OPPORTUNITIES FOR BIO-ETHANOL PRODUCTION FOR THE TANZANIA SUGAR SECTOR

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1.0 INTRODUCTION

Ethyl alcohol (ethanol) is a very satisfactory fuel by itself and can replace petroleum gasoline fuel in motor vehicle fuel.

However ethanol can also be mixed with gasoline in different proportions. This mixture is then called GASOHOL. In the US gasohol is a mixture of 90% gasoline and 10% absolute alcohol. In Brazil it is either a 20% alcohol mixture with gasoline or 100% alcohol without gasoline. Alcohol/petrol mixtures were fairly popular at the end of World War II. After World War II the trend was generally to move away from using gasohol especially in Australia, SA, and France. Brazil and India continued to be significant consumers. However, its wide spread use as a transport fuel has been constrained by high production costs as against gasoline prices.

Technical Considerations

Ethyl alcohol (ethanol) can be produced either from A, B or C Molasses, syrup or cane juice. There are three main stages in ethyl alcohol production namely :-

Fermentation, Distillation and Dehydration process.

The fermentation process of molasses results from the action of yeast which first inverts the sucrose by the action of invertase secreted by the yeast. Then the inverted sugar is converted to ethyl alcohol and carbon dioxide according to the following reactions:

\[
\text{C}_{12}\text{H}_{12}\text{O}_{11} + \text{H}_2\text{O} + \text{invertase} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{C}_6\text{H}_{12}\text{O}_6 \\
\text{levulose} \quad \text{dextrose}
\]

\[
\text{C6H12O6} \quad 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2 \\
\text{ethyl alcohol} \quad \text{carbon dioxide}
\]

The theoretical yield from 1lb of invert sugar is 0.511 lb of absolute alcohol and 0.489 lb of carbon dioxide. Modern methods with high efficiency yield about 90% of the theoretical.
We will not go into the details of the technical analysis here because it has been shown elsewhere that the processing and blending of alcohol (anhydrous) is technically possible.

2.0 COMMERCIAL VIABILITY

The terms commercial viability and commercial feasibility are normally used interchangeably and refer to there being sufficient expected profitability from ethanol production, which may be conditional on government support.

There are three key factors for commercial viability namely:

1. The price of sugar
2. Price of crude oil/gasoline
3. Government support

The first of the three factors, the price of sugar is important because it represents the opportunity cost of the sugar crop used to produce ethanol. The second is the price of crude oil/gasoline— which provides a benchmark against which to gauge the competitiveness of ethanol. The last factor is the existing government support, expectations about its continuance and possible new forms of future support.

The other important aspect in the alcohol manufacturing is the handling of the stillage. Kujala gives the stillage volume of 8-13 times the volume of alcohol produced, it is therefore important when designing a new distillery to consider it as a total processing complex in which effluent treatment/disposal is an integral part of the plant. Vinasse can be used in various ways:

1. Directly as fertilizer for small distilleries
2. Animal feed
3. For fuel – it can be concentrated from 10% solids to 60% and can then be used directly as fuel and can serve 50% of fuel consumption in a distillery.

3.0 PRODUCTION COSTS ESTIMATES

Recent literature shows the following production cost by countries for fuel ethanol

<table>
<thead>
<tr>
<th>Country</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>$0.15 – 0.21/litre from sugarcane juice/molasses</td>
</tr>
<tr>
<td>US</td>
<td>$0.25/litre from corn</td>
</tr>
<tr>
<td>Country</td>
<td>Cost of Fuel Ethanol</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Australia</td>
<td>$0.30/litre from C molasses</td>
</tr>
</tbody>
</table>
| European Union| $0.48/litre of sugar beet  
                 $0.60 if beet is valued at EU quota value |

It is obvious that Brazil is the lowest cost producer of fuel ethanol.

### 4.0 BRAZIL CASE STUDY

Brazil ethanol history is as per appended table 1. Proalcool was launched in 1975 after world oil prices soared in 1974 (OPEC). The Brazilian government supported Proalcool via heavy intervention and subsidization at the beginning through subsidized loans required for industrial production base, control of production, of marketing and prices (producer and consumer) in order to guarantee competitiveness between alcohol and gasoline for consumers and between alcohol and sugar for producers. In 1983, Brazil had 7 million vehicles using 20% alcohol mixture and 595,000 vehicles having engines, which use 100% alcohol.

In 1997 the alcohol sector began to be liberalized by removing the rigid pricing structures. Today the government only mandates the gasoline/ethanol-blending ratio, but the market forces freely determine prices.

The highlight is the strong competitiveness of Brazil fuel ethanol production against gasoline and crude oil. According to a leading Brazilian analyst by late 2000 ethanol was being produced at a cost that was competitive with the price of gasoline in the world market. Anhydrous ethanol can be produced in centre/South Brazil at $28.40 per barrel, meaning that it can compete with gasoline in the world market when the price of crude oil is between $22.70 and $23.70/barrel.

However, the scale of the Brazilian distillers is very important; these are large-scale units achieving significant economies of scale and throughput, utilizing state of the art technology and using bagasse as a major part of the fuel source for distillation. Costs could be significantly higher for smaller scale distillers in other countries.

