ANAEROBIC DIGESTION OF SWEET SORGHUM BAGASSE AS A STRATEGY TO INCREASE THE VALUE OF THE CROP IN THE CONTEXT OF A BIOENERGY SUPPLY CHAIN

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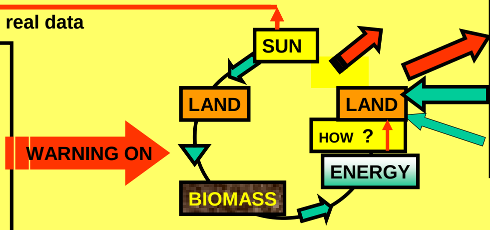
Quantitative real data

The Tranformity Triangle

TRASFORMITY VALUES SEJ
(Solar Energy Joul)

Solar Energy	1
Rain	18190
Fertile soil	73770
Fuels	20.000-80.000
Crops	20.000-200.000
Elettricity	50.000-300.000
Fertilisers	10^6 - 5. 10^7
Human work	10^6 - 10^9



- **Thermochemical** (combustion, gasification, pyrolisis)
- **Biochemical** (biogas, bioethanol)
- **Pseudo-Chemical** (biodiesel)

SORGHUM : MAIN CROSSOVER EFFECTS and OBJECTIVE BENEFIT ON LAND

TECHNOLOGY T1	TECHNOLOGY T2	T1 and T2	Integration effect on	Integration effect on	main to LAND benefit from
Thermochemical Bagasse gasification	Biogasification	T and Bg	T + gas energy value some by-products to Bg(1)	Bg + possible thermophilic	B org. matter T ashes (*)
Thermochemical Bagasse pyrolisis	Biogasification	T and Bg	T some by products to Bg	Bg + possible thermophilic	B org. matter
Thermochemical Bagasse combustion	Biogasification	T and Bg	----	Bg + possible thermophilic	B org. matter T ashes (2)
Bioethanol	Biogasification	Be and Bg	Be + electrical power	Bg + good substrate	Bg
Biodiesel	Biogasification	Bd and Bg	Bd + electrical power	Bg + good substrate	Bg

(1) To be proved with biogasification experiments
(2) To be used carefully, may be a long-term environmental problem

BIOGASIFICATION SEEMS TO BE A NICE BRIDGING BETWEEN BIOENERGY AND LAND

BIOGASIFICATION OF SORGHUM (Bicolor L. Moench, Keller Variety)

4 liters (hydrolysis reactor) + 10 liters (methanogenic ractor)

Substrate characteristics

Bagasse
typical chemical analysis
Variable with storage time

Dry Matter 105 °C	%	31.4
Humidity	%	68.6
D.M 550°C		90,7
Organic Carbon	% d.m.	67.5
Lignin	% d.m.	17.8
Avl. Org. Carbon C. Org - Lignin	% d.m.	49.7
P total	mg/kg d.m.	1809
KTN	mg/kg d.m	8917
Org. Carbon	% w.m.	21.7
Avl. Org. Carbon*	% w.m.	15.6
P total	mg/kg w.m.	568
KTN	mg/kg w.m.	2800
COD 10g/200 ml	mg/l	1240
C/N		75.8
C_avl : N		55.8
C:N:P		373:5:1
C_avl : N:P		276:5:1

* ±15%

Fresh sweet sorghum extract
Variable with material dimentions and storage time

Initial sugar content of whole plant	% d.m.	35 - 48
Sugar content after 48 h	% d.m.	32 - 43
TSS	g/l	1.75 - 2.06
VSS	g/l	1.68-1.94
KTN	mg/l	21 - 26
P total	mg/l	31 - 38
Carbohydrates	g/l	15.2 – 22.6
Total COD	g/l	16,7 - 24.3
Soluble COD	g/l	14.6 - 20.3

Continuous Biogasification Results

Bagasse

Process type 35-37 °C	Biogas yield l/g VSSadd	CH_4 %	HRT days
One-phase CSTR	0.24-0.27	65-67	16
One-phase CSTR Thermal Pre-hyodrolised bagasse (60-65°)	0,28-0,30	66-67	10
One-phase CSTR lab sonicated bagasse	0.26-0.27	67-68	16
(1) One-phase CSTR + bovine rumen (5- 30%)	0.35-0.41	70–73	16
(2) One-phase CSTR MPC	0.33-0.38	63-66	16
Two-phase CSTR	0.30-0.32	69-72	2+8
(3) Two-phase CSTR Hydr. 45°C Methan. 37° C	0.37-0.40	69-72 H_2 14 %	0.5+8

Fresh sweet sorghum extract

Process type 35-37 °C	Biogas yield l/g VSSadd	CH_4 %	HRT days
One-phase CSTR	0.28-0.30	66 ±2	12
One-phase CSTR MPC*	0.32-0.35	68 ±3	15
Two-phase CSTR	0.34-0.35	69±3	1+8
Two-phase CSTR** Hydr. 45°C Methan. 37° C	0.34-0.35	70±3 H_2 18 %	0.5+8

(1) SerecoBiotest-RR Process
(2) SerecoBiotest-MPC reactor (Microbial Proximity Concept) no mixing applied
(3) To attain max yield the parameters of the process (pH, temerature, flow rate of transfer from H to M reactors) needs to be real time controlled (ANN control implemented).

work in progress on fermentative H_2 generation followed by AD with CH_4 production

see G.Antonopoulou et al. Bioresource Technology 99 (2008) 110-119 and ref. therein