

# Sustainable Production Systems





# **Economic and Sustainability Evaluation of New Technologies in Sorghum and Millet Production in INTSORMIL Priority Countries**

**Project PRF 205  
John Sanders  
Purdue University**

## **Principal Investigator**

John H. Sanders, Purdue University, Dept of Agricultural Economics, West Lafayette, IN 47907

## **Collaborators**

Felix Baquedano, Apartado Postal 6149, Managua, Nicaragua  
Tahirou Abdoulaye, INRAN, JCAR, ICRISAT, Sadore, Niger  
Kidane Georgis, EARO, PO Box 2003, Addis Ababa, Ethiopia  
Barry I. Shapiro, ICRISAT, Patancheru AP 502 324, Hyderabad, India  
Jeffrey D. Vitale, Dept. of Ag Economics, Oklahoma State University, Stillwater, OK 74078  
Nega Wubeneh, ILRI, BP 5689, Addis Ababa, Ethiopia  
Botorou Ouendeba, formerly ICRISAT and INRAN, Niamey, Niger  
Lloyd Rooney, Texas A&M University, Dept. of Soil and Crop Sciences, College Station, Texas 77843

The major activities during this year have been the completion of graduate student projects and the completion of field research to evaluate the impacts of the improved marketing strategies. There are two graduate students being supported by this project. One has been doing his field research in Tigray, Ethiopia on the introduction of the combination of new sorghum technologies and market sector reform. Ethiopia has been introducing floor prices for the cereals and farmer cooperatives during the last three years. Both benefit the farmer by enabling him to obtain higher prices. The cooperatives provide loans to farmers for their cereals at harvest time but the farmer or the farmers' organization can sell later after the price recovers. The cooperatives also provide farmer members with cheaper fertilizer via bulk purchases. Moreover, they have greater bargaining power than individual farmers for selling sorghum. We are evaluating the effects of these market reforms on technology introduction and farmers' incomes. This student is expected to finish his Ph.D. thesis in early 2007. The other student has been working on Inventory Credit for millet in Niger. He will be collaborating with the USAID regional program supported Marketing-Processing Project, which is facilitating the introduction of Inventory Credit and four other marketing reforms into three Sahelian countries, Niger, Mali, and Senegal. This field research evaluates the impacts of the improved marketing strategies on the more rapid introduction of new sorghum and millet technologies and gives research support to the USAID development project. This above regional development activity (the Marketing-Processing Project) is funded by the regional USAID office in Accra and managed by INTSORMIL. The results of the studies of both students will provide information needed by the governmental bodies in each country in making policy decisions.

## **Publications**

### ***Journal Article***

Abdoulaye, Tahirou and John H. Sanders, "New technologies, marketing strategies and public policy for traditional food crops: Millet in Niger," *Agricultural Systems*, 90: 272-292

### ***Book Chapter***

Sanders, John H. and Barry Shapiro, 2006 "Policies and market development to accelerate technological change in the semiarid zones: A focus on Sub-Saharan Africa," in Payne et al (editors), *Dryland Agriculture*, 2nd Edition, Agronomy Monograph No. 23, American Society of Agronomy, Crop Science Society of Agronomy, Soil Science Society of Agronomy, Madison, Wisconsin, 879-900.

### ***Extension Publications***

Abdoulaye, Tahirou, John H. Sanders and Botorou Ouendeba, 2006, *Quelle Cereale pour les Aliments de Volaille in Afrique de l'Ouest: Sorgho ou Mais?* INTSORMIL, Bulletin No. 4, Lincoln, Nebraska. 24 pages  
Also four country specific laminated two pages written from this bulletin for each of the countries. These were widely distributed in the four Sahelian countries (Niger, Burkina Faso, Mali, and Senegal).

***Theses***

Baquedano, F., 2005, "The economics of inventory credit in western Niger," unpublished MS thesis, Department of Agricultural Economics, Purdue University, West Lafayette, IN.

Yigezu, A. Y., 2005. "Technological and policy changes for improving farmers' welfare in the Amhara region (Ethiopia)," unpublished MS thesis, Department of Agricultural Economics, Purdue University, West Lafayette, IN.

