Seventh framework programme
Food, Agriculture and Fisheries, and Biotechnology

Specific International Co-operation Actions
Small or medium scale focused research project

Sweet Fuel

Sweet Sorghum
an alternative energy Crop

Grant Agreement n° 227422

Deliverable 3.22:

Five sweet sorghum varieties (R-lines) with $ma_5ma_5Ma_6Ma_6$ and $Ma_5Ma_5ma_6ma_6$ genotype

Composition of the consortium

CIRAD
ICRISAT
EMBRAPA
KWS
IFEU
UniBO
UCSC
ARC-GCI
UANL
WIP

During the development of the SweetFuel project in 2008 and 2009, it was our understanding that it would be necessary to develop sorghum lines with the contrasting genotypes for the maturity genes (Ma_5,ma_5 and Ma_6,ma_6) to develop photo insensitive (PI) sorghum lines with the genotypes $ma_5ma_5Ma_6Ma_6$ *and* $Ma_5Ma_5ma_6ma_6$ that flower in approximately 60 – 70 days after planting indifferent to day length. The hybrids developed from the cross of these lines would produce photosensitive (PS) hybrids ($Ma_5ma_5Ma_6ma_6$) that flower when the day length is less than 12 hours and 15 or 20 minutes. Initially we had difficulty in obtaining genetic sources with the contrasting genotypes $ma_5ma_5Ma_6Ma_6$ *and* $Ma_5Ma_5ma_6ma_6$, due to questions regarding IP. However, we were able to develop photosensitive hybrids using PI male sterile female lines with the recessive maturity gene ma_1ma_1 and PS male pollinator lines with the dominant Ma_1Ma_1 by planting in March when both PI and PS genotypes flower simultaneously to produce PS hybrids Ma_1ma_1.

Several experimental PS hybrids (Ma_1ma_1) have been generated and evaluated for biomass production. We are currently in the process of releasing CMSXS 7015 as BRS 7016, a biomass photosensitive hybrid developed by Embrapa Maize and Sorghum to meet the growing demand for complementary feedstock as an alternative to sugarcane for second generation ethanol production and co-generated energy. This cultivar has high yield potential of fresh biomass (average 150-190 t ha^{-1}), and dry biomass (50-60 t ha^{-1}) and high levels of fiber content (22-28%), low moisture in biomass (50-60%), resistance to lodging and to major pathogens. Average maturity cycle for the harvest is about 150-180 days after sowing. The photograph below shows the development of CMSXS 7015 about 150 days after planting.

In 2013 we were able to acquire sources of the genotypes $ma_5ma_5Ma_6Ma_6$ *and* $Ma_5Ma_5ma_6ma_6$ *that* flower in approximately 60 – 70 days after planting. We made the first crosses and back crosses to sweet sorghum B and R lines in 2013/14. Completing the backcrossing process over the next two years, we will be able to produce PS sweet sorghum hybrids taking advantage of the breeding and improvement progress made with PI sweet sorghum lines.

We completed an evaluation trial with 20 experimental PS biomass hybrids in 2012/13 and 2013/14 to identify additional biomass hybrids to register and release during the next 12 months. The following table demonstrates the dry matter productivity potential of four experimental hybrids in Minas Gerais State of Brazil in 2012/2013 (t ha^{-1}).

Biomass Hybrid	Nova Porterinha (MG)	Sete Lagoas (MG)	Santa Vitoria (MG)	Average
CMSXS7000	21.2	42.0	38.2	33.8
CMSXS7007	18.2	57.0	27.2	28.4
CMSXS7015*	35.7	52.8	39.2	42.6
CMSXS7018	25.5	69.6	37.4	44.1
Forage Hybrid	13.2	15.8	12.7	13,9
Average (Biomass)	25.2	45.8	35.5	35.5

*Registration and Release programmed for 2014.

The potential biomass production of five new Embrapa biomass hybrids evaluated in Uruguay 2013/14 in a temperate climate similar to Southern Europe is demonstrated in the following table.

Experimental Biomass Hybrid (Embrapa)	Plant Height (m)	Fresh Biomass Production (t ha^{-1})	Dry matter (%)	Dry Matter Production (t ha^{-1})
1	4.8	84.3	29	24.3
2	4.9	124.3	26	32.6
3	5.0	100.7	22	21.8
4	4.8	131.1	28	37.1
5	4.9	89.3	28	25.3

This clearly demonstrates that PS biomass sorghum has a potential in both temperate and tropical climates. There is a longer growing period (up to eight months) in a tropical environment but with less hours of sunlight per day and a shorter growing period (up to six months) but with longer days and a potential of 40 t ha^{-1} or more dry matter production.