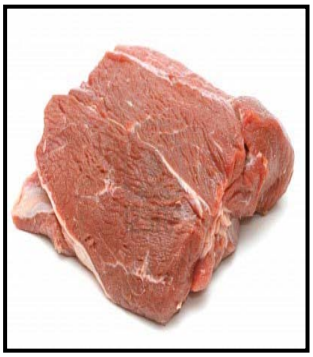
BMR FORAGE SORGHUM PROJECT
WORK PLAN AND PROGRESS REPORT 2010-2012

Associate Award Cooperative Agreement No. AID-OAA-LA-10-00009

INTSORMIL, University of Nebraska-Lincoln



More milk	More weight	*"bmr"* sorghum	More meat

USAID FROM THE AMERICAN PEOPLE

INTSORMIL

BMR FORAGE SORGHUM PROJECT

WORK PLAN AND PROGRESS REPORT 2010-2012

Name of Project: Identification and Release of Brown Midrib (*bmr*) Sorghum Varieties to Producers in Central America and Haiti

Associate Award Cooperative Agreement: No. AID-OAA-LA-10-00009

Execution Time: October 1, 2010 to September 30, 2013

Name of Primary Grantee: INTSORMIL, University of Nebraska, Lincoln
srmlcrsp@unl.edu

Submitted by: E. A . "Short Heinrichs, Assistant Director, INTSORMIL; Rene Clara Valencia, INTSORMIL Central America Coordinator and Bill Rooney, Sorghum Breeder, Texas A&M University.

Summary:
Scientists from the INTSORMIL-CENTA project based at the National Center for Agricultural Technology and Forestry (CENTA) of El Salvador have worked for five years to develop varieties of sorghum for grain and forage that are highly nutritious to cattle. Using the gene *bmr*-12, they combined commercial varieties CENTA S-2, S-3 CENTA, CENTA RCV and VG 146 and produced 75 new varieties. Plants with the *bmr* gene have low fiber cell wall lignin which makes the plant more readily digestible and allows more nutrients to be absorbed in the stomach of animals. Thus, *bmr* sorghum competes with more expensive maize on the nutritive value level. In addition, sorghum is more resilient to weaterher extremes e.g. flooding and drought and requires less water for production.

Based on the potential impact of these varieties on reducing rural poverty and increasing nutrition USAID/W is supporting a project (2011-2013) to rapidly distribute these CENTA-developed varieties to Costa Rica, Honduras, El Salvador, Guatemala, Panama, Nicaragua and Haiti. Fifteen *bmr* varieties were evaluated in each country in Year 1 and the best performing varieties were selected. These varieties were then evaluated in on-farm field demonstrations and in dairy farm feeding tests in each country in Year 2. Results indicate that dairy farmers had an average increase of 20% in milk production and weight gain of the cattle was 900 g per animal per day (10% increase over conventional sorghum).

El Salvador, Nicaragua, Honduras and Guatemala have already commercially released bmr forage sorghum varieties to dairy farmers in 2012 and further releases will follow in the other countries in 2013. The *bmr* varieties are rapidly spreading throughout Central America. In 2012 there were 8,000 ha of *bmr* varieties and these varieties benefited 5,800

vulnerable households. By 2014 it is projected that these varieties will cover 40,000 ha in Central America and Haiti and will benefit 23,000 vulnerable households.

The *bmr* varieties are poised to have a significant impact on increasing rural income and promoting food security throughout Central America and Haiti. If the entire 388,800 ha of sorghum in these seven countries is in *bmr* sorghum 381,550 farmers would benefit and total income would increase by $163,227,090 per year.

Program Objective: Promote food security, health and nutrition through the dissemination of *bmr* forage sorghum in Central America and Haiti.

Program Goals: To accelerate agriculture growth and improve the nutritional status of the Central American and Haitian rural communities.

Table 1. Main program activities:

Activity		Year 1	Year 2	Year 3
Foundation seed production				
Testing of advanced lines				
On-farm demonstrations				
Varieties released and in on-farm demonstrations				

Primary outcomes/accomplishments:

- 75 *bmr* varieties have been developed at CENTA.
- The best 15 of the CENTA developed *bmr* varieties were evaluated in all countries.
- The two best performing varieties in each country were selected.
- These two varieties were evaluated in on-farm field demonstrations and in dairy farm feeding tests in each country.
- Results indicate that dairy farmers have shown an average increase of 20% in milk production and weight gain of 900 g per animal per day.
- *bmr* sorghum varieties with high yield potential and high quality grain and forage have been made available to dairy farmers through commercial releases by the national programs.
- There are 8,019 ha in *bmr* sorghum in 2012 and this is projected to increase to 41,200 by 2014.

- There are 5,883 vulnerable households benefitting from *bmr* sorghum technology and this is projected to increase to 23,232 by 2014.
- Private companies, national programs, NGOs and artisanal seed producers in each country are producing seed of these varieties with the goal of placing 50 tons on the market in the region by 2013.