# **Cropping Systems to Optimize Yield, Water and Nutrient Use Efficiency of Pearl Millet and Grain Sorghum**

**Project UNL 213  
Stephen C. Mason  
University of Nebraska**

## **Principal Investigators**

Dr. Stephen C. Mason, University of Nebraska, Dept. of Agronomy, Lincoln, NE 68583  
Dr. Samba Traoré, Cinzana Research Station, IER, B.P. 214, Segou, Mali  
Dr. Nouri Maman, INTARNA Research Station, B.P. 429, Maradi, Niger  
Dr. Minamba Bagayoko, IER, Niono, Mali  
Dr. Taonda Sibiri Jean Baptiste, INERA, Koudougou, Burkina Faso  
Mr. Seyni Sirifi, INRAN, Kollo, Niger  
Mr. Siebou Pale, INERA, Koudougou, Burkina Faso  
Mr. Maximo Hernández Valle, CENTA, San Salvador, El Salvador  
Mr. Orlando Téllez Obregón, INTA, Somoto, Nicaragua  
Mr. Leonardo García Centeno, UNA, Managua, Nicaragua

## **Collaborating Scientists**

Ing. René Clará Valencía, Central America Regional Coordinator, San Salvador, El Salvador  
Dr. Bruce Hamaker, Food Scientist, Purdue University, West Lafayette, IN 47907  
Dr. Jeff Wilson, Millet Breeder, USDA-ARS, Tifton, GA 31793  
Dr. Issoufou Kapran, Sorghum Breeder, INRAN, Niamey, Niger  
Dr. Charles Wortmann, Soil Scientist, University of Nebraska, Lincoln, NE 68583  
Dr. Martha Mamo, Soil Scientist, University of Nebraska, Lincoln, NE 68583  
Dr. David Jackson, Food Scientist, University of Nebraska, Lincoln, NE 68583  
Boniface Bougouma, Food Scientist, IRSAT/DTA, Ouagadougou, Burkina Faso  
Prof. R. Klein, Agronomist, West Central Res. & Ext. Center, Univ. of Nebraska, North Platte, NE 69101  
Dr. Roger Elmore, Agronomist, University of Nebraska, Lincoln, NE 68583  
Dr. Drew Lyon, Agronomist, Panhandle Res. & Ext. Center, Univ. of Nebraska, Scottsbluff, NE 69361  
Dr. Alex Martin, Weed Scientist, University of Nebraska, Lincoln, NE 68583  
Dr. Lloyd Rooney, Food Scientist, Texas A & M University, College Station, TX 77843  
Ing. Vilma Ruth Calderon, Food Scientist, CENTA, San Salvador, El Salvador  
Ing. Quirino Argueta Portillo, Soil Scientist, CENTA, San Salvador, El Salvador  
Ing. Rafael Obando Solis, Plant Breeder, CNIA/INTA, Managua, Nicaragua  
Mr. Nanga Mady Kaye, Agronomist, Moundou, Chad  
Dr. Gerrit Hoogenboom, Agronomist, University of Georgia (SANREM) CRSP

## **Accomplishments 2005 - 2006**

### ***West Africa***

Research on-station and on-farm documented grain and stover yield increases of 250 to 300 kg ha<sup>-1</sup> grain and 700 to 2000 kg ha<sup>-1</sup> stover of pearl millet and grain sorghum from microdose fertilizer application in Burkina Faso, Mali and Niger. Technology transfer is on-going.

Research on-station and on-farm on different soil types across Burkina Faso documented an animal traction zai produced similar yields to traditional zai systems, but with 278 man-hours less labor per ha. Technology transfer is on-going.

On-station crop residue management research in Mali from the 1990's has been transferred to producers in surrounding villages. Survey's report that 70% of producers have adopted leaving all or part of crop residues on the soil surface, or incorporating into the soil.

Enhanced national scientific capability has been accomplished by completing two M.S. and one Ph.D. student programs for scientists from the region.

Contributed to knowledge about West African pearl millet cropping systems through publication of three scientific journal articles.

