



**Seventh framework programme  
Food, Agriculture and Fisheries, and Biotechnology**

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



# Sweet Sorghum an **alternative energy Crop**

**Grant Agreement n° 227422**

## **Deliverable 7.8:**

*Validation of the concept in Brazil and India*



### Composition of the consortium

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

## In Brazil

The current (06/2014) energy sorghum scenario in Brazil is to crop sweet sorghum to complement the sugarcane production during the off season, particularly during the two months (March and April) preceding the beginning of sugar cane harvesting.

In 2009 and 2010, several entities of the private seed sector promoted using sorghum hybrids that were not sweet sorghum hybrids, but forage sorghum hybrids with juicy stem but low or intermediate sugar levels in the juice. The seed companies promised ethanol yields of greater than 2500 liters per hectare, but pilot demonstration with the sugarcane sector only produced between 800 or less and 1200 liters per hectare. These levels were not sustainable and did not give satisfaction to the sugarcane sector.

This negative experience of low ethanol production of several large distilleries coupled with government policy to maintain the price of gasoline at lower levels has also had the effect to put a cap on ethanol prices near or below production costs which has been a strong factor in reducing the adoption of sweet sorghum for ethanol production.

However in 2011, EMBRAPA developed a partnership with the sugarcane sector to promote sweet sorghum. Improved varieties developed at EMBRAPA were provided to some distilleries and reached in pilot and demonstration areas a production of 2500 liters per ha. The sugarcane sector was a little skeptical before experimenting sweet sorghum, but quickly saw the value of cropping sweet sorghum to complement the sugarcane production. As sweet sorghum is harvested and transformed the same as sugarcane (see photos here under), without investing in equipment and extending his area of production, an industrial can increase the operating window of his plant and of course increase his production (up to 25%). In addition, the bagasse issued from juice extraction has a good caloric value and can be burnt like sugarcane to generate electricity.

Even if there are still significant problems to solve in the production system (geometry of plantation, adaptation of new harvesters etc...), we can reasonably expect a great future for sweet sorghum in Brazil. It has already been able to reach good results with EMBRAPA sweet sorghum varieties reaching 2500 and 3000 liters per hectare in pilot scale demonstration. Embrapa released three Embrapa developed sweet sorghum varieties in 2013. First year experimental hybrids from Embrapa were very promising in 2013/2014 and we expect to release commercial hybrids in 2016.

For more information on harvest and transformation of sweet sorghum stalks to produce ethanol, watch the film produced in 2012 by EMBRAPA at:

<http://www.sweetfuel->

[project.eu/sweetfuel\\_events/complementation\\_of\\_sugar\\_cane\\_by\\_sweet\\_sorghum\\_in\\_brazil](http://www.sweetfuel-project.eu/sweetfuel_events/complementation_of_sugar_cane_by_sweet_sorghum_in_brazil)



Harvest sweet sorghum with a sugarcane harvester



Notice that panicles are cut down and stay on the ground



Delivery of stalks to the pant



Extraction of the juice from the first mill



6 mills for an efficient juice extraction (>99%)



Bagasse is conveyed to be burnt





Distillation tank



Quality control of ethanol

## In India

The improved sweet cultivars of Sweetfuel i.e. ICSV 93046, ICSV 25299 and ICSV 25306 were evaluated in two sugarmill regions i.e. Sri Datta sugarmill and Jawahar sugarmill in Kolhapur district of Maharashtra along with national check CSV 24SS in one acre area at each of the location. Kolhapur region is the sugarbowl of India. The sugarmill staff was trained at ICRISAT on sweet sorghum cultivation practices. The crop at both the locations is satisfactory and the data is given below. The varieties ICSV 93046 and ICSV 25299 recorded 3713 L/ha and 2693 L/ha ethanol (96% purity) yield respectively. As the seed of ICSV 93046 resemble more like traditional M-35 variety the farmers in that area want to go for large scale cultivation in Jawahar sugar mill area.



Sweet sorghum beside sugacane plantation



ICRISAT sweet sorghum hybrid with good grain production which is essential for small farmers



Other site where sugarcane and sorghum are combined



Mill for juice extraction from sugarcane before cristalization for sugar production

The sugarmill management is now fully convinced that sweet sorghum could be a viable feedstock for enhancing the operational window of their distilleries for production of transport grade ethanol for use in the national blending program. However the oil marketing companies who purchase the ethanol from sugarmills are looking for lower prices than the quoted Rs 40-42. The system is economically viable as farmers could get benefit from Rs 17018 to Rs 50241/ha by sale of grain and stalk at market prices while the distillery could get benefit excluding processing costs Rs33768 and Rs 64242 (sale price of ethanol: Rs 38/lit).

**Table 1. Sweet sorghum demonstration data at Jawahar sugar mill, Kolhapur, Maharashtra**

Parameter	CSV 24 SS	ICSV 93046	ICSV 25299	ICSV 25306
Plant height (m)	1.83	2.75	2.13	2.16
Days to 50% flowering	70	82	78	80
Stalk yield (t/ha)	37.52	58.41	61.71	53.15
Juice yield (t/ha)	11.82	21.96	19.40	18.27
Bagasse yield (t/ha)	25.61	36.36	41.32	32.94
Initial Brix%	17.91	19.51	17.61	15.66
Grain yield (t/ha)	3.46	2.72	2.51	3.54
Ethanol yield per M.T.	40.67	52.02	49.37	34.06
Total ethanol yield (L/ha)	1981	3713	2693	2006

**Table 2. Sweet sorghum demonstration data at Shri Datta sugar mill,Kolhapur, Maharashtra**

Parameter	CSV 24 SS	ICSV 93046	ICSV 25299	ICSV 25306
Plant height (m)	2.26	2.42	2.64	2.71
Days to 50% flowering	67	77	72	75
Stalk yield (t/ha)	48.71	71.38	54.54	58.90
Juice yield (t/ha)	22.28	34.42	14.18	13.54
Bagasse yield (t/ha)	25.81	36.22	40.02	44.66
Initial Brix%	15.34	18.24	16.64	15.21
Grain yield (t/ha)	3.25	2.97	2.65	2.75