

SHORT, NON-REFEREED PAPER

## **AN ECONOMIC ANALYSIS OF THE POTENTIAL BIO-POLYMER INDUSTRY: THE CASE OF SUGARCANE**

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### **Abstract**

The South African sugar industry faces both external economic competition and internal adversity. Such difficulties have led to a decline in sugar production and revenue over the past seasons. Strategies to enhance revenue and secure production may protect against longer-term industry decline. Data gathered from individuals within the associated industries propound varying reasons for the negative growth in production and revenue. However, the consensus view converges toward a product diversification scenario, for example, the Brazilian sugarcane-to-ethanol programme. This study analyses the economic potential of converting portions of South Africa's sugarcane to selected bio-polymers (plastics). An economic and environmental cost-benefit analysis may measure the relative viability of producing biopolyethylene and polylactic acid from sugarcane in a South African bio-refinery. However, despite a potentially positive net-present value calculated from quantitative research, the market landscape was further revealed in this short paper by assessing the qualitative features of agents within the sugarcane and polymer industries. An interview-based questionnaire examined the rate and likelihood of the industries to adapt to bio-based diversification. European, American and Asian markets have attained bio-refining success. By conducting simultaneous quantitative and qualitative analyses, it is clear as to what the future holds not only for the South African sugarcane industry, but for the bio-based chemical industry too.

*Keywords:* sugarcane, economic, bio-refinery, downstream, polymer, development

### **Introduction**

A bio-based economy draws at least some proportion of its resources from biomass, instead of relying wholly on non-renewables or fossil sources. Rapid growth of the global bio-based polymer market is beneficial for the South African (SA) economy should it aim towards a bio-based economy. Bio-refining brings about economic income and decreased carbon emissions, and can improve the sustainability of the SA sugar industry. Sugar, or other sugarcane fractions, can be converted into bio-based polymers. Woolworths and The Coca-Cola Company already offer bio-based polymer packaging, produced from Brazilian sugarcane, for selected products in SA.

This short paper discusses the results of an economic survey which evaluates the bio-based polymer market potential in SA, using sugarcane feedstock. Seventeen stakeholders along the sugarcane-to-polymer value chain were interviewed for data collection. This survey complements a Master's thesis in economics (University of KwaZulu-Natal).

## Methodology

An interview based questionnaire consisting of 13 closed and 18 open-ended questions was devised and trialled. The approach incorporated various factors of the potential bio-based polymer and current sugar industries in SA. The 17 stakeholders along the value-chain were primarily directors, sustainability managers, researchers, or in other positions which required significant knowledge or expertise for this type of survey. Interviews were scheduled between 24 September and 5 December 2016 and the primary researcher conducted, in person, the interviews and discussed the open-ended questions possibly more liberally than the closed questions.

The data was analysed by means of visual statistical comparison for the closed questions. This was primarily graphed and compared by means of weighted percentages for the Likert scale results. Using descriptive or inferential statistical analysis on such a small sample, combined with a Likert scale, can be ambiguous and misleading. Results are therefore interpreted wholly rather than summarily. The open-ended questions are analysed qualitatively and findings are based on the cohesion of information and the trends in the responses given.

Closed format results with a less than 70% response rate (12 out of 17 responses) are omitted from this paper due to the lack of confidence (i.e. five omitted questions). Open format results are discussed based on the question relevance since some are technically targeted.

## Results and Discussion

Based on the results shown in Table 1, the primary certainty is that most agents along the value chain are optimistic about a bio-based polymer application in reference to its use and hence, presence, in the country. This positive attitude is beneficial for the emergence of a bio-based economy as there is a willingness by the majority of involved stakeholders to adapt and contribute to this industry.

The other certainty is that financial competitiveness is strongly perceived as an obstacle for the potential growth of the market, with 88% either agreeing or strongly agreeing. This positive attitude may be in conflict with the potentially higher production costs. A European study reflected a highly similar attitude versus cost relationship (BIO-TIC, 2014).

The 'green premium' is the higher price of bio-based or environmentally friendly goods and services. This premium is often due to greater production costs (as point 2.a suggests), but may also be a result of supply constraints and profit considerations. The results from this research indicate that a premium is acceptable for both of the bio-based polymers, but that a premium in excess of 10% is at risk of becoming unfavourable, based on the low responses above that percentage. A European study on green premiums for bio-based polymers exhibited a similar trend although the average percentages chosen were slightly higher by approximately 10% (Carus, et al., 2014). This higher premium in Europe is likely a result of a higher median income and standard of living, whereas in SA the price elasticity of common disposable plastics is expected to be higher due to the relatively lower income.

