual. Many of the farmers offerred their farms to be used for research studies.

Grain Utilization (Quality) Research

Research Methods

The Central America program has historically concentrated on improving the grain yield and processing characteristics of sorghum for use in tortillas and related products with research conducted at the Escuela Agrícola Panamericana in Honduras. In recent years the research has broadened to include grain sorghum flour substitution in yeast and sweet breads in El Salvador. This research has included market surveys, and research on specific grain quality/food utilization issues by CENTA, with undergraduate students from the Escuela Agrícola Panamericana, or graduate students at Texas A & M University or the Instituto Tecnologico y de Estudios Superiores, Monterrey, Mexico. In 2002, CENTA established collaboration with the Universidad José Matías Delgado in El Salvador, and conducted research on decortification of sorghum grain, development of new sweet bread recipes, and determination of shelf life of sweet breads made with whole sorghum grain.

Research Results

Research in El Salvador during the past 20 years has developed the technology for incorporating sorghum flour from white, food-grade sorghum cultivars for use in French and sweet bread for urban areas. The research also developed use of 100% sorghum flour for sweet bread, cold drinks (horchatas, refrescos); hot drinks (atoles); and popped sorghum (alboroto). Five tests were conducted with rice millers to decorticate sorghum grain, all being unsuccessful. Several new sweet bread recipes were developed all using 20 to 25% whole sorghum grain flour. Twelve products were evaluated for shelf life, with pastelito de leche and pastelito de piña being 7 days; queiquito, guaracha and pegadito being 25 days; semita alta, pelona, canasta, gusano and picuda being 30 days: and semita pacha, novia and pichardine being 35 days.

Agronomy Research

Research Methods

Agronomic research was conducted in 2000-2002 to evaluate nitrogen use efficiency of grain sorghum photoperiod-sensitive and -insensitive genotypes and to determine optimal nitrogen fertilizer rate recommendations. Four to six grain sorghum varieties were grown at sites in El Salvador and in Nicaragua with four nitrogen fertilizer rates. Flowering date, plant height, grain and stover yield, and grain and stover nitrogen concentration data were collected. Fertilizer use efficiency and utilization nitrogen use efficiencies were calculated from these data. Nitrogen rate by plant population studies were conducted with broomcorn at six locations in Nicaragua.

Research Results (See Project UNL-213 Report for More Detailed Information)

In Central America, nitrogen application increased sorghum grain yields quadratically for both photoperiod-sensitive and -insensitive varieties. Little difference in nitrogen use efficiency (NUE) was found among the photoperiod-insensitive varieties tested, indicating that broader screening of germplasm in Central America sorghum breeding programs will be needed to identify and develop high nitrogen use efficient photoperiod-insensitive sorghum varieties. Nitrogen application of 90 to 115 kg ha^{-1} was necessary to optimize grain yields. In El Salvador, the photoperiod-sensitive varieties SCP-805 and ES-790 for relay intercropping with maize were found to be high yielding and to have high NUE and % N Fertilizer Recovery. Grain yields were optimized with 47 kg ha^{-1} N application. Validation trials are underway on-farm in collaboration with non-governmental agencies to promote the use of the variety 85-SCP-805 with moderate application of nitrogen fertilizer.

Broomcorn yields were not influenced by changes in plant population, but were influenced by nitrogen rate which varied across locations. On average, broomcorn yield increased linearly to nitrogen application with a 16% increase in yield for each 30 kg ha^{-1} nitrogen applied.

Mutual Research Benefits

Many constraints to sorghum production are similar between Central America and the U. S. including drought, diseases, and insects. U.S.-based scientists can provide germplasm that could at least partially alleviate the effects of some of these constraints. The maicillos criollos are a unique type of grain sorghum and can potentially contribute useful food quality traits to U.S. germplasm. Several maillos criollos lines are presently in the Texas A & M University /USDA-ARS Sorghum Conversion Program. Germplasm exchange will contribute to development of novel genetic combinations with multiple stress resistance, wide adaptation, and improved food quality. INTSORMIL's collaborative research in entomology and plant pathology research includes pests that affect grain sorghum both in Central America and in the U.S., such as sorghum midge, fall armyworm, gray spot and ergot. Economic development of Central American countries will increase food security in the region, and potentially increase U.S. exports to the region.