Countries where program is active: Costa Rica, El Salvador, Nicaragua, Honduras, Guatemala, Panama and Haiti

Key Partners:

INTA, Costa Rica
CENTA, El Salvador
INTA, Nicaragua
DICTA, Honduras
ICTA, Guatemala
IDIAP, Panama
Chibas-Bioenergy, Haiti

Coordinators:

René Clará Valencia, INTSORMIL – In Region Coordinator
W.L. Rooney, INTSORMIL – Central America Coordinator
E. A. Heinrichs, INTSORMIL – Associate Director

Potential Economic Impact of the *bmr* Project:

Projected yield increase - Research in Central America indicates a 15% increase in grain and forage biomass production. With a total of 502,000 tons of sorghum grain produced in the seven countries a 15% increase in grain production equals a 75,370 ton increase. An increase in forage quantity of 15% at the current 55 ton/ha will result in an 8 ton/ha increase. In addition there will be a significant increase in milk, beef, and poultry production due more nutritive forage.

Projected productivity gains - Based on results of feeding *bmr* sorghums in the U.S., the gains expected should increase milk and meat production by 15% and 10%, respectively in CA and Haiti.

Projected revenue increase - With an average farm income of $1,750 per year for small-holder farmers and $4,500 for medium holder farmers a 15% income would be an increase of $263 for smallholders and $675 for medium-holder farmers. Based on the number of hectares of sorghum and the extent of the dairy and meat industry in each country the total amount of potential increased revenue ranges annually from $320,850 in Panama to $52,191,600 in El Salvador (see table).

Table 2. Projected marginal rate of return on investment

Country	Hectares in sorghum	Sorghum producers (no.)	Income increase per year ($)
Costa Rica	18,000	3,800	1,625,640
El Salvador	101,000	122,000	52,191,600
Guatemala	50,000	56,000	23,956,800
Haiti	89,000	81,000	34,651,800
Honduras	65,800	70,000	29,946,000
Nicaragua	59,000	48,000	20,534,400
Panama	6,000	750	320,850
Total	**388,800**	**381,550**	**163,227,090**

- Marginal rate on return on investment is estimated to be 1.25 (125%).

Year 1 Workplan

Breeders' Seed Production - Fifteen *bmr* sorghum lines of varying pedigree and phenotypic characteristics have already been selected in the CENTA sorghum breeding program (see table below). The 15 *bmr* accessions selected for further evaluation were selected based on their adaptation, good agronomic characteristics, tolerance to major diseases and pests, high grain yield, and high and nutritious forage production. These selections are uniformly brown midrib and have high yield for both grain and forage. CENTA is currently increasing seed of these lines with intent to produce enough seed for multi-environment testing. Seed of these lines will be distributed to cooperators in each country.

Evaluation - A 20-entry test, composed of the 15 selections (Table 1), four common (non-*bmr*) varieties and one local variety (non-*bmr*) will be planted in two environments (defined by planting date) each in Costa Rica, Guatemala, El Salvador, Haiti, Honduras, Nicaragua, and Panama. One trial will be planted in the first planting season (May-June) to identify varieties that produce well in a high rainfall environment (primarily for silage). The second environment in each country will be planted in August to identify the best varieties for the production of grain, forage, and ensilage. Agronomic data (such as but not limited to anthesis, maturity, height and biomass and grain yield, lodging and disease ratings, and composition samples will be collected from each location. Evaluations of the quality of the forage and grains will be completed by INTSORMIL PI (Rooney), who has an equipped NIR (Near-Infrared) spectroscopy analysis laboratory that measures sorghum forage quality parameters such ADF (Acid Detergent Fiber= lignin and thus digestibility values), NDF

(Neutral Detergent Fiber= reflects the amount of forage the animal can consume), IV DMD, (In Vitro Dry Matter Digestibility), etc. Based on agronomic and composition data, a subset of varieties will be selected for validation and seed production.

Activities conducted in Yr 1, 2009-2010: Research

- Planted a breeding nursery of 75 *bmr* sorghum varieties at CENTA, El Salvador to select the best grain and forage varieties.
- Selection of the top 15 varieties (table).

Table 3. Identification of the best varieties in each country

No.	Variety
2	CI 0972 bmr
3	CI 0970 bmr
4	CI 0973 bmr
5	CI 0916 bmr
6	CI 0919 bmr
7	CI 0914 bmr

No.	Variety
8	CI 0910 bmr
9	CI 0925 bmr
10	CI 0929 bmr
11	CI 0932 bmr
12	CI 0936 bmr
13	CI 0938 bmr
14	CI 0943 bmr
15	CI 0947 bmr

No.	Normal Checks
16	CENTA RCV
17	VG-146
18	CENTA S-2
19	CENTA S-3
20	Local check

Once the evaluation of year 1 is completed, three lines will be validated with additional testing in year 2. These trials will be replicated for data collection but they will also be used as demonstration plots to sow the local producers the potential of the new varieties. At the end of year 2, the best lines in each country will be provided to seed companies for seed multiplication. During and at the end of year 2, certified seed of the selected varieties will be provided in limited amounts (10 and 20 kg) to local farmers.