When asked about the absorption of higher bio-based production costs by the producer, responses weighed more towards disagreement with this likelihood. However, as discovered in one interview, there is a South African case where producers are absorbing the added cost. It is, however, not expected to be a rational economic choice in the long-run in a competitive market environment, but is strategic in the short run for product awareness and to sustain market share until costs fall. Coca-Cola International also claims to be absorbing the higher costs for their 30% bio-based PET bottle (Coca-Cola Company, 2012).

**Table 1. Selected closed-format results.**

Values represent choice count:

Question		Answer Set				
1	What is your industry's attitude in South Africa on the application of bio-based polymers?	Very Positive	Positive	Neutral	Negative	Very Negative
		5	7	3	1	1
2	Obstacles for bio-polymer market growth in South Africa are:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a	Limitations in the financial competitiveness of bio-polymers	8	6	1	1	0
b	Lack of a supporting policy framework for bio-polymers	3	8	2	4	0
c	Unclear benefit for changing to biopolymers for plastic good producers and converters	6	4	1	5	0
d	High switching costs related to converting of bio-polymers	2	9	2	3	1
3	What premium for bio-polyethylene as a drop-in substitute for petrochemical polyethylene would you or your customers pay?	0%	0-10%	10-20%	20-30%	30-50%
		2	8	2	0	0
4	What premium for polylactic acid as a substitute over another similar petrochemical polymer would you or your customers pay?	0%	0-10%	10-20%	20-30%	30-50%
		3	6	2	1	0
5	Bio-polymer purchasers (producers of end goods) will be willing to pay a higher premium than the consumers of those end goods:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		1	4	3	5	4
6	If competitively priced and similar in quality, consumers would be motivated to purchase local plastic products over imported plastic products or products produced from imported polymers:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		1	5	5	3	3
7	Policy framework could likely be implemented to mandate more use of bio-polymers in South African plastic production:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		4	9	1	3	0
8	Policy framework could potentially be implemented to subsidise bio-polymer production and/or usage in plastic production:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		2	5	0	5	5

The open-format section revealed that SA is primarily an importer of polymers and monomers which can be produced from sugarcane. Ethylene is a monomer for many types of polymers and is currently severely undersupplied in SA. It can be produced from sugarcane bio-ethanol, the costs for which are not currently available. The ethylene shortage may be preventing other polymer production in SA.

The primary polymer demand lies in polyethylene (PE) and polyethylene terephthalate (PET), whereas polylactic acid (PLA) has mixed projections. It is suggested that the physical properties of PLA are desirable for some and concerning for others. It is a unique polymer since it is not a drop-in substitute for a petrochemical polymer.

The short-term (five-year) trends for the bio-polymer industry were reported to be product awareness and large-scale investment to establish a notable industry in SA. The medium-term (five to 15-year) trends moved towards cost reduction and increased competitiveness, whereas the long-term (over 15-year) expected trend is handling foreign competition from countries such as China and India, as well as increasing agricultural sustainability.

A significant portion of the interview-questionnaire dealt with adversities in the sugar industry. Reflections of certain respondents within the industry suggested that the decline stemmed from five areas: technological, staff, foreign competition, product base, and climate. The technological issues relate to the state of technology and capital reinvestment. The staff concern relates to lack of human capital and unproductive labour. Foreign competition is the low international price of sugar which SA cannot compete with, hence requiring protection against 'dumped' imported sugar. The product base is a concern since the SA sugar industry primarily produces sugar and is therefore dependent on the demand and world price. Finally, the climatic conditions are beyond control and can only be nursed as best as possible. The factors which can be attended to internally are technological improvements and product diversification. Lack of human capital and unproductive labour may extend beyond the control of the industry. Producing bio-based polymers is an approach to diversify sugar production, diversify risks, and an attempt to capitalise on an emerging bio-based market. Furthermore, it can reduce the dependency on the world market price for sugar.

The open-format results indicate that there is a demand for PE and PET, both of which can be produced from sugarcane. This, in combination with the need to diversify the sugar industry, can set a platform for production if the costs are feasible and accurately determined.

### **Conclusion**

The interview based questionnaires reveal that a bio-based polymer industry is preferred by experts within the various perquisite and polymer industries. Cost competitiveness may be an obstacle for entry since the South African cost of sugar production is higher than that of foreign producers such as Brazil, coupled with low crude oil prices which favours petrochemical polymer production. Despite these cost-challenging conditions, statistics reflect that it may be possible to compensate by means of a green premium within the 10% region. The SA sugar industry has feedstock potential to support this internationally exhibited bio-based system, but challenges lie in sustaining the sugarcane production and price. Overall, a detailed cost study is required to complement this research, but based on the findings thus far, the economic potential to produce bio-based polymers from sugarcane in SA does exist.

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