Institution Building

Equipment and Other Support

INTSORMIL has provided pass-through funding and supplies for pathology laboratories in El Salvador and Nicaragua. Three chlorophyll meters were purchased to facilitate agronomy

research on N fertilizer management and nitrogen use efficiency.

Training and Education

Mr. Javier Bueso (Honduras), Assistant Professor, Escuela Agricola Panamericano (Honduras) , completed a Ph.D. degree in Food Science at Texas A&M University, and Rafael Mateo (Honduras) is pursuing a Ph.D. in plant breeding at Texas A&M University. Johnson Zeledón (Nicaragua) is pursuing a Ph.D. degree in entomology at Mississippi State University, and Segio Pichardo Guido has just started a Ph.D. program in plant pathology at Mississippi State University. Candidates for INTSORMIL-supported graduate degree programs in the United States are being chosen to meet regional priorities, and assistance with English language study is being provided. Short-term training on experimental design, data analysis and scientific communication is planned for 2003-2004. Jesus Narro (Mexico), Sergio Picahrdo Guido and Yanet Gutiérrez (Nicaragua) attended the Fuscarium Workshop sponsored by Kansas State University in June 2003. Martha Perez Valdivia, Marion Suarez, Vicente Reyes and Augusto Romero received B.S. degrees at UNA in Nicaragua with thesis research conducted on INTSORMIL collaborative agronomy experiments.

Networking

Institutions/Organizations

INTSORMIL support has contributed to increased collaboration among CENTA, INTA and UNA during the past four years. In El Salvador, increased collaboration with the non-governmental organizations ESBESA, ESBESA-Ramírez Consultores, MAG/AVES, FUNPROCOOP, PRODAP (Proyecto de Desarrollo Rural en la Región Paracentral), and FUNDESYRAM (Fundación Para E Desarrollo Socio-Económico y Restauración Ambiental) primarily with validation testing of sorghum varieties to be released. A collaborative relationship has also been established with the Universidad José Matías Delgado. In Nicaragua, increased collaboration with the CIRAD-CIAT Watershed Project at San Dionisio has been strengthened, especially collaboration with Dr. Gilles Trouché, sorghum breeder. Also collaboration with the universities of Campesina (UNICAM), Centroamericana (CSA) and Católica del Tropico Seco de Estelí (UCATSE), and with the non-governmental organizations ADRA-Ocotal, CARITAS-Matagalpa and CARE-Estelí have been developed. National programs have strong linkages to private seed companies, and are developing closer ties with feed and food utilization companies. Particularly noteworthy is providing technical assistance to the seed company Productora de Semilla in Guatemala. Close working ties with the Asociacíon Salvadoreña de Panifacadores (ASPAN) in El Salvador continues. Improved networking with INTSORMIL universities and Instituto Tecnologico y de Estudios Superiores, Monterrey, Mexico is desired through graduate education and collaborative research efforts. INTSORMIL is actively working to promote strengthed collaborative linkages.

Travel

INTSORMIL sponsored the Central America Research Directors meeting 3 October, 2002 in Managua, Nicaragua with representation from INTA, UNA, CENTA and INTSORMIL.

Nine scientists and two research directors attended the INTSORMIL Principal Investigators Conference in Addis Ababa, Ethiopia in November 2002. Several research planning meetings were held with U.S. and Central American scientists during the meeting.

Regional coordinators and 6 collaborating scientists attended the PCCMCA meeting April 27 - May 2, 2003 in La Ceiba, Honduras. Thirteen sorghum research papers were presented by INTSORMIL collaborators.

Dr. Larry Claflin visited INTSORMIL scientists conducting collaborative research in El Salvador and Nicaragua in Dec., 2002.

Regional coordinator René Clará visited Nicaragua several times to coordinate activities and assist with the INTA plant breeding program. He also visited Productora de Semillas in Guatemala to provide assistance on sorghum seed production.

Dr. Stephen Mason, Regional Coordinator, made trips to El Salvador and Nicaragua in September-October 2002 and to El Salvador and Honduras April-May, 2003.