



**Sweet sorghum as a feedstock for combined
production of biofuel and green power
opportunities and applicability for the restructuring of the
Italian sugar industry**

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etaflorence ✱ renewableenergies

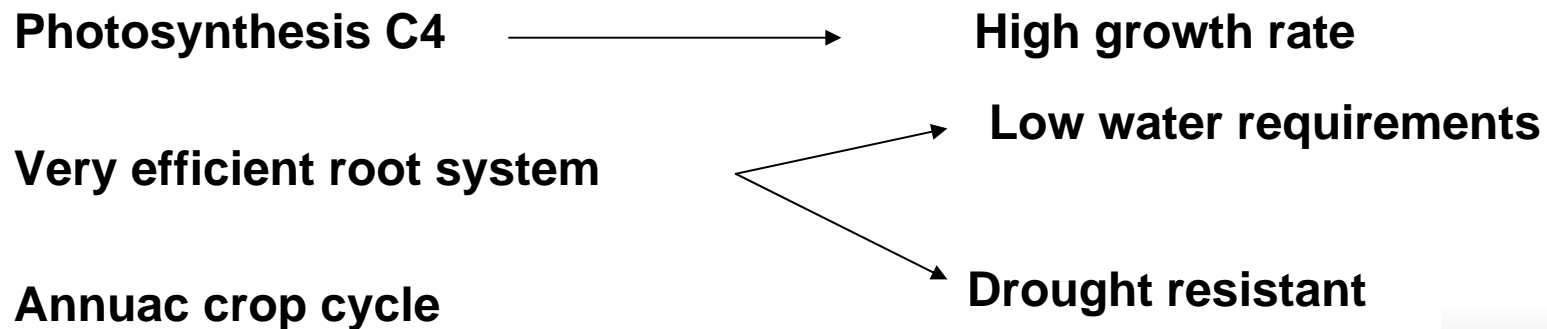
Sweet Sorghum

Botanical and Agronomical Aspects

Scientific Name: *Sorghum bicolor* L. Moench

Family: Graminae

Origin: Northern and East Africa



Traditional use: forage, concentrated syrup (USA)

Sweet Sorghum

Botanical and Agronomical Aspects

Lateral shoots

Stems up to 5 m height – pithfilled stems



Inflorescence: panicule

(1.000-5.000 seeds)

Self-pollinating

**Leaf area smaller
than mais**



Strong root system

Tillering sprouts



Sweet Sorghum

Agronomical Aspects

Minimum tolerated temperature: 7-10°C

Optimal growth temperature: 27-30°C

Water requirements: 500-600 mm

Soil requirements: tolerant to salty and alkali soils (pH 5.0-8.5),

Nutritional requirements: high mineral absorption efficiency

Fertilization: 120-150 Kg/ha N; 60-70 Kg/ha P₂O₅; 60-120 K₂O

Cultivar and genetic improvement

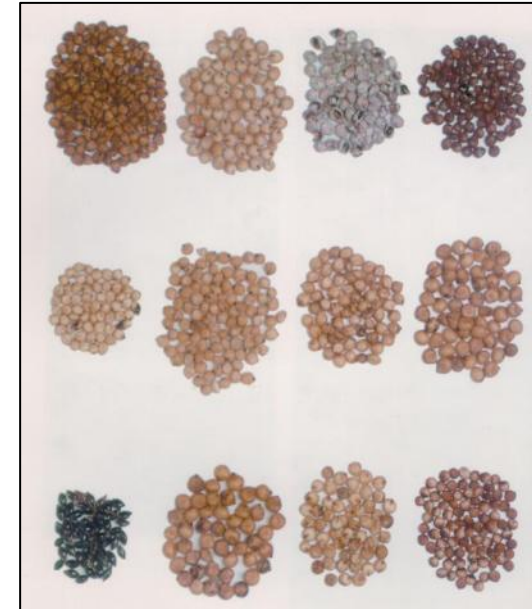
The first experiences of genetic improvement date back to 1850 in USA (Cv. Amber from China)

Hybridization trials at the beginning of XX century

Several varieties developed between 1920 and 1950

In Italy several varieties tested in 2000-2001 (ECHI-T project)