At the end of year 3, we expect that *bmr* varieties will be commercially released in each country and seed made available for multiplication by small seed companies and/or producers. The seed quantity produced in each country will be dependent on the demand.

Farmer explaining the performance of the 15 *bmr* varieties and check varieties in his field, El Ejido, Panamá.

Table 4. Selection of *bmr* varieties in each country- Yr 1.

Country	*bmr* varieties selected
Guatemala	CI0925, CI0929, CI0932, CI0936, CI0943, CI0947
El Salvador	CI0925, CI0929, CI0947, CI973
Honduras	CI0910, CI0929, CI0947
Nicaragua	CI0938, CI0943, CI0947
Costa Rica	CI0916, CI0919, CI0925, CI0929, CI0936
Panamá	CI0929, CI0943, CI0947 CI0968
Haití	CI0947, CI0929

Participants in the dissemination of new *bmr* varieties - Private companies, government extension, NGOs, and host country scientists will participate in the dissemination of the varieties selected in each country.

Activities conducted in Yr 2, 2011-2012: Validation

Sorghum breeders and extension personnel observing the performance of *bmr* varietes being evaluated in a farmer's field in Zacapa, Guatemala, 03/29/2011.

Table 5. Selection of bmr varieties based on testing in farmers' fields-Yr 2.

Country	Validation on farmers' fields	Varieties selected for commercial release
Guatemala	CI0925, CI0929, CI0932, CI0936, CI0943, CI0947	CI0929, CI0947*
El Salvador	CI0925, CI0929, CI0947, CI973	CI0929, CI0947*
Honduras	CI0910, CI0929, CI0947	CI0910, CI0929*
Nicaragua	CI0938, CI0943, CI0947	CI0943, CI0947*
Costa Rica	CI0916, CI0919, CI0925, CI0929, CI0936	CI0919, CI0929**
Panamá	CI0929, CI0943, CI0947 CI0968	CI0929, CI0943**
Haití	CI0947, CI0929	CI0947*, CI0929

***Commercially released in 2012**

****To be commercially released in 2013**

CI-0910 *bmr* forage sorghum, San Andrés, El Salvador.

CI-0919 *bmr* forage sorghum, Guanacaste, Costa Rica.

CI-0929 *bmr* forage sorghum, San Andrés, El Salvador.

Prof. Lloyd Rooney, Texas A&M, observing CI-0943 *bmr* forage sorghum, CENTA, San Andrés, El Salvador.

CI-0947 *bm*r forage sorghum, San Andrés, El Salvador

Activities conducted in Yr 3, 2012-2013: Seed Production and Transfer to Farmers

- Increase of basic seed of the varieties selected in farmer field testing for use in the production of certified and artisanal seed**.**
- Official release by national governments of the varieties selected.
- Production of certified and artisanal seed by private seed companies and artisanal seed production associations.
- Transfer of seed to producers and training of producers in the art of producing their own seed for future plantings.

Bagging *bmr* forage sorghum seed for distribution to farmers, Santa Crúz Porrillo, El Salvador, 01/04,2011.

Table 6. *bmr* varieties to be transferred to producers in each country- Yr 3.

Country	*bmr* varieties selected
Guatemala	CI0929, CI0947
El Salvador	CI0929, CI0947
Honduras	CI0910, CI0929
Nicaragua	CI0943, CI0947
Costa Rica	CI0925, CI0929
Panamá	CI0929, CI0943
Haití	CI0929, C0947

Table 7. *bmr* varieties of which seed is available for certified and artisanal seed production for Yr 2013-2014 in each country.

Country	*bmr* varieties (seed available for 2013-2014 sowing)
Guatemala	CI0929, CI0947
El Salvador	CI0929, CI0947
Honduras	CI0910, CI0929
Nicaragua	CI0943, CI0947
Costa Rica	CI0925, CI0929
Panamá	CI0929, CI0947
Haití	CI0929, CI0947

Table 8. In vitro digestibility of *bmr* sorghum varieties distributed to the farmers in Central America.

Variety	TND (%)	IV DMD (%)	IV DMD (tm/ha)
CI0947 *bmr*	63.7	76.9	9.34
CI0929 *bmr*	60.2	80.7	10.07
CI0910 *bmr*	61.9	63.5	10.33
CI0943 *bmr*	62.8	81.7	9.40
CI0925 *bmr*	63.8	77.9	9.65
CI0936 *bmr*	63.6	71.1	8.72
Normal Check (Sureño)	63.7	63.5	8.71

TND= Total nutrient digestibility; IV DMD= In vitro dry matter digestibility

Dairy cows feeding on *bmr* sorghum forage, Ipala,Chiquimula, Guatemala, 11/30/2012.

File: EAH/bmr workplan and progress report 2010-2012 02 2013