IDRC–114e

Cassava Harvesting and Processing

PROCEEDINGS OF A WORKSHOP HELD AT
CIAT, CALI, COLOMBIA
24–28 APRIL 1978

EDITORS: EDWARD J. WEBER
JAMES H. COCK
AMY CHOUINARD

CASSAVA HARVESTING AND PROCESSING IDRC-114e

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IDRC
Centro Internacional de Agricultura Tropical (CIAT) IDRC-114e
Cassava harvesting and processing: proceedings of a workshop held at CIAT, Cali, Colombia, 24–28 April 1978. Ottawa, IDRC, 1978. 84 p.

/IDRC publication/. Report of a workshop on /cassava/ /harvesting/ and /food processing/ – discusses /feed production/, /drying/ /food technology/, effects of chip size and shape; /starch/ extraction, use of cassava /flour/ in /food preparation/, cassava /fermentation/ for /fuel/ /alcohol/ production. /List of participants/.

UDC: 633.68 ISBN: 0-88936-188-6

Microfiche edition available

IDRC-114e

Cassava Harvesting and Processing

Proceedings of a workshop held at CIAT, Cali, Colombia, 24–28 April 1978

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International Development Research Centre
and the
Centro Internacional de Agricultura Tropical, CIAT

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Prospects of Cassava Fuel Alcohol in Brazil

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Centro de Tecnologia Promon, Rio de Janeiro, Brazil

Abstract. Alcohol production in Brazil increased 100% in 1 year and will continue to rise rapidly in the next 10 years, reflecting the government's plans to expand the use of ethanol as a motor fuel. Sugarcane alcohol constitutes a major proportion of the current increase, but cassava alcohol is expected to account for much of the growth later on. Production of the latter is expected to receive marked impetus from agronomic improvements and better processing technology.

In Brazil, alcohol production from fermented vegetable products (ethanol) has increased 100% in 1 year, owing partly to financial incentives offered by the National Alcohol Program and partly to the low sugar price on the international market (Yang and Trindade 1978). By 1980, the Brazilian government forecasts that production will even outstrip official estimates (Brazil Industry and Commerce Ministry 1978), and by 1985 it is expected to reach 4–6 million m^3, providing that the present trend continues. More than half the output will come from the 163 projects approved to February 1978 by the National Alcohol Committee; the new projects are more capital intensive and target-oriented than existing units.

Cassava alcohol production alone is projected to reach 1 million m^3 by 1985 (Fig. 1), starting from a standstill in 1978. The first cassava alcohol distillery, which is owned by the Brazilian oil monopoly Petrobras, has a capacity of 60 000 m^3/day.

The increase in production corresponds to new plans and patterns for alcohol consumption. In 1975, the pharmaceutical, cosmetics, etc. industries dominated consumption, accounting for 50.9% of the total produced; fuel alcohol and the chemical industry represented only 35.6% and 13.5%, respectively. In 1985, fuel alcohol is expected to constitute 73%, the chemical industry 20%, and other industries, a mere 7%.

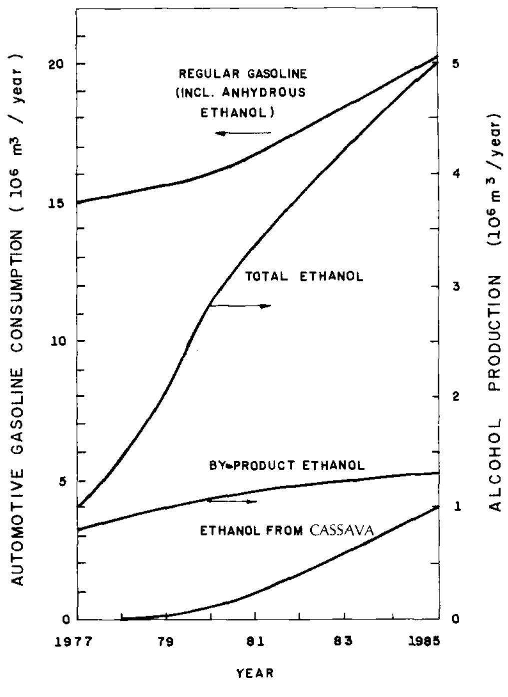

Fig. 1. Projected ethanol production and automotive gasoline demand in Brazil, 1977–85.

