Cassava for Food or Fuel?

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ABSTRACT

Developing countries have the special problem of needing to greatly increase energy inputs to increase food and industrial production, yet (face) severe shortages of foreign exchange (with which) to purchase imports. In several developing countries, energy farming could boost rural development, increase agricultural productivity and save scarce foreign exchange. There is a danger though that such a development might compete with food crops. (IFA, 1980).

Introduction

In mid-1982 the cessation of continuously increasing petroleum prices and the apparent surplus of oil seemingly reduced interest in the "energy problem" - but the problem has not gone away. This paradox is perhaps explained by the fact that in reality the "energy problem" of the 1970's was one of price rather than one of supply. However, in the 1980's, because oil prices are tied to world inflation and because developing countries, as indicated in the opening quote, are faced with a growing need for liquid energy, the energy problem is going to be one of both price and supply. Even if developed countries, the consumers of approximately 73% of all petroleum energy, achieve substantial savings in petroleum use, there is little reason to assume that these additional supplies are easily transferred to the developing countries. Developing countries, because of their generally low level of energy utilization, have only limited opportunities for energy conservation. Therefore, the best that they can do is adopt energy efficient methods while increasing energy consumption. It is within this context that oil deficient developing countries face the "energy problems" of the 1980's.

One suggested solution for developing countries facing dual problems of energy shortages and limited foreign exchange (thereby limiting the ability to import petroleum products), is to develop an agro-energy production system (AEPS). For this paper an AEPS will be narrowly defined as the use of agricultural products (specifically cassava) to produce liquid energy, primarily ethyl alcohol, ethanol, as a gasoline replacement[2]. A number of writers (Brown 1980, FAO 1981) have noted that alcohol fuels offer the most immediate substitute for the increasingly expensive petroleum-based fuels. This possible solution to the energy

[2] In general terms the definition of an AEPS is the use of agricultural products or waste to produce energy.

problem of the 1980's, however, poses alternative problems. First, the possible conflict of using agricultural resources to produce fuel rather than food, and second, fuel resulting from an AEPS is not necessarily cheap, (Table 1)[3]. At the heart of the issue is the question of whether ornot a country has sufficient resources to meet both its food and energy needs. This paper presents an examination of some of the advantages and disadvantages of an AEPS for cassava-producing countries.

Table 1. Ethanol cost based on cost of cassava versus 1980 retail gasoline prices (US$).

	Cost		
	Cassava $/ton	Ethanol $/litre	Retail Gasoline Price $/litre
Brazil	8.00	.14	.85
Thailand	23.50	.39	.45
South Africa			.65

Potential for Agro-energy in LDCs

Prima facae developing countries which have an agricultural surplus and an energy deficit are potential candidates for development of an agro-energy system.[4] Surprisingly, only 11 countries meet these conditions (Table 2).

Of the 11 countries, only five - Brazil, Dominican Republic, Kenya, Philippines, and Thailand - produce cassava in excess of domestic food requirements[5]. The six remaining countries either do not produce cassava, Ethiopia[6] and Turkey, or only produce limited quantities of cassava, Argentina, Cuba, South Africa, and Sudan. Because this paper deals only with cassava AEPS, it is the first five countries and South Africa[7] which become the focus of the analysis.

The energy problems of these countries are multi-faceted. In all of them (with the possible exception of South Africa) energy imports account for more than 30% of all export earnings, and the relative importance of energy imports is now two or three times greater than what it was in the early 1960's. In three of the countries - Brazil, Dominican Republic and Thailand - the growth in demand for energy during the period 1974-1979 exceeded the growth in the supply of energy

[3]The ethanol prices presented in Table 1 do not include taxes while the gasoline price includes taxes.
[4]Countries with both agricultural and energy surpluses will probably find agro-energy too expensive.
[5]This condition insures that the physical potential exists for both production of food and fuel from cassava. The same type of condition could be placed on any other agricultural product which might be considered as a potential energy feed-stock.
[6]It is doubtful that Ethiopia, as a result of the ongoing military problems, is now self-sufficient in food.
[7]South Africa does not now produce cassava in substantial quantities, but was included in the analysis because the government plans to convert the Makatini Flats in northern Zululand into cassava plantations for producing ethanol. (Brown, 1980).

Table 2. Developing countries which have agricultural surplus and energy deficiency

	% Self-sufficiency Agricultural	Energy
Dominican Republic	141	1
Cuba	139	1
Thailand	131	8
Argentina	123	91
Philippines	121	9
Brazil	119	32
Kenya	114	7
Sudan	112	2
Ethiopia	108	10
South Africa	106	91
Turkey	104	36

Adapted from FAO 1980

(WB, 1981). The magnitude of the problem, in terms of the need to import crude petroleum, is greatest for Brazil and Thailand (Table 3). It is, however, gasoline consumption, accounting for 9% to 24% of total crude petroleum imports, which is the immediate target of an AEPS, because ethanol substitutes only for this "fraction of the barrel."

