

Crop Utilization and Marketing



An Evaluation of New Market Development and Marketing Strategies on Sorghum and Millet Farmers' Income in Tanzania and Zambia

Project OSU 200
Donald Larson and J. Mark Erbaugh
Ohio State University

Principal Investigator

Donald Larson, Ohio State University, CMPS/3064 Smith Lab/174 Eighteenth Ave, Columbus, OH 43210
J. Mark Erbaugh, Ohio State University, IPIA/113 Ag Admin Building/2120 Fyffe Road, Columbus, OH 43210

Collaborating Scientists

Emmanuel Mbiha, Sokoine University of Agriculture, Morogoro, Tanzania
Fredy Kilima, Sokoine University of Agriculture, Morogoro, Tanzania
Gelson Tembo, University of Zambia, Lusaka, Zambia
Priscilla Hamukwala, University of Zambia, Lusaka, Zambia

The program completed research field work for one M.S. candidate (Zambia) and one Ph.D. candidate (Tanzania). Research involves the evaluation of the effects of new market development and marketing strategies for sorghum and millet on farmers' income in Tanzania and Zambia. The INTSORMIL/CRSP issued a request for proposals to strengthen the marketing research component for eastern and southern Africa. The OSU research work was initiated as part of this effort nearly one year ago. We worked to complete the analyses of the farm level data that was collected and complete an in-depth study of the entire value added supply chain for one of three potential valued added markets for sorghum and millet. The three markets with the most potential are fortified food processing, animal feeds, and commercial beer brewing. A diagnostic report examining the problems and constraints of the selected supply chain will be prepared by the end of this year. The report will contain recommendations on how the value added supply chain can be improved. Achieving a successful supply chain model has strong possibilities for expanding and replicating this model to other value added markets for sorghum and millet. The research data will be used for host-country graduate student thesis preparation.

Major achievements

Ohio State University is conducting marketing research with faculty at the Department of Agricultural Economics and Agribusiness, Sokoine University of Agriculture (SUA), Faculty of Agriculture, Morogoro, Tanzania and the Department of Agricultural Economics and Extension Education, the University of Zambia (UZ), School of Agricultural Sciences, Lusaka, Zambia. In each country, a questionnaire was developed with host country collaborators to survey farmers who use new and traditional production technologies and marketing strategies. Usable questionnaires were completed with slightly over 100 farmers in major sorghum and millet producing areas in each country (Dodoma in Tanzania and Siavonga in Zambia). Many additional interviews with key informants in the private and public sectors of the host countries were

completed to obtain valuable insights about the adoption and profitability of new sorghum production and marketing technology. The key informants included farmers, input supply firms, sorghum buyers, processors, and wholesalers in the sorghum beer brewing and food processing value chain for the 'new technology' users and the 'traditional technology' users. Public sector interviews included USAID/Tanzania, USAID/Zambia, sorghum and millet researchers (e.g., INTSORMIL), government policy makers, statistical agencies, CARE, and others such as the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

An interim report of the findings has been completed and a final report is due for completion by September 30, 2006. A paper entitled "Strategic Management Options for Growing Power Foods Ltd.: Dar Es Salaam, Tanzania" by E. R. Mbiha, Donald W. Larson, J. Mark Erbaugh, and Thomas Worley was presented at the International Food and Agribusiness Management Association (IAMA) 16th Annual World Forum and Symposium in Buenos Aires, Argentina. June 9-14, 2006.

