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The Impact of Biofuel Production on Food Security: A Briefing Paper with a Particular Emphasis on Maize-to-Ethanol Production[1]

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Abstract

A multi-feedstock approach is crucial for sustainable biofuel production in South Africa. In respect of ethanol production, biofuel producers should be allowed to draw on a range of starch-based crops including maize. A multi-feedstock approach will enable producers to select crops best suited to the agro-climate of the regions where their plants are situated and to minimize logistic costs by sourcing crops grown closest to their plants. In recent months, plans to use maize to produce ethanol have raised concerns that this could jeopardize food security in South Africa.

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Introduction

Biofuels have emerged as the scapegoat internationally (and locally) for high food prices. Even a cursory Google search will immediately bring up numerous articles to this effect in both the local and international media. But many of these articles are pure hype, many simply copying each other's ideas, and very few display any real knowledge of agricultural economics.

Jacques Diouf, the Director General of the UN Food and Agricultural Organization, has warned that this hype is obscuring the true potential the biofuel industry has for poverty alleviation in developing countries, particularly Southern Africa. In an opinion piece in the Financial Times, he argues "biofuels provide us with a historic chance to fast-forward growth in many of the world's poorest countries, to bring about an agricultural renaissance and to supply modern energy to a third of the world's population"[2].

In South Africa, media reports have quoted influential government officials who argue against using maize to produce ethanol on the grounds that this will contribute to food inflation[3] Coming at a time when Cabinet is considering a strategy for the local biofuel industry, these comments in media reports cannot go unchallenged, as they ignore several very important agricultural and logistical advantages in using maize to produce bio-ethanol.

It is in this context that the authors would like to use the opportunity to present this briefing paper to convey background information on the agricultural industry, maize in particular, which is pertinent to the impact of biofuel production on rural development, poverty alleviation and food security.

It is our contention that for South Africa to have a sustainable biofuel policy, biofuel producers must be allowed to draw on a variety of crops. A multi-feedstock policy will enable biofuel producers to select crops best suited to the agro-climate of the regions where their plants are situated and to minimize logistical costs by sourcing energy crops that are grown closest to their plants. In respect of ethanol, this range of crops should include maize, but also sugarcane, sugar beet, sweet and grain sorghum, lower grade wheat, triticale and pearled barley.

Optimizing Logistical Advantages

Logistical concerns are a major motivation for the multi-feedstock approach. Blending ethanol with fossil-based petrol is technically complex and should best be

2 Diouf J, Biofuels should benefit the poor, not the rich, Financial Times, 15 August 2007.
3 See for example comments by Reserve Bank Governor Tito Mboweni in Mboweni casts doubt on maize for ethanol, 3 August 2007, Reuters, and comments by Science and Technology Minister Mosibudi Mangena in Biofuel subsidy unlikely, says minister, 30 July 2007 Reuters.

done at the refineries. The refineries are located at the coast (Durban and Cape Town) and inland (Sasolburg in Mpumalanga). The Durban refineries are closest to the main sugar growing areas. The Sasol refineries (Secunda and Sasolburg) serve the country's largest fuel consumer base, particularly in Gauteng, and are situated closest to the North West, Free State and Mpumalanga maize belts.

After feedstock and energy costs, transport costs will be the highest costs of an ethanol plant. To be viable, therefore, a plant must be located such that both the costs of trucking in the ethanol feedstock (e.g. maize or sugar) and those of trucking out the ethanol are minimized.

Absa Agribusiness, in conjunction with the consultancy firm Agrista, conducted a preliminary study to determine an optimal location for ethanol plants using either maize or sugarcane on the grounds of minimizing the costs of transporting in feedstock and transporting out ethanol.

The Absa / Agrista study also investigated the optimal location for an ethanol plant to supply the inland refineries. An optimal location is one that can minimise inbound and outbound transport costs, namely:

- Transport of the biomass to the biofuel plant.
- Transport of the ethanol to the nearest petroleum refineries.
- Transport of by products to off takers – in the case of maize this would be distillers dried grains and solubles (DDGS) to the feedlots.

