

## POTENTIAL OF SUGARCANE AS A RENEWABLE SOURCE OF ENERGY IN BANGLADESH—AN ASSESSMENT

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### ABSTRACT

The relevant information regarding production of sugarcane, sugar and its by-products in Bangladesh were collected from different sources. The energy potential of sugar and the by-products of sugarcane were computed and analyzed. Based on ten years data from 1981 to 1990, the average annual production of sugarcane is  $6.97 \times 10^6$  tons and the average annual net energies productivity of this sugarcane is  $24.7764 \times 10^9$  MJ of which  $22.82 \times 10^9$  MJ is from biomass (bagasse + leaves & tops) and  $1.9537 \times 10^9$  MJ is from molasses. These energy obtainable from biomass and molasses may be used commercially for the production of electricity and motor fuel to minimize the energy crisis of the country and to reduce the dependence on foreign grants for energy production systems.

Key words : Sugarcane, Biomass, Renewable energy

### INTRODUCTION

The reserves of the conventional fuel sources are limited and is being exhausted day by day. The present trend of research is, therefore, focussed on the exploitation and efficient use of renewable sources of energy.

Renewable energy sources on the earth include wind power, hydro-power, solar energy, animal energy and biomass which contribute to around 25% of the world's primary energy needs. The largest energy contributors are biomass and hydro-electricity which contribute about 14% and 5% respectively. In developing countries around 35% of energy needs are met from biomass and the countries such as Ethiopia, Rwanda and Sudan receiving over 90% of their primary energy from biomass. In rural China and India over 75% of the energy comes from the biomass (Gregory, 1992).

Sugarcane, grown in both tropical and sub-tropical areas, is one of the most efficient harvesters of solar energy. This is one of the few crops from which each and every part of the plant could be converted into useful energy. Solomon *et al.* (1988)

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have assessed energy producing capabilities of sugarcane in tropical and sub-tropical climate and rated it as a most promising energy crop. Apart from sugar and molasses, biomass productivity of sugarcane is comparatively higher which makes it economically viable for industrial production of combustible gases, charcoal, briquettes, paper, power alcohol and electricity.

In Bangladesh about 166.5 thousand hectare land area is under sugarcane cultivation producing about 6.97 million tons of sugarcane each year, which can be a major source of energy (Table 1).

The main aim of this study was to explore sugarcane (sugar and sugarcane by-products) as the alternate energy production source to save valuable foreign currency of the country.

Table 1. Area, production and yield of sugarcane in Bangladesh

Year	Area (x 10 <sup>3</sup> ha)	Production (x 10 <sup>3</sup> ton)	Year	Area (x 10 <sup>3</sup> ha)	Production (x 10 <sup>3</sup> ton)
1981	148.9	6600	1986	160.3	6640
1982	161.1	7136	1987	164.7	6896
1983	165.9	7257	1988	173.2	7207
1984	166.7	6960	1989	172.0	6707
1985	163.5	6878	1990	187.8	7423

Average area under sugarcane production =  $166.5 \times 10^3$  ha

Average annual production of sugarcane =  $6.97 \times 10^6$  ton

Average yield of sugarcane = 40 to 45 ton/ha

Source : Statistical Yearbook of Bangladesh (1991), p. 148.

## MATERIALS AND METHODS

Ten years' data (from 1981 to 1990) on the production of sugar and the by-products of sugarcane has been collected from 16 sugar mills of the country (Table 2). These data were used to get actual recovery of sugar, bagasse, molasses and alcohol on percent cane basis (Table 3).

The annual sugarcane production in the country is presented in Table 1. The production of sugar, molasses and bagasse in the country can be estimated on the basis of the percentage recovery of the products in the mills. The average production of leaves and tops is assumed to be 30% of the cane (Gurumurthy, 1988).

Table 2. Production of sugar, molasses, bagasse and alcohol in sixteen sugar mills

Year	Sugarcane crushed (x 10 <sup>6</sup> tons)	Production in thousand metric tons			Production of alcohol (x 10 <sup>3</sup> ton)
		sugar	molasses	bagasse	
1981	1.77	140.674	66.740	637.105	11.960
1982	2.47	202.168	92.495	890.432	16.575
1983	2.22	181.355	81.503	798.098	14.605
1984	1.90	151.353	70.202	683.939	12.580
1985	1.18	87.849	43.893	423.574	7.866
1986	1.02	82.498	38.080	366.908	6.824
1987	2.29	181.925	85.994	833.252	15.410
1988	2.20	178.260	83.323	786.961	14.931
1989	1.33	110.000	48.698	478.915	8.727
1990	2.10	183.862	76.010	754.633	13.621

Source : Sugar mills of Bangladesh.