Economics of Cassava Alcohol Production

In the first quarter of 1978, costs for sugarcane alcohol production were slightly less than those for cassava. From juice extraction, the process using sugarcane is semicontinuous (Fig. 2), whereas cassava alcohol processing is primarily done in batches (for a more complete description, see Menezes p. 41). There are four major steps in cassava processing, namely, preparation of the cassava mash, conversion, fermentation, and distillation (Yang et al. 1977). Conversion

Table 1. Economics of production of anhydrous ethanol from cassava and sugarcane (150 m^3/day cassava distillery operating 330 days/year, 49 500 m^3/year; 150 m^3/day sugarcane distillery operating 180 days/year, 27 000 m^3/year).

Cost item (Exchange rate: Cr.$17./U.S. $1)	Cassava distillery		Sugarcane distillery	
Fixed investment (10^6 U.S. $)	16.8		14.0	
Working capital (10^6 U.S. $)	1.1		2.1	
	(U.S. $/$m^3$)	(%)	(U.S. $/$m^3$)	(%)
Feedstock:				
Cassava roots at U.S. $31.2/t	214	59.3	–	–
Sugarcane at U.S. $11.6/t	–	–	175	49.3
Enzymes, chemicals, and utilities	58	16.0	5	1.4
By-products[a]	(20)	(5.5)	(17)	(4.7)
Labour	10	2.8	12	3.4
Maintenance materials, operating supplies, insurance, and administrative expenses	18	5.0	26	7.3
Taxes[b]	16	4.4	52	14.6
Depreciation	34	9.4	50	14.1
Net operating profit[c]	31	8.6	52	14.6
Selling price	361	100.0	355	100.0

[a]Difference between the cost of direct application of stillage as fertilizer and the credit of sales of hydrated ethanol and fusel oil.

[b]Includes income tax, value-added tax (sugarcane), and social tax (sugarcane and cassava).

[c]Return on investment of 12%/year, DCF, based on the annual sum of depreciation and net operating profit, and 15-year operational life for the distillery.

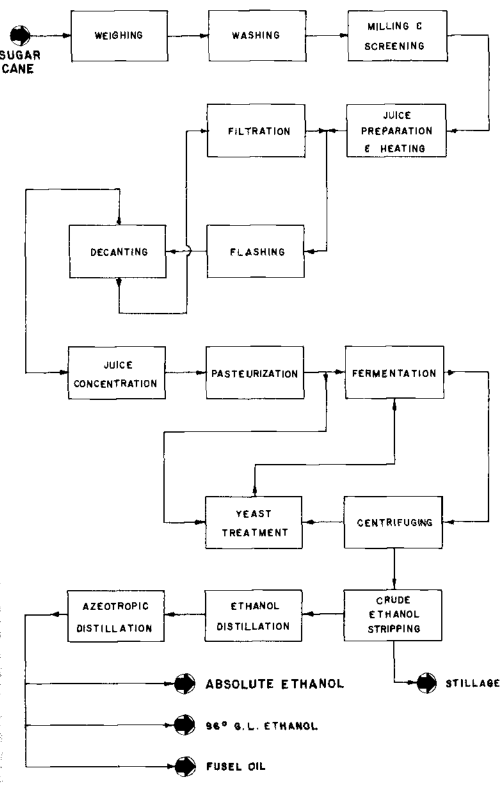

Fig. 2. Alcohol production from sugarcane (Yang et al. 1977).