In the maize-to-ethanol analysis, six locations were chosen due to their proximity to:

- Maize growing areas. These were the major maize growing areas in the eastern and western Highveld and the Free State maize.
- Major rail and road transport infrastructure.
- The refineries in Sasolburg and Secunda, both in the Mpumalanga province.
- Major feedlots.

Sasolburg emerged as the lowest-cost location for a maize-to-ethanol plant due to it also being home to the Sasol refinery. This gave it the lowest ethanol transportation costs. Sasolburg also had the lowest total supply chain cost and a low maize procurement cost.

Secunda was rated as the second-best location, again due to its proximity to the petroleum refineries[4], followed by Bothaville in the Free State, due to its proximity to the major maize growing areas and good transport network. Both those locations were favored by low outbound ethanol costs and, due to their proximity to major

4 The Secunda biofuel plant has a marginal ethanol transport cost as the Secunda refinery, Natref, is a coal-to-liquids producer only. Hence ethanol from the Secunda biofuel plant will need to be transported to Sasolburg.

feedlots and low DDGS transport costs. The plants were initially evaluated in isolation from each other. The exercise was then further refined to determine the effect of two competing maize-to-ethanol plants, one in Bothaville and one in Sasolburg. For the purposes of this exercise it was assumed that both plants were owned by the same owner who sought to minimize costs for both plants.

The effect of the competition for both plants was a slight increase in maize procurement (i.e. under R100 000) and an increase in DDGS transport costs. For the Bothaville plant, the DDGS transport costs increased substantially (approximately R4 million). This was due to the Bothaville plant losing its Sasolburg feedlot offtaker to the Sasolburg plant and being forced to transport the remainder of its DDGS to a Pretoria offtaker once its Randfontein and Viljoenskroon offtakers were saturated.

The Absa / Agrista studies indicate how sensitive biofuel plant locations are to transport costs. For example, the Bothaville plant was clearly penalised because its existing offtakers in Viljoenskroon and Randfontein weren't big enough to absorb its DDGS once it lost its Sasolburg offtaker.

The studies give an indication of the type of analysis required when selecting feedstock for ethanol production. In particular, a clear conclusion was reached that, because of the transport cost sensitivities, any biofuel policy that prohibits maize would result in ethanol being blended only in KwaZulu Natal as it will be too expensive to truck sugarcane or ethanol inland.

A single feedstock policy will therefore impose a severe constraint on the introduction of a national, as opposed to a regional, ethanol blend.

Suitable Feedstock for Biofuel Production

In addition to maize and sugar, ethanol can also be produced from a range of other crops. Other commercially grown candidates include sugarbeet, sugarcane, triticale, lower grade wheat, pearled barley and grain and sweet sorghum. Depending on agro-climatic factors, some of these can also substitute maize for ethanol production. Grain sorghum is particularly attractive as it is not a main food crop, is hardy and can be grown on the same lands as maize. Thus a ban on maize production for ethanol will simply have the effect that fields are put under crops which substitute maize as feedstock for ethanol production.

Grain SA estimates the total scope of maize production to meet current food and feed market demand for 2007/8 at 2,391,448 hectares. However, SANSOR has reassured Grain SA there will be enough seed available to plant 3,700,000 hectares. The availability of this excess seed means it will be possible to start producing

ethanol immediately if maize is used as a feedstock. It will not be necessary to wait until seed supplies have been built up, as may be the case with other crops.

Much has also been made of sugar being a more efficient crop to use for ethanol production, especially, if the ethanol yield from sugar is compared to the ethanol yield from maize.

However, it is important to note that, in South Africa, unlike in the US and the EU, biofuel production is driven predominantly by the need for rural development: to enhance food security and eradicate poverty by creating sustainable income earning opportunities. The need to achieve energy security (as is the case in the US) or attain strict environmental goals (as is the case in the EU) is of lesser importance.

As a result, it may be necessary in certain circumstances to use a less efficient crop for ethanol production if this crop has a higher rural development potential. Maize meets these criteria in two respects.

Firstly the maize-to-ethanol production process generates a protein and carbohydrate rich animal feed known as DDGS (distillers dried grains and solubles). South Africa currently has a shortage of quality protein in the feed market, and DDGS can be used to supplement imported and expensive soya oilcake, an important protein source, as well as feed components such as hominy chop and maize gluten meal.