Table 3 The composition of sugarcane as obtained during processing in the mills

Product	Percent (by weight) of cane		
	Range		Average
Sugar	7.48 — 8.77		8.13
Molasses	3.63 — 3.79		3.72
Bagasse	35.78 — 36.44		36.00
Filtercake	3.52 — 3.66		3.59
Water	47.79 — 51.00		48.50

The estimate of alcohol production is based on the fact that there is 224 liters of alcohol in each ton of molasses and the specific weight of alcohol is 0.80 kg/L (More et al., 1985).

The energy content of bagasse, leaves and alcohol has been calculated based on their average annual production and their average calorific values taken from different sources (Table 4).

Calculations were made according to the following formulations using BASIC programming in a personal computer.

Let  $W_{sc}$  = Annual average production of sugarcane, metric tons

X = Percent recovery of the product, kg

Then the weight of the product,

$$W_p = W_{sc} \times X \times 1000 \times (X/100) \quad \dots \dots \dots (1)$$

The production of alcohol ( $W_{alc}$  liters) from molasses can be estimated as follows.

$$W_{ale} = W_{sc} \times (X/100) \times 224 \quad \dots \dots \dots (2)$$

Let  $H$  = calorific value of the product in KJ/kg.

Then energy content of the product in MJ and kWh is given by the eqn (3) and eqn (4) respectively.

$$E_{MJ} = W_p \times H \times 10^{-3} \quad \dots \dots \dots (3)$$

$$E_{kWh} = E_{MJ} / 3.6 \quad \dots \dots \dots (4)$$

The net energy available from each product and by-product is the value in eqn (3) multiplied by the efficiency of the conversion system. The energy content of filter cake and the water has been neglected in calculating the total energy content of sugarcane.

## RESULTS AND DISCUSSION

The compositions of sugarcane (10 years average of 16 mills) is shown in Table 3. Sugarcane after processing gives sugar, molasses, bagasse, filter cake and water. The percentage of sugar and the by-products were found to vary within the ranges shown against them in Table 3. The estimate of energy content of each of these product and by-products are shown in Table 5.

Table 4 The average calorific values of sugar and the sugarcane by-products

Product	Heat value (kJ/kg)	Reference
Sugar	16.7	Kenneth et al. (1970)
Molasses	25116.0	Maheshwari et al. (1981)
Bagasse	15906.8	Singh et al. (1980)
Leaves & tops	14408.2	Kumar et al. (1984)

Table 5 Estimated energy potential of sugar and sugarcane by-products in Bangladesh

Product	Average production ( $\times 10^3$ ton)	Energy available	
		( $\times 10^6$ MJ)	( $\times 10^6$ kWh)
Sugar	566.061	2.85	0.79
Molasses	259.284	1953.65	542.68
Bagasse	2509.2	11974.0	3326.11
Leaves & tops	2509.2	10845.92	3012.75
Sugarcane	5844.345	24776.42	6882.33

The annual available energy from sugar, molasses, bagasse and leave & tops are  $2.85 \times 10^6$  MJ,  $1.9537 \times 10^9$  MJ,  $11.974 \times 10^9$  MJ and  $10.846 \times 10^9$  MJ, respectively assuming a fixed and gross value of 30% conversion efficiency (More *et. al.*, 1985).

Out of total available energy,  $2.85 \times 10^6$  MJ energy from sugar is utilized through human consumption;  $1.9537 \times 10^9$  MJ energy from molasses is used as medicine, drink (i. e. alcohol) and animal feed;  $11.974 \times 10^9$  MJ energy from bagasse is utilized as fuel for the mills' boilers and domestic cooking and as raw material for paper;  $10.846 \times 10^9$  MJ energy from the leaves and tops is utilized as animal feed and domestic fuel. Renewable energy obtainable from biomass ( bagasse + leaves & tops ) totaling to  $22.82 \times 10^9$  MJ has the commercial potentiality, if managed properly, for the production of motor fuel (power alcohol) and electricity.

### CONCLUSIONS

Average annual energy productivity of sugarcane based on ten years' data from 1981 to 1990 is  $24.7764 \times 10^9$  MJ of which  $22.82 \times 10^9$  MJ is from biomass and  $1.9537 \times 10^9$  MJ is from molasses. The biomass energy may be used commercially to minimize the energy crisis of the country and to reduce the dependence on foreign grants for energy production systems.

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