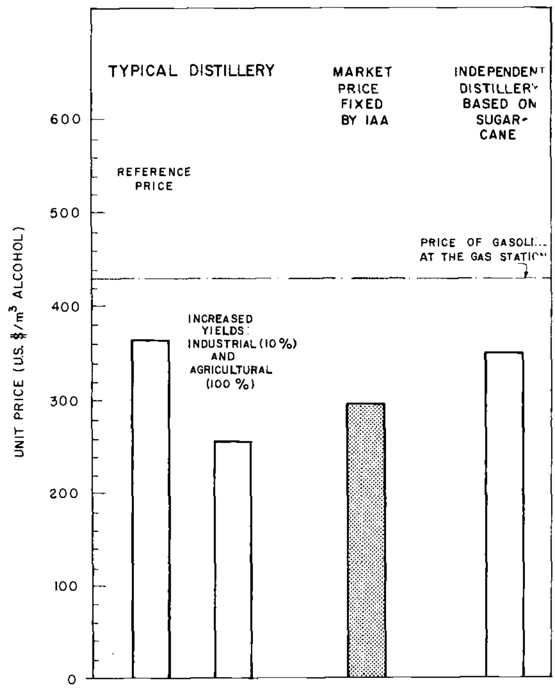

Fig. 3. Calculated prices of cassava and sugarcane alcohol compared with market price (fuel utilization).

Table 2. Economics of production of anhydrous ethanol from cassava (150 m^3/day distillery operating 330 days/year, 49 500 m^3/year).

Cost item (Exchange: Cr.$17/U.S.$1)	Base distillery	Continuous conversion	Cassava stalks as fuel[b] Mechanical drying	Sun drying	Methane from stillage as fuel[c]
Fixed investment	16.8	15.2	22.6	16.8	19.1
Working capital	1.1	1.1	1.2	1.1	1.1
Total investment	17.9	16.3	23.8	17.9	20.2
Investment referred to that of base distillery as 100%	100	91	133	100	113
Selling price[a] U.S. $/$m^3$	361	349	396	358	370
Price referred to that of base distillery as 100%	100	97	110	99	102

[a]Return on investment of 12%/year, DCF, based on the annual sum of depreciation and net operating profit, and 15-year operational life for the distillery.

[b]Cassava stalks/roots weight ratio: 1.3/1.0 resulting in complete substitution of firewood.

[c]Methane supplementing only 8.3% of total fuel requirements, in a conservative estimate. Electric power supply from external source in all cases.

comprises cooking, liquefaction, and saccharification. Cooking of cassava mash is done to disperse the starch molecules into solution, forming a gel. Liquefaction and saccharification are steps in which enzymes are used to convert starch into fermentable sugars.

The calculated prices are substantially the same for cassava and sugarcane alcohol (Table 1) — both are around 20% higher than the official price at U.S. $294/$m^3$ and lower than gasoline price at the station (U.S. $429/$m^3$).

The required fixed investment is higher for cassava alcohol production than for sugarcane, but the difference is partially offset by the higher working capital required for the latter because of the limited sugarcane harvesting season and the higher alcohol storage capacity needed for year-round supply. Earlier figures reported by Carvalho Jr et al. (1977) do not correspond to the author's calculations due to a lower official exchange rate of U.S. dollars to cruzeiros based on Brazil's internal inflation rate.

Cassava and sugarcane alcohol production in independent distilleries could be modified to lower costs. New developments in processing are especially likely in cassava alcohol because of its shorter history of intense research. Other cost reductions will result from the Brazilian government's intention to decrease taxes in official prices for fuel alcohol. The combination of improved agroindustrial processes and lower taxes could make a substantial impact on cassava alcohol cost (Fig. 3).

Possibilities for improving operations of the typical cassava alcohol distillery (Table 2) include more efficient use of energy and by-products (Centro de Tecnologia Promon 1977; Yang et al. 1977). Continuous starch conversion and the use of cassava stalks as cooking fuel in the distilleries are two examples. Within 1–5 years industrial yield should improve 10%, corresponding to better distillery design and processes, and improved agronomic practices should increase agricultural yield by 50% in 5 years and as much as 100% within 10 years.