9 genotypes selected as very promising: Keller, Mn, Dale, Wray, Theis, M81-E, AT623XRoma, Chinese1



In Germany: evaluations, trials and genetic improvement since early '90, with good results at 52°

Ongoing research programs in USA, INDIA, BRASILE, CINA

Some selected traits: adaptation to temperate climates, fermentable sugar content, resistance to logging

Yield

70-90 t/ha fresh biomass

Average productivity

5-7 t/ha grains

6-7 t/ha sugar

Distribuzione del peso

Stalk: up to 75%

Leaves: 10-15%

Grains: 7%

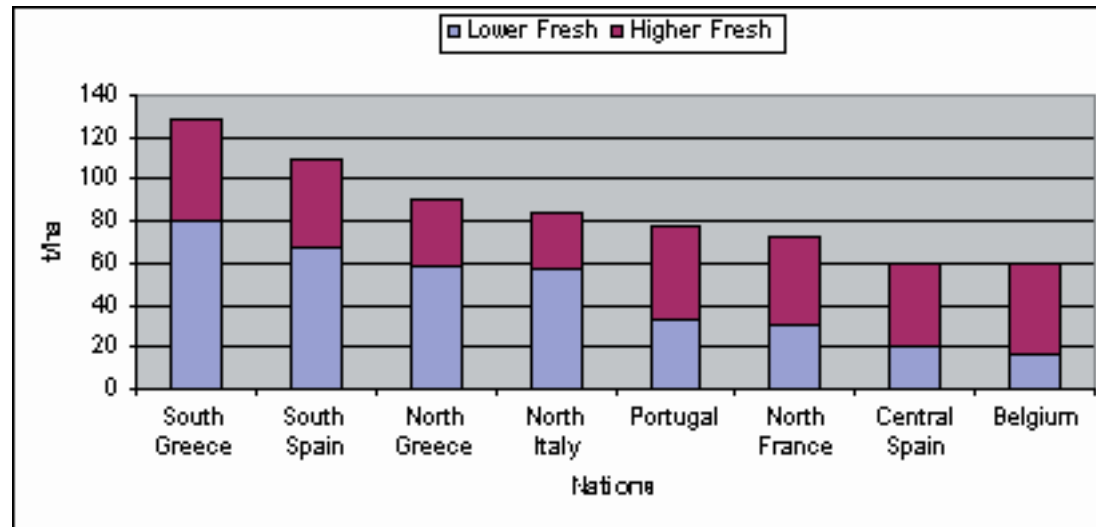
Roots: 10%

Ethanol yield (sugar + starch): 5.500 up to 6.000 l/ha

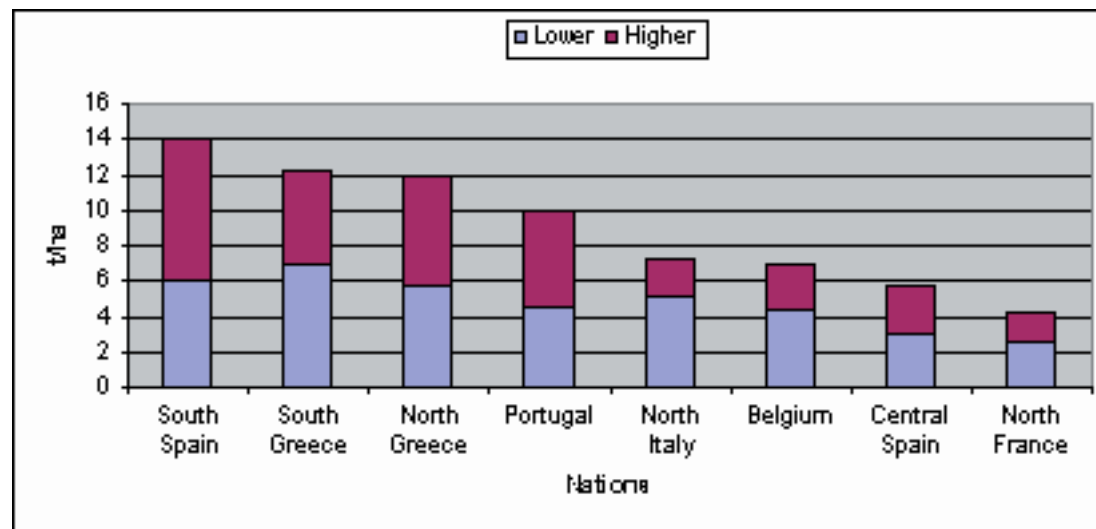
in tropical climates two harvests per year are possible!