### **Central America**

UNL-213 has identified 85-SCP-805 as a superior photoperiod sensitive sorghum variety for production in association with maize. This variety has high grain yield, high nitrogen use efficiency and high responsiveness to nitrogen fertilizer application. Seed production has been promoted with farmers (artesanal system) and transferred across El Salvador, and is now starting in Honduras. An economic impact study is presently being conducted in El Salvador.

UNL-213 has completed on-farm evaluation of two forage hybrids and the dual use variety CENTA S-3 that increase milk and meat production. These cultivars have been released in El Salvador and Nicaragua

This project has contributed to national program scientific capability by assisting with workshops sorghum grain and forage utilization. Over 100 persons participated in each of these workshops.

UNL-213 has enhanced Nicaragua scientific capability through short-term training of one scientist, and supervising 26 undergraduate theses with research conducted on sorghum.

This project has contributed to knowledge about sorghum cropping systems through publication of two scientific journal articles and five oral papers at PCCMCA meetings.

### **Nebraska**

UNL-213 developed a production practice package for grain pearl millet production in Nebraska, includes planting date, seeding rate, row spacing, weed control and N fertilizer management.

Research documented the effects of nitrogen and crop rotation on sorghum grain quality, and the interrelationship of biological nitrogen fixation, soil nitrogen transformations and other factors involved in enhancing grain yield by using crop rotation with soybean.

The project has enhanced U.S. scientific capability by completing two M.S. students, and incorporating research results into crop management courses taught at the University of Nebraska. It has enhanced the knowledge of sorghum/pearl millet cropping systems in the U.S. through publication of 9 scientific articles.

### **Publications**

Maman, N., S.C. Mason and D.J. Lyon. 2006. Nitrogen rate influence on pearl millet yield, N uptake and use efficiency in Nebraska. *Comm. Soil Sci. Plant Analysis* 37: 127 - 141.

Casteneda, J.W., S.C. Mason, Q. Argueta and R. Ventura. 2006. Nitrogen response and use efficiency of photoperiod-sensitive sorghum varieties in El Salvador. *Agronomia Mesoamericana* 17(2): 19 - 25.

Kaye, N.M., S.C. Mason, D.S. Jackson and T.D. Galusha. 2006. Crop rotation and soil amendment influence alters sorghum grain quality. *Crop Sci.* 46: (In Press).

Kaye, N.M., S.C. Mason and T.D. Galusha. 2006. Nodulating and non-nodulating soybean rotation influence on soil NO<sub>3</sub>-N and water, and sorghum grain yield. *Agron. J.* 98: (In Press)

Garcia Centeno, L., O. Tellez and S.C. Mason. 2006. Uso eficiente del nitrogeno por 16 lineas de sorgo en Nicaragua. *Agronomia Mesoamericana* (Submitted)

Garcia Centeno, and S.C. Mason. 2006. Incorporacion del mungo como fuente de nitrogeno para produccion de sorgo. *La Calera* (Submitted)

Tojo Soler, C.M., N. Maman, X. Zhang, S.C. Mason and G. Hoogenboom. Determining optimum planting dates for pearl millet for two contrasting environments using a modeling approach. *Agric. Systems* (Submitted).

# **Soil and Water Management for Improving Sorghum Production in Eastern Africa**

## **Project UNL 219**

**Charles Wortmann and Martha Mamo**  
**University of Nebraska**

### **Principal Investigators**

Charles Wortmann & Martha Mamo, Dept. of Agronomy & Horticulture, Univ of Nebraska, Lincoln, NE 68583-0915

### **Collaborating Scientists**

Gebisa Ejeta, Purdue Univ., Department of Agronomy, Purdue University, Lilly Bldg State Street, West Lafayette IN 47907-1150.

Steve Mason, University of Nebraska, Department of Agronomy and Horticulture, 279 Plant Science, Lincoln, NE 68583-0915

Kidane Georgis- EARO-Addis Ababa, P.O. Box 2003, Addis Ababa, Ethiopia.

Amare Belay and Gebreyesus Brhane, Mekelle Agricultural Research Center, P.O. Box 492, Mekelle, Ethiopia

Girma Abebe and Tewodros Mesfin, EARO-Melkassa, Nazareth Agricultural Research Center, P.O.Box 436, Nazareth, Ethiopia

Kaizzi Kayuki, KARI-NARO, P.O. Box 7061, Kampala, Uganda.