Table 3. Crude petroleum production, consumption and import and gasoline consumption, 1980.

	Crude Petroleum (1,000 MT)				Gasoline	
	Prod.	Cons.	Import	kg/ca.	Cons.	as % of Cr.Pet.
Brazil	8,841	54,318	43,637	442	9,616	22%
Dominican Republic		1,340	1,457	247	307	21%
Kenya		3,039	3,404	185	310	9%
Philippines	535	9,831	9,375	203	1,790	9%
South Africa		13,000	15,000	394	3,615	24%
Thailand	10	8,718	8,908	188	1,755	20%

Sources: UN, 1982

The ability of all six of these countries to reduce their dependency on external energy sources by the development of a cassava AEPS depends in the first instance on the degree to which cassava production exceeds the demand for cassava as a human food[8]. The two countries with the greatest "surplus" of cas-

[8]Implicit in this initial analysis is the assumption that a country is willing to divert cassava used for non-food purposes to the production of ethanol.

sava, and hence immediate potential to produce substantial quantities of ethanol, are Brazil and Thailand (Table 4).

Table 4. Production and consumption of cassava as a human food, and ethanol equivalence of surplus (1,000 MT).

	Prod. (1)	Cons. (2)	Difference (1)-(2)	Ethanol (1,000 litres)
Brazil	25,600	12,413	13,187	2,373,660
Dominican Republic	168	138	30	5,400
Kenya	592	574	18	3,240
Philippines	1,182	1,098	84	15,200
Thailand	8,353	373	7,980	1,436,400

Source: FAO, 1982.

Even assuming that a given country appears to have the capacity to produce cassava ethanol at an economical price, there is an initial limit to the amount by which imported fuel can be reduced, because existing cars can only be modified to use a maximum 20% ethanol:80% gasoline ratio. While it is possible in the long run to have an automobile fleet burning 100% ethanol, the immediate limit is that no more than 20% of all gasoline can be replaced by ethanol. Even given this apparently limited market for ethanol only Brazil and Thailand have the potential to development a cassava AEPS capable of replacing 20% of the nation's gasoline (Table 5). South Africa, if it achieves its cassava production targets, would be able to replace 10% of the nation's gasoline consumption with ethanol.

Table 5. Comparison of potential ethanol market (20% of gasoline consumption) and ethanol production (1,000 litres).

	20% Cons. gasoline (1)	Potential ethanol (2)	(2)/(1)
Brazil	2,598,243	2,373,660	91%
Dominican Republic	82,951	5,400	7%
Kenya	83,762	3,240	4%
Philippines	483,658	15,200	3%
South Africa	976,773	489,090	50%
Thailand	474,201	1 436,400	302%

Cost and Benefits

The immediate benefits of an AEPS are the apparent savings in foreign exchange. If the six countries produced to the limit of their ethanol capacity or market, and assuming that this replaces an equivalent amount of imported oil, the maximum foreign exchange benefits are as shown in Table 6.

Table 6. Maximum foreign exchange benefits* from production of cassava ethanol.

	Ethanol potential as percent of oil imports	Dollars benefit of import savings
Brazil	4.03	$ 597,353,000
Dominican Republic	.27	1,359,000
Kenya	.07	805,000
Philippines	.12	3,825,000
South Africa	2.40	123,096,000
Thailand	10.84	119,567,000

*Assuming an oil price of $40/barrel.

Again the indication is that only in Brazil, South Africa and Thailand could an AEPS be expected to make a substantial contribution to import savings. Additionally, in the case of Thailand, the foreign exchange savings must be compared to the foreign exchange earnings of cassava exports. The initial comparison suggests that import savings are slightly greater than export earnings of an equivalent amount of cassava exports, assuming an f.o.b. price of $100/ton of pellets. Therefore, it could be argued that the Thais would be indifferent (in terms of foreign exchange) to the use of cassava for the production of pellets or ethanol. However, present attempts to curtail the amount of cassava which can be imported into the European Economic Community (Phillips, 1981) cast doubt on the long run future of this market, and suggest that the ethanol market may become an increasingly viable outlet for cassava.