Every ton of maize used to produce ethanol will yield approximately 300kg of DDGS. Hence, about 30% of the maize used to produce ethanol can revert back to the food production process as animal feed. This increased availability of animal feed from the ethanol production process will have an important impact in lowering meat and dairy production costs. This is a crucial advantage that maize has over the more efficient sugarcane as an ethanol feedstock. The potential of energy crops to also supplement available animal feed stocks should therefore be taken into account in addition to a crop's energy production efficiency when selecting crops for ethanol production.

A further advantage of using maize to produce ethanol is the rural development opportunity entailed in maize production. There are certain areas in the country, some situated close to the inland refineries, with underutilized agricultural production, which would be ideally suited for grain-based ethanol production.

The Agricultural Research Council[5] estimates that South Africa has a maximum of 25 million hectares of arable land. If only underutilized arable communal land is used for biofuel production, it may be possible to cultivate either five million

5 Van der Walt M, Schoeman JL, Overview of land suitability for biofuel crop: a report for the department of agriculture, ARC-Soil Climate and Water, March 2006.

hectares of grain sorghum, four million hectares of sunflower, three million hectares of maize or two million hectares of soya.

According to the estimate, production from these areas alone may produce five million tons of maize, enough for five ethanol plants (at old yield levels not the current 3.5 – 4 t/ha that is normal today).

A number of private-public partnership proposals are being considered for farmers in the former-homeland areas to produce grain under a co-operative type model. Grain produced from such projects would normally be sold in the feed and food market and price risk to be managed through the use of instruments on Safex. However, a biofuel industry targeting emerging farmers may create an additional market which may have a stabilizing influence on grain prices and income for such projects. Income generated in such projects will make a significant contribution to food security. Thus, discounting maize for ethanol production on the premises that it is less energy efficient than sugar ignores the important rural development potential of this crop, and its versatility.

Local Market Constraints

Maize prices are notoriously volatile, mainly for their steadfast adherence to the basic economic law of supply and demand. Maize production capacity is based on the price signal of the previous season, which in turn determines the tons of maize produced during the following season. If price signals are low, the industry reacts by limiting production in the following season. Consequently, and more often than not, maize prices increase during the next season, thus setting in motion a boom bust cycle of prices.

In South Africa this boom bust cycle is even more acute due to the limited market for locally produced maize. While the country has the potential to produce about 12 million tons of maize without undue pressure on current natural resources, local consumption is stagnant at about 9 million tons. Any maize produced in excess of this cannot compete on world markets where prices have been depressed by the surpluses produced by heavily subsidized farmers, notably from the US.

The limited market therefore makes the South African maize price highly sensitive to supply and demand signals. South African producers, unlike their northern hemisphere counterparts, receive no subsidies to help weather low commodity prices. Hence, to survive financially, they base their decisions on price signals and the profitability of production. If prices are low, market signals indicate that supply is too high. Producers then decide to decrease their proneness to risk and as a result production is contracted. Thus planting decisions are more often than not divorced from agro-climatic factors, such as rainfall, and the country's true production potential.

The impact of the maize price on planting decisions is shown in Figure 1. In particular, the high prices in 2001/2002stimulated farmers to put a record 3.5 million hectares under production, leading to surplus production the following year and a consequent 40% drop in the maize price. The following year, about 400,000 hectares less were planted to maize, but with strong carryover stocks from the previous season still in the market, this was not enough to stabilize the maize price. The price recovered slightly in 2003/4 but dropped another 39% in the 2004/5 season. A steady increase in prices has been seen in the 2005/6 and 2006/7 season as the replenishing of depleted stocks coincides with drought depressing yields.