Yield

Fresh biomass



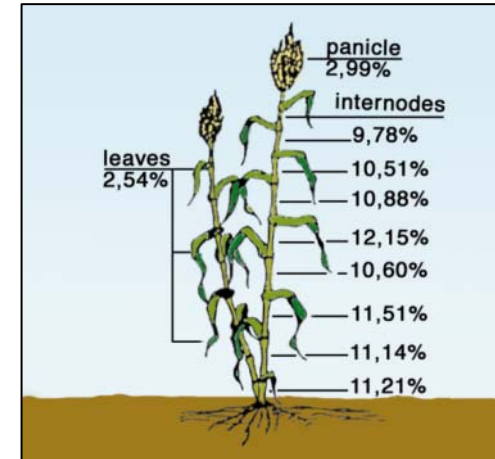
Sugar



Source: Eubia

Sugar Content

Contained in the stalks, can be extracted by mechanical extraction or diffusion



Over 14 different sugars - the main ones:

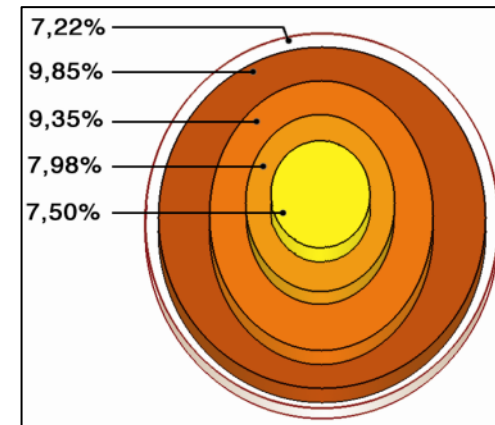
Saccharose

Glucose

Fructose

Homogeneous distribution of sugars

in the stalks



Harvesting

Several prototypes of dedicated sweet sorghum harvesters were developed in Italy between '80 and '90



	Tanesini Prototype	Pasquali Prototype	Otma Prototype
Harvesting speed (km/h)	0,68	0,78	0,71
Effective capacity (ha /h)	0,08	0,109	0,05
Harvesting time (h/ha)	12,5	9,16	20
Power (kW)	60	58,8	Towed
Lenght of harvested product (mm)	Entire stalk without leaves	Entire stalk without leaves	300

Harvesting

Crop requirements for harvesting

Need to separate panicles and leaves from the stalks where juice is contained

Need to prevent sugar juice in the stalks from fermentation during transportation and storage

Requirements similar to those of sugarcane harvesting

THEREFORE

The best identified solution so far for sweet sorghum harvesting is the adaptation of sugarcane harvesters



CLAAS CC 1400 sugar cane harvester

Harvesting



Cutting of panicles



Separation of leaves



Cutting of stalk in billets 20 cm



125 kW – 4,3 Km/h

Very good performance and productivity

60 t/h
or
0,7 Ha/h

BUT

Size too big for transportation on road (9 X 4,5 m), need for adaptation

STORAGE

Fermentation starts soon after harvesting

Loss of sugar during storage

The largest the size of harvested stalks, the better and longer is the conservation fermentable sugars before extraction

Harvester	Corn chopper	Pasquali and Tanesini prototype	Otma prototype and Claas CC 1400 harvester
Lenght of harvested product (mm)	5-20 mm	Entire stalk	300 mm
Cubic mass	350 kg/m ³	150 kg/m ³	225 kg/m ³
Sugar losses after 6 hours	25%	-	-
Sugar losses after 5-7 days	>50%	4-5%	10%
Sugar losses after 28-30 days	>>50%	18-20%	24-28%