Soares Xerinda, INIA, Av. das FPLM, POBox 3658, Maputo, Mozambique

### **Summary**

The purpose of this project is to promote economic growth, improve nutrition and increase yield. Opportunities to increase yield or to reduce production costs have been identified while promising research is continuing and technology dissemination activities have been initiated. Following verification and fine-tuning of the targeting of tied-ridge tillage for semi-arid areas of Ethiopia, extension efforts have been initiated while other aspects of tie-ridge technology are under investigation. Four opportunities for low-input management of soil fertility in semi-arid eastern Uganda have been verified as economical using farmer participatory approaches; information dissemination is underway and more detailed research has been initiated to assess the sustainability of these practices. Research on tillage alternatives commenced in 2005 in Tanzania. The study of some effects of occasional tillage for no-till systems has been completed while investigation of other aspects continues. Skip row planting as a means to reduce the effects of water deficits on yield is being investigated at three locations in Ethiopia and five locations in Nebraska.

Improved institutional capacity. A researcher, Gebreyesus Brhane, who completed his MS degrees at Alemaya University with support from UNL 219, and Dr. Kaizzi Kayuki came to UNL as visiting scientists. The research of a US and two international graduate students who have completed their degrees was supported by this project. An atlas of sorghum production in eastern Africa that is now being published is expected to improve institutional capacity by providing information useful for national and regional planning.

### **Publications and Presentations**

#### ***Journal Articles***

Brhane, G., C.S. Wortmann, M. Mamo, H. Gebrekidan, and A. Belay.

2006. Micro-basin tillage for grain sorghum production in semi-arid areas of northern Ethiopia. *Agronomy Journal* 98:124-128.

Wortmann, C.S., S.A. Xerinda, M. Mamo and C.A. Shapiro. 2006. No-till row crop response to starter fertilizer in eastern Nebraska: I. irrigated and rainfed corn. *Agronomy Journal* 98:156-162.

Wortmann, C.S., S.A. Xerinda, and M. Mamo. 2006. No-till row crop response to starter fertilizer in eastern Nebraska: II. rainfed grain sorghum. *Agronomy Journal*. 98: 187-193.

#### **Dissertations and Theses**

Garcia, Juan Pablo, 2005. The effects of occasional tillage in no-till systems on nutrient distribution and uptake and on vesicular arbuscular mycorrhizal (VAM) colonization. MS thesis, Dep. of Agronomy and Horticulture, University of Nebraska-Lincoln.

Miller, Gregory G., 2006. Sorghum and mycorrhizal responses to liming strategies in pH stratified soil. MS thesis, Dep. of Agronomy and Horticulture, University of Nebraska-Lincoln.

Quincke, J. Andres. 2006. Occasional tillage or no-till systems to improve carbon sequestration, and soil physical and microbial properties. PhD dissertation, Dep. of Agronomy and Horticulture, University of Nebraska-Lincoln.

#### ***Abstracts***

Occasional Tillage of No-Till Systems: Water Infiltration and Runoff Assessment with a Portable Rainfall Simulator. Charles S. Wortmann, Martha Mamo, Juan A. Quincke. American Society of Agronomy.

Occasional Tillage of No-Till Systems: Vertical Distribution of Labile Soil Carbon Pools. Juan A. Quincke, Martha Mamo, Charles S.Wortmann. American Society of Agronomy.

A Decision Guide for Tied-Ridging in Semi-Arid Areas of Ethiopia. M. Gebreyesus Brhane, Tewodros Mesfin, Amare Belay, Martha Mamo, Charles S.Wortmann. American Society of Agronomy.

Roles for Herbaceous and Grain Legumes, Kraal Manure and Inorganic Fertilizer for Soil Fertility Management in East-

ern Uganda. Kayuki C. Kaizzi, John Byalebeka, Charles S.Wortmann, Martha Mamo. American Society of Agronomy.

Occasional Tillage in No-Till Systems: Soil Phosphorus Distribution and Crop Uptake. Juan Pablo Garcia, Charles S.Wortmann, Martha Mamo. American Society of Agronomy.