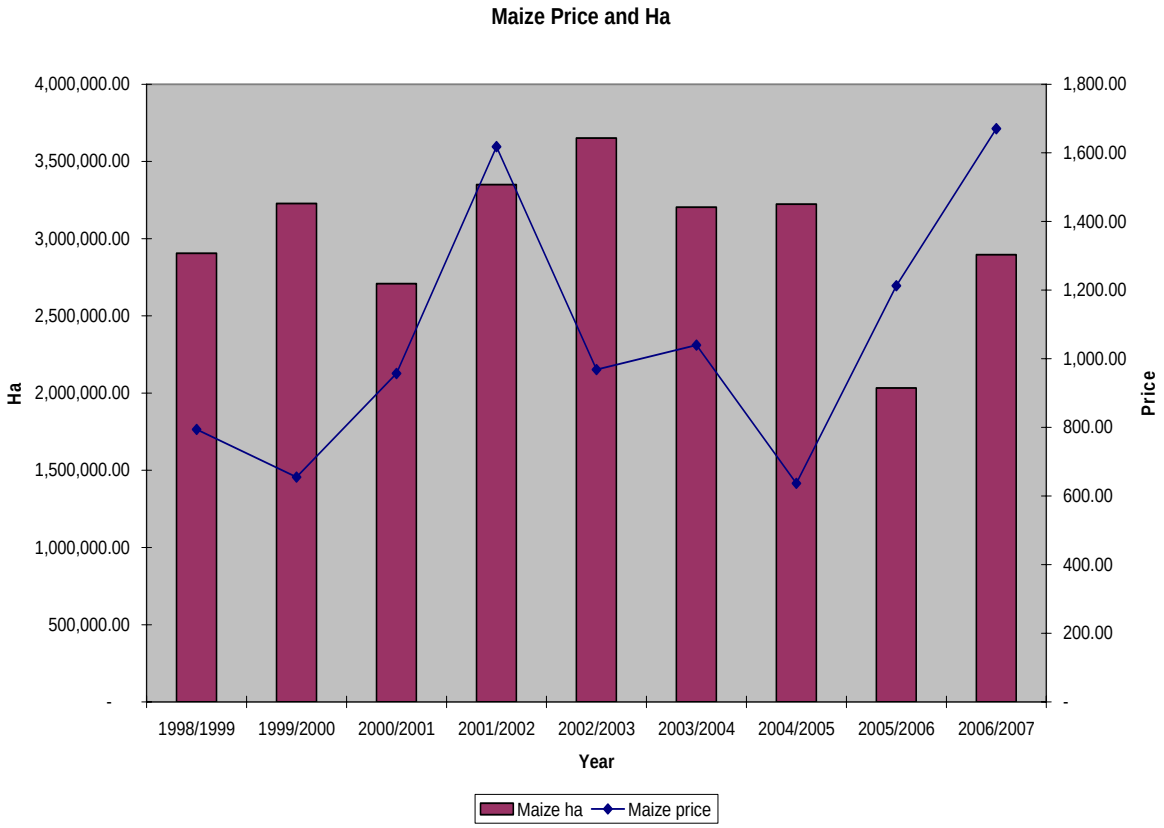

Figure 1. Impact of Maize Price on Planting Behaviour
Source: Grain SA Database (a) & Crop Estimates Committee

The 2006/07 maize harvest has been so low (6.9 million tons according to the latest Crop Estimate Committee report), that maize may need to be imported to meet demand. Drought is correctly blamed for the low maize harvest. However, it must also be remembered that due to the very low maize prices over the past two seasons far fewer hectares were planted to maize. During the previous 2005/06-season, only 6.6 million tons were harvested. In contrast, the 2004/05-season yielded nearly 11.5 million tons. Thus, even without the drought, the country would have had a

lower maize crop, indicating that climate related factors do not always play the only role in determining the size of the maize crop.

Maize in South Africa typically trades at a price that varies between import and export parity. Even a small overproduction of maize in the country has the effect of dropping the price of the entire crop, and not just the export portion, to export parity. The strong maize harvest of the 2004/5 production season, combined with carryover stocks, brought the yellow maize price down to export parity prices in 2005.

By establishing a market for feedstock through a *"supportive incentive dispensation for ethanol plants",* this will immediately increase the medium-term local demand to about 12 million tons. This increase in demand should ease the volatility of the maize prices and ensure, in the long term, that the country's full maize growing potential is exploited. Arguably, this should contribute to food security by bringing food price stability.

In assessing South Africa's capacity to increase maize production (and also its true maize production potential), it is important to consider historical planting and yield trends. There has been a steady reduction of about 2 million hectares in maize plantings since 1970 (Figure 2) mainly as a result of declining profitability in maize production. The effect of this has been that only the best producers, with economies of scale, have survived.