While foreign exchange contribution of an AEPS may be limited, it may be other aspects of an AEPS which lead to its promotion. It has been calculated that in Brazil every million litres of cassava ethanol imply 96 to 280 jobs, $300,000 of investments, $140,000 to $220,000 in operating expenses, $70,000 in fixed costs, and require 320 to 660 hectares of land (CTP, 1977 and Phillips, 1978). There is little reason to assume that the range of employment creation or the investment cost of establishing a distillery will differ greatly from one country to another. Therefore the Brazilian data coupled with national data on the yield of cassava are used to provide an initial estimate of the investment and land requirements, and employment creation which might be associated with establishment of an AEPS.

Data in Tables 6 and 7 suggest that initial benefits of an AEPS are foreign exchange savings and jobs created[9], and that the costs are those of investment and operation. In this analysis land requirements are considered to be neither a cost nor a benefit, because it was assumed that the introduction of an AEPS did not alter the amount of land devoted to cassava. The conclusion to be reached is given the operating set of assumptions, are:

[9]In this analysis, new jobs represent approximately 5% of the employment creation figures contained in Table 7. The remaining 95% of the employment creation represents a redeployment of labor from production of cassava for non-food markets to the ethanol market.

- that Brazil, South Africa, and Thailand would appear capable of realizing the greatest benefits from a cassava AEPs;
- that the annual foreign exchange savings exceeds investment costs;
- that the potential size of the cassava ethanol market in all six countries except Thailand is, in the first instance, limited by the availability of raw material; and
- that developments in external markets for cassava may determine the Thai interest in renewable energy.

Future of Agricultural Energy Systems

For the Dominican Republic, Kenya and the Philippines a cassava AEPS would appear to be capable of making only a limited impact on the respective economies. For the other three countries an AEPS has the potential of providing up to 20% of the nation's gasoline needs[10]. The benefits of an agricultural energy production system could be increased if employment creation is maximized, which, however, implies increasing cassava production. The prime constraint to such expansion would appear to be the agricultural land base. In the Brazilian, South Africa and Thai cases this does not appear to be a problem. In Brazil it is known that in the northeast alone, farmers with less than 50 hectares have sufficient good, but unused, land to produce 2 billion litres of ethanol, assuming a yield of only 8 tons of cassava per hectare. While the expanse of the northeast mitigates against collecting and processing cassava from the numerous small farmers, it does appear that with proper incentives and development of infrastructure small farmers there would produce the required cassava (Phillips, 1981).

Table 7. Potential investment and land requirements, and employment creation associated with national AEPS.

	Investment (million $)	Land (1,000 ha.)	Employment creation
Brazil	$711.9	1,099	227,880 - 664,440
Dominican Republic	1.6	3	518 - 1,512
Kenya	1.0	2	307 - 896
Philippines	4.6	8	1,459 - 4,256
South Africa	146.7	181	46,944 - 136,090
Thailand	142.2	176	45,523 - 132,720

Thailand, on the other hand, would probably have little difficulty in utilizing cassava as a renewable energy source if either the European Market is closed to Thai tapioca pellets, or if petroleum prices experience another sharp increase. In fact the problem which Thailand could face would be that of an excess supply of ethanol.

[10]South Africa is restricting its cassava production targets to 10% of the nation's gasoline needs.

South Africa has identified an area for cassava plantations and should not find land a constraining factor.

In the other three countries data on the availability of unused land suitable for cassava production is not at hand, therefore the possibility of developing an expanded cassava AEPS is not known. Clearly if the land is available it is possible that the marginal benefits of an AEPS in these countries will be greater than in Brazil, South Africa and Thailand. Only a more detailed analysis will demonstrate if this is in fact the case.

This analysis attempted to resolve the food-fuel issue by assuming that cassava price is the same in all markets and that cassava used in the energy market came from the non-food markets or from increased production. These assumptions implied that neither the demand for cassava as an energy feedstock nor the price of such cassava would adversely affect the food market. In the course of the analysis it was not, however, possible to calculate if the energy market would be able to pay a higher price for cassava, and thus divert cassava from the food market. It might be suggested in closing that the relatively high price of cassava ethanol, assuming average cassava prices, does not support the contention that the energy market will cause the price of cassava to rise.

Conclusions here are that only 11 developing countries are now potential candidates for some type of an agricultural energy production system; that only six have a potential of developing a cassava AEPS; and that only three - Brazil, South Africa, and Thailand - can expect to easily realize substantial benefits from such a system. Results are deficient in that the analysis was done at an aggregate level and that it focused only on cassava. This latter deficiency is justified by the fact that this paper presents a method of analysis which is applicable to other agricultural feedstocks.

The important finding of this study is that a limited number of developing countries might realize substantial benefits from the establishment of an agricultural energy production system. The "lull" in the energy problem provides the ideal time for these countries to further explore this possibility, but the "lull" may have removed the immediate incentive to explore this possible solution to the energy problem of the 1980's.

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