Chemical and Physical Aspects of Food and Nutritional Quality of Sorghum and Millet

**Project PRF 212
Bruce R. Hamaker
Purdue University**

Principal Investigator

Bruce R. Hamaker, Dept. of Food Science, Purdue University, West Lafayette, IN 47907

Collaborating Scientists

Mr. Kaka Saley, Cereal Scientist; Mr. Moustapha Moussa, Cereal Technologist; Ms. Ramatou Seydou, Chemist; Dr. Issoufou Kapran, Sorghum Breeder; INRAN B.P. 429, Niamey, Niger

Ms. Senayit Yetneberk, Cereal Scientist, EARO, Nazret Research Station, P.O. Box 436, Nazret, Ethiopia

Ms. Betty Bugusu, Cereal Scientist, KARI, Katumani Natl Dryland Farming Res. Ctr, P.O. Box 340, Machakos, Kenya

Mr. Ababacar N'Doye, Research & Development Director, ITA, B.P. 2765, Dakar, Senegal

Dr. Iro Nkama, Professor, University of Maiduguri, P.O. Box 1069, Maiduguri, Nigeria

Mr. Boniface Bougouma, Cereal Scientist, IRSAT/DTA, B.P. 7047, Ouagadougou, Burkina Faso

Dr. John Taylor, Cereal Chemist, University of Pretoria, Food Technology Department, Pretoria 0002, South Africa

Dr. Adam Aboubacar, Assistant Professor, University of Wisconsin-Stout, P.O. Box 790, Menomonie, WI 54751

Dr. Arun Chandrashekar, Cereal Chemist, CFTRI, Dept. of Food Microbiology, Mysore 570013, India

Dr. Gebisa Ejeta, Sorghum Breeder; Dr. Layi Adeola, Poultry Nutritionist; Dr. Moustapha Benmoussa, Plant Molecular Biologist, Purdue University, West Lafayette, IN 47907

Dr. Brian Larkins, Plant Molecular Biologist, University of Arizona, Tucson, AZ 85701

Dr. Tae Wae Moon, Food Chemist, Seoul National University, Seoul, Korea

This project is completing studies having high impact potential including the completion of a Nigerien graduate student's M.S. degree, to complete partially-supported research on sorghum protein utilization, and to write and submit articles for publication. More specifically these activities will include:

- Completion of the student project of Moustapha Moussa on the development of low-cost commercially profitable pre-gelatinized sorghum and millet flours for thin and thick porridges. These products hold exceptional promise as convenience foods for urban consumers in West Africa who prefer to consume thin porridges for breakfast, light mid-day meals, and snacks and would benefit from instant porridges to be mixed with hot water. Still to be completed during the extension year are optimization of the process, shelf life studies, completion of sensory evaluation, as well as promotion with donors in Niger.
- Completion of a study, in collaboration with A. N'Doye of the Institut de Technologie Alimentaire, Dakar, Senegal on the feasibility of using sorghum and millet storage proteins as viscoelastic polymers to make leavened products.
- Write and submit publications on pre-gelatinized sorghum and millet flours and sensory evaluation studies conducted in Niger, on new uses for sorghum and millet proteins and on high digestibility sorghums.

Food and Nutritional Quality of Sorghum and Millet

Project TAM 226 L.W. Rooney Texas A&M University

Principal Investigator

Lloyd W. Rooney, Professor, Food Science & Agronomy, Cereal Quality Lab, Soil & Crop Sciences Dept., Texas A&M University, College Station, Texas 77843

Cooperator: Ralph D. Waniska, Professor, Food Science, Cereal Quality Lab, Texas A&M University, College Station, Texas 77843

Collaborating Scientists

Dr. A. Touré, Sorghum Breeder, Institute Economic Rurale, Bamako, Mali

Dr. G. Peterson, Texas A&M Ag Research and Extension Center, Lubbock, TX 79401

Drs. W.L. Rooney and D. Hays, Texas A&M University, Soil & Crop Sciences, College Station, TXs 77843-2474

Drs. Mitch Tuinstra, Dept. of Agronomy, and Joe Hancock, Dept. of Animal Sciences and Industry, Kansas State University, Manhattan, KS 66506-5506

Dr. Sergio Serna-Saldivar, Professor and Head, Food Science, ITESM de Monterrey, Monterrey, Mexico

Professor John R.N. Taylor, Head, Food Technology Dept., University of Pretoria, Pretoria 0002, South Africa