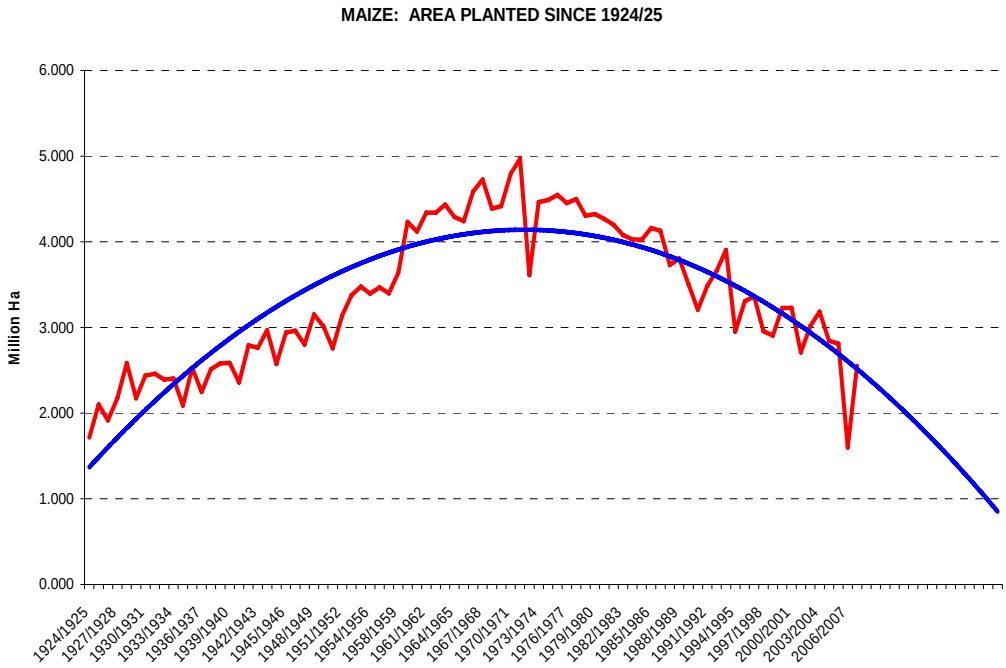

Figure 2: SA Maize Areas – 1924/5 to 2006/7
Source: Grain SA Database (b)

This decline in production has, however, also coincided with an increase in the total average yield for maize production due to developments in biotechnology and improvements in crop protection remedies and traditional breeding methods, the effect of which is that South Africa today produces more maize on fewer hectares.

It is crucial therefore that recommendations, in respect of the production of biofuels be made with a proper understanding of the dynamics of the local and international commodity markets. Maize as a feedstock for ethanol production should not be rejected until its advantages for rural development and its potential to ease volatilities in the local maize price has been properly assessed.

Postscript

In the period between the drafting of this paper and its acceptance for publication by IAMA, the South African government has released its national biofuel strategy. The strategy is disappointing for its conservatism and its lack of vision on the potential of biofuel production to stimulate rural development. South Africa and Southern Africa have vast underutilized portions of agricultural land that would be suitable for production of raw commodities. The strategy also pays scant regard to the fact that South Africa is energy insecure, and that the bulk of its energy requirements are met from coal and other non-renewable energy sources.

The strategy proposes that biofuels constitute two percent of the national fuel supply pool by 2013, down from 4.5% in initial draft proposals. This amounts to 260 million litres of ethanol barely sufficient for two commercial litres. The strategy also prohibits the use of maize for ethanol production on the grounds that this would contribute to food insecurity in the country.

However, arguments raised in this paper were not taken into account in the strategy. In addition the prohibition on maize is misguided for failing to take into account that local maize prices are determined by international maize prices, hence local prices will be high irrespective of whether maize is used for biofuel production or not. In an eloquent critique of the strategy, Investec economist, Fazel Moosa, has argued that in banning maize for ethanol production South Africa has essentially confined itself to "importing the world's high food prices without reaping the rural development and employment security benefits [from maize-to-ethanol production] that other countries are". [6]

6 Moosa F, Getting biofuels right, Press release: Investec Capital Markets, 13 March 2008.

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