In Brazil, over the course of the two decades, new technologies increased sugar and fermentation yields significant. Increased productivity development of cane varieties, better soils and fertilizer practices and increases in the sugar content of cane (from 9.5% in 1977 to 14% in 1999) were all important factors. Furthermore there was an increase in fermentation yield by 17%. All these factors have increased the ethanol productivity from 3,000 – 4,000 litres/ha to 5,000-10,000 litres/ha over the same period.

The increase productivity over the years has lowered production cost of ethanol; making ethanol price competitive against gasoline.
Ethanol use is also expanding in countries other than Brazil. The most promising developments are in US and Japan. In addition initiatives are being developed in Latin America, Peru, Bolivia, Paraguay and Columbia.

5.0 THE TANZANIA SCENARIO:

The Tanzania sugar sub sector is growing very fast as per appended tables 2-5 We will soon reach self sufficient as per the 10 year development plan of the Sugar Board of Tanzania. (Table 6) Thereafter the industry may choose to stagnate or to diversify. Neither the export markets to the EU nor to the regional markets are guaranteed because of the high production costs. Likewise we cannot profitably export to the world market due to the same reasons.

At the same time the price of petrol is increasing and we do not have our own oil reserves. Studies done before by TIRDO, Vogelbusch, and Lukyaa, show that in the 1970’s & 1980’s use of gasohol without Government support was uneconomical. Launching a gasohol proprame by then would have required the government to intervene by reducing tax on fuel alcohol. However there has been significant increase in the price of petrol to warrant a more thorough feasibility study to determine whether it is now economical without Government support.

As we all know ,Tanzania has vast suitable land for cane growing as has been shown in the Industries ten year Development. In fact more suitable land is yet to be identified.

6.0 POLITICAL, SOCIAL AND ECONOMIC CONDITIONS TO ACHIEVE GASOHOL POLICY

The Role Of The Government

Markets and Government have complementary roles in industrialization. Markets are adept at dealing with the growing complexity that comes with industrialization, but they are rarely perfect. Governments must sometime intervene either to make something mandatory or to bring an awareness of a certain product through the media of via political propaganda.

Let us quote from Piere Moriete about the he thinks of introducing the Gasohol or “green petrol” policy as calls it.

“Three years of experience in proposing the Green petrol policy to be adopted by various governments among developing countries have taught me that the best
idea, the soundest and the most logical solution to a problem is not accepted easily when first introduced.

The Brazilian examples were not enough to convince most of the countries to accept, on their government level, the idea of considering alcohol as a permanent source of energy especially where the conditions are land without digging 300 metre deep for searching oil, (and of course with less cost for research) has taken years to be accepted by government such as Thailand and Philippines. The industrial technology is not the most difficult to sell, it is the intellectual technology which is most difficult, when it obliged people to take a different approach in solving the problem of energy shortage and to meet the necessities to carry on such a policy as green petrol”.

Thus, the Government has to make a stand about alcohol as gasoline substitute now.

**Political conditions**

Little can be achieved if the government does not have a serious concern or insight to the energy shortage in the country. The Government must face the problem of energy in full view realized the impossibility to meet all the energy requirements, by importations of oil. It should then become clear that it has to find in its land with its own national resources a source of energy of its own. Tanzania we have coal, gas, but gasohol should be considered as the most important liquid fuel especially because it is also renewable.

**Social conditions**

The Government should ensure that people are made aware of the advantages of using gasohol and if necessary it should be mandatory to buy petrol only when it is blended with gasohol as a certain rate (10-20%). People should be made aware that there is no need to be apprehensive as there is no damage to the car engine.

**Economic conditions**

The Government must be prepared if necessary to initially subsidize alcohol price, by tax rebate. It must also fix an attractive price for alcohol so as to encourage investment and obtains loans from international finance institutions

**Legal aspects**

Legal matters pertaining to fuel alcohol / gasohol as opposed to portable alcohol should be sorted out.
No one disputes today that the dependence on oil imports is something to be fought against. We may follow Brazil’s strategy, and diversify to gasohol.

However the replacement of gasoline by mixture of alcohol and gasoline or by straight alcohol is a relatively complex problem, which necessitates detailed studies; to take into consideration technical, economical, legal and social factors. Putting into operations a fair-sized alcohol programme would required a significant lead time of over 3 years; hence, the necessity to start immediate investigation to avoid remaining in the energy crisis for many years to come.

The Government should be supportive of the Gasohol project as was the case of Brazil. Experience has shown that even though the cost of production may be high at the beginning of the programme, it can be reduced considerably over time.

Ultimately though the longer term sustainability of the “ethanol option” for sugar depends on whether or not fuel ethanol programs based on sugar crops can ultimately stand on their own two feet! Predictable and adequate government support is obliviously critical in getting a fuel scheme off the ground, but ultimately, sustainability over the longer term comes through the ability to lower costs and compete more directly with gasoline.

It is quite possible that if the production cost of gasohol is sufficiently lowered, we may even export the product to regional markets or even export to the EU under EBA.

The Sugar Industry has a golden opportunity for transformation and development.

Let us take up the challenge.

Thank you for listening.
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