Ms. Ruth Vilma Calderon, Food Technologist, and Ing. René Clará, Sorghum Breeder, CENTA, Km 331/2 Carretera a Santa Ana, San Andrés, La Libertad, El Salvador

Ms. Eliette Palacio, Seed Technologist, INTA, Managua, Nicaragua

Dr. Javier Bueso, Associate Professor, Escuela Agrícola Panamericano, Zamorano, Honduras

Dr. John Sanders, Professor, Agriculture Economics, Purdue University, W. Lafayette, IN 47907-2056

Summary

New, more-efficient, higher-yielding white tan photosensitive varieties from the IER breeding program in Mali have excellent properties for food processing. They escape significant weathering/molding that adversely affects earlier insensitive white tan sorghums which led to their failure. Farmers were pleased with the grain quality for their own food and appreciated the opportunity to sell the grain at a potential premium. The principle of supply chain management from seed to food products has been demonstrated; however, more work to obtain wide-spread participation is required.

Similar situations exist in El Salvador where small farmers have vertically integrated and sell their own white tan sorghums in the form of baked products. There are some significant successes in this area.

United States value-enhanced white food sorghums developed in part by this project and promoted by the US Grains Council in Japan continued to be used by the Japanese food industry to market snacks and several other products. The white sorghums are color sorted, decorticated, and used as an ingredient in a wide variety of foods including brewing. The cost of value-added white sorghums is competitive with domestic Japanese rice.

Several small mills in the US are producing sorghum flour for niche markets. The operations are small, but produce sorghum flour and other products that have been made into foods for Ce-

liac-Sprue patients and ethnic groups. Other food companies are developing new food products and preparing mixes for special markets.

Special sorghums with high levels of phenols and antioxidants were extruded to produce snacks with high levels of antioxidants. The extruder is a low-cost, short-barrel friction type that could be used by small companies in targeted countries, i.e., Central America. The extrudates are high in dietary fiber as well as antioxidants. We found that whole, cracked and decorticated sorghums produced a wide variety of extrudates. The extruded whole grain products have significant appeal as health foods. Bread machine mixes with sorghum bran, gluten, flax and barley flour produced good-quality bread with a natural dark color and improved nutritional value.

We continue to monitor the quality of new food-type sorghums in special sorghum nurseries grown in the sorghum belt by collaboration with Dr. Tuinstra, Rooney, Peterson and others. The IFSAT trials consisting of advanced food sorghums of potential value in host countries is evaluated for quality annually in several locations. Several parental sorghum lines released from our program are used in commercial food hybrids. New commercial sorghum hybrids with tan plant white pericarp color were released by commercial hybrid seed companies. Red tan plant hybrid sorghums have excellent milling properties compared to red purple plant sorghums.

Tannin and other special sorghums have excellent levels of antioxidant power, high dietary fiber and impart attractive dark natural color to baked products. They can be incorporated into a wide variety of products. Small quantities of tannin sorghum bran were an effective preservative for ground beef patties.

Workshops on food sorghums and special tannin sorghums as health foods were presented in South Africa, Central America, Mali and to technical conferences and industry personnel in the USA.

Three students completed MS degrees in Food Science and Technology. Three short-term trainees from Central America and Africa were hosted.

Publications and Presentations

Journal Articles

- Awika, J.M., C.M. McDonough, and L.W. Rooney. 2005. Decorating sorghum to concentrate healthy phytochemicals. *J Ag and Food Chem* 53:6230-6234.
- Dykes, L., L.W. Rooney, R.D. Waniska, and W.L. Rooney. 2005. Phenolic compounds and antioxidant activity of sorghum grains of varying genotypes. *J Ag & Fd Chem* 53:6813-6818.
- Rooney, L.W. 2005. Ten myths about tannins in sorghums. *International Sorghum and Millets Newsletter* 46:3-5. SICNA/ICRISAT.

Dissertations and Theses

- de Castro, A. May 2006. In vitro starch digestibility and estimated glycemic index of sorghum products. MS Thesis. Texas A&M University, College Station, TX. 113 pp.
- Perez Gonzalez, A.J. December 2005. Specialty sorghums in direct-expansion extrusion. MS Thesis. Texas A&M University, College Station, TX. 115 pp.
- Cedillo Sebastian, G. December 2005. Nutraceutical tortillas and tortilla chips prepared with bran from specialty sorghums. MS Thesis. Texas A&M University, College Station, TX. 109 pp.

Miscellaneous Publications

- Rooney, L.W. 2005. Food and nutritional quality of sorghum and millet, Project TAM-226. INTSORMIL Annual Report 2005, University of Nebraska, 103-111.

Abstracts

- Dlamini, N., C.M. McDonough, L. Dykes, L.W. Rooney, and J. Taylor. 2006. Ready-to-eat products prepared by the extrusion cooking of whole and decorticated sorghums that are high in antioxidants. Institute of Food Technology Annual Meeting and Food Expo, June 24-28, Orlando, FL (Poster). <http://www.abstractsonline.com/viewer/>
- De Castro, A., C.M. McDonough, Waniska, R.D., and L.W. Rooney. 2006. Effect of extrusion on starch availability of sorghum products. Institute of Food Technology Annual Meeting

- and Food Expo, June 24-28, Orlando, FL (Poster). <http://www.abstractsonline.com/viewer/>
- Shin, D., R. Miller, J. Keeton, L.W. Rooney, and R.D. Waniska. 2006. Antioxidant, color and sensory properties of sorghum bran in pre-cooked ground beef patties varying in fat. Institute of Food Technology Annual Meeting and Food Expo, June 24-28, Orlando, FL (Poster). <http://www.abstractsonline.com/viewer/>
- Turner, N.D., A. Diaz, S.S. Taddeo, J. Vanamala, C.M. McDonough, L. Dykes, M.E. Murphy, R.J. Carroll, and L.W. Rooney. 2006. Bran from black or brown sorghum suppresses colon carcinogenesis. *Experimental Biology: Advancing the Biomedical Frontier*, San Francisco, CA. #394.6. <http://www.eb2006-online.com/pdfs/006564.PDF?PHPSESSID=3384411635c50bc0ea6bdd8f67ecf>
- Calderon, V.R, F. Herrera, R. Clara, and L.W. Rooney. 2005. Sorghum utilization for human consumption in El Salvador, C.A. American Association of Cereal Chemists (AACC) International Conference, September 11-14, Orlando, FL. <http://www.aaccnet.org/meetings/2005/abstracts/p-277.htm>
- Cedillo, G., A. de Castro Palomino, C.M. McDonough, R.D. Waniska, and L.W. Rooney. 2005. Corn tortillas high in antioxidants and dietary fiber. American Association of Cereal Chemists (AACC) International Conference, September 11-14, Orlando, FL. <http://www.aaccnet.org/meetings/2005/abstracts/p-308.htm>
- de Castro Palomino, A., C.M. McDonough, R.D. Waniska, and L.W. Rooney. 2005. In-vitro starch hydrolysis index and estimated glycemic index of sorghum products. American Association of Cereal Chemists (AACC) International Conference, September 11-14, Orlando, FL. <http://www.aaccnet.org/meetings/2005/abstracts/p-275.htm>
- Dlamini, N.R., J.R.N. Taylor, C.M. McDonough, and L.W. Rooney. 2005. Antioxidant properties of whole grain African sorghum-based foods. American Association of Cereal Chemists (AACC) International Conference, September 11-14, Orlando, FL. <http://www.aaccnet.org/meetings/2005/abstracts/p-272.htm>
- Perez, A.J, A. de Castro, D. Guajardo, and G. Cedillo. 2005. Krunchips multi colored all natural tortilla chips. American Association of Cereal Chemists (AACC) International Conference, September 11-14, Orlando, FL.
- Perez-Gonzalez, A.J., C.M. McDonough, M.N. Riaz, and L.W. Rooney. 2005. Extrusion of whole-grain and milled specialty sorghum. American Association of Cereal Chemists (AACC) International Conference, September 11-14, Orlando, FL. <http://www.aaccnet.org/meetings/2005/abstracts/p-187.htm>
- Hines, L.R. and L.W. Rooney. 2005. Development of an improved gluten-free bread with dietary fiber, antioxidants, and omega-3 fatty acids. Institute of Food Technology Annual Meeting and Food Expo, July 17-20, New Orleans, LA. (Poster)
- Cedillo, G., C.M. McDonough, R.D. Waniska, and L.W. Rooney. 2005. Nutraceutical corn tortillas prepared using bran from specialty sorghums. Institute of Food Technology Annual Meeting and Food Expo, July 17-20, New Orleans, LA. (Poster)
- Perez-Gonzalez, A. 2005. Performance of specialty sorghums in whole-grain extrusion. Institute of Food Technology Annual

Meeting and Food Expo, July 17-20, New Orleans, LA. (Presentation)

Proceedings/Presentations

Gu, L., S.E. House, L.W. Rooney, and R.L. Prior. 2006. Sorghum bran in the diet dose dependently increased excretion of catechins and microbial derived phenolic acids in rats. *Experimental Biology: Advancing the Biomedical Frontier*, April 1-5, San Francisco, CA.

Rooney, L.W. 2006. Rice & Sorghum Extrusion Properties. *Snack Foods Processing Short Course*, March 12-17, College Station, TX.

Rooney, L.W. 2006. Progress in sorghum utilizations for food and feed, 5th Australian Sorghum Conference January 30 - February 2, 2006, Gold Coast, Australia.

Rooney, L.W. 2005. Discussion: Developing supply chain managements. *Technology Diffusion and Supporting Services for Food Processors in the Sahel*, December 14-15, Saly, Senegal.

Rooney, L.W. 2005. The process and pitfalls of developing supply chains. *Technology Diffusion and Supporting Services for Food Processors in the Sahel*, December 14-15, Saly, Senegal.

Rooney, L.W. 2005. Sorghum utilization and health benefits. *Frito-Lay R&D personnel*. September 23, Plano, TX.

Entrepreneurship and Product Development in East Africa: A Strategy to Promote Increased Use of Sorghum and Millet.

Project UNL 220

David S. Jackson

University of Nebraska – Lincoln

Principle Investigator

Dr. David S. Jackson, University of Nebraska - Lincoln, Dept. of Food Science & Technology, 256 Food Industry Bldg, . Lincoln, NE 68583

Collaborating Scientists

Ms. Jill Gifford, University of Nebraska, Food Processing Center, Lincoln, NE 68583

Dr. Joseph J. Mpagalile, Sokoine University of Agriculture, Dept. of Food Science and Technology, P. O. Box 3006, Morogoro, Tanzania

Ms. Joan Scheel, University of Nebraska, Food Processing Center, Lincoln, NE 68583

Dr. Curt Weller, University of Nebraska, Dept. of Biological Systems Engineering, Lincoln, NE 68583

High impact activities are being conducted during this period. This project is actively working with 30-40 entrepreneurial business clients in Tanzania. The entrepreneurs are either already engaged in processing small quantities of sorghum products or are conducting sorghum food product development / business development activities that will lead to the marketing of new products. The project provides integrated marketing and product/process development services to these clients with the aim of 1) establishing a product development / market development assistance infrastructure at Sokoine University of Agriculture, 2) developing entrepreneurial food business and micro-enterprises that increase food and economic security, and 3) “pulling” sorghum and millet through the marketing channel, thus providing consumers with improved food choices and providing farmer/producers with increased market stability/incomes.

During this period we are completing the following activities:

- Provide training of business clients with the “From Recipe to Reality and From Product to Profit” workshop series.
- Provide customized (one-to-one) technical and business development support.
- Localize development of program materials for other East African nations. Evaluate the “pull model” of increasing sorghum/millet consumption) and document specific financial and social impacts (specific businesses developed and/or supported, increase(s) in products sold, and increase(s) in business income.

