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Full Length Research Paper

Economics of sugarcane production on large scale farms in the Eshowe/Entumeni areas of KwaZulu-Natal, South Africa

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The recent surge in input markets has serious implications for the South African cane growers. The Bureau for Food and Agricultural Policy (BFAP), have estimated that the aggregate South African farm input cost will rise by 53% in 2008. This situation is creating cash flow and solvency concerns for sugarcane growers. This study attempts to examine the factors influencing sugarcane production on large scale farms, the resource use efficiency pattern and returns to scale to report evidence related to resource use and farm productivity. This study was based on data collected from a sample of 31 large-scale sugarcane farmers in the Eshowe-Entumeni areas; these are farmers that produce in excess of 5000 tonnes seasonally. Given the increasing input prices in the sugarcane industry and management objective to minimize production costs, a double-log production function was estimated using the total sugarcane harvested in tonnes per hectare as dependent variable subject to the production costs. The result of the study indicates that farm staff and fertilizer is the most predominant costs item accounting for 62% of the total cost of production, while the double log estimates revealed that the coefficients of all the explanatory variables included in the model are statistically significant in explaining the variation in sugarcane output on the farm. The results further points to the non optimal use of resources, and a decreasing returns to scale, hence the need for resource adjustment. Policy implication for potential increase in productivity and farm income are discussed.

Key words: Sugarcane, productivity, resource use, efficiency, return to scale.

INTRODUCTION

Sugarcane production is one of the major contributors to the South African economy. South Africa is the world's 10th biggest producer of high quality sugar with an estimated mean annual production of about 20 million tonnes of sugarcane. This production generates an annual income from the sale of sugar and molasses of about US$1 billion (Hassan, 2008; SASA, 2009). The South African sugar industry also contributes to the economy in terms of its agricultural and industrial investments, foreign exchange earnings and its linkages with major suppliers, support industries and customers. The industry supplies for domestic consumption, the Southern African Customs Union (SACU) region and the world market. It is estimated that the industry generates an annual average direct income of R7 billion which constitutes R4.5 billion in value of sugar cane production (SASA, 2009). The industry also contributes considerably to employment generation directly and indirectly. Direct employment, with an estimated 77, 000 jobs, is mostly concerned with the production and processing of sugar cane while indirect employment, which is estimated to contribute 350 000 jobs, is more concerned with the upstream and downstream industries. Furthermore, an estimated 2% of the South African population depends on the sugar cane industry for a living (SASA, 2009).

Sugarcane can also be used for the production of other commodities, in particular that of renewable energy. It is estimated that up to 4% of South Africa's liquid fuel pool

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(+/- 500-million litres) could potentially be supplied from ethanol manufactured from sugar that is currently exported to world markets (Parker, 2009). This could potentially have a positive impact on the nations' gross domestic product as the production of ethanol partially offsets fuel that is currently being imported.

The South African sugar industry covers three main producing areas; these are KwaZulu-Natal, Mpumalanga and Eastern Cape Provinces. Sugar is manufactured by six milling companies with 14 sugar mills operating in these regions (SASA, 2009/10). The sugarcane growing sector is made up of approximately 35, 300 registered sugarcane growers, farming mostly in KwaZulu-Natal Province.

The South African sugar industry is committed to Government initiative at transferring 30% of commercially owned farm land to the previously disadvantaged South Africans by 2014. As of 2007, there were 358 previously disadvantaged growers (new freehold growers) owing 42 397 ha of cane land, and one previously disadvantaged miller owing another 7 951 ha of cane land, bringing to 15% the total extent of black owned freehold cane land. This reform was achieved through willing buyer/willing seller open market transactions (Armitage et al., 2009).

However, the skewed distribution of land, with the resolution of many outstanding land claims across the cane growing regions, and the ongoing land redistribution initiative still remains one of the problems facing the South African sugar industry; other problems exist in terms of the political predicament of having to reduce the pressure on demand for land as a limited resource, and the uncertainty around the viability of farm size. Policy makers are faced with the challenge of having to achieve both growth and equity within the South African agricultural sector. Also, the South African cane growers' financial circumstances have been deteriorating since 2003 (Wayne, 2009a).

On the average, farmers have been unable to fully cover their production costs. This is due to increase in input prices without a corresponding increase in the price of sugar (Wayne, 2009b). An estimated 45% increase in inputs cost from 2003/04 to 2007/08 was reported mainly attributed to increasing fertilizer and fuel prices (SACGA, 2010). The Bureau for Food and Agricultural Policy (BFAP), have estimated that the aggregate South African farm input cost will rise by 53% in 2008. This situation is creating cash flow and solvency concerns for cane growers. This study therefore attempts to examine the factors influencing sugar cane production on large scale farms and resource use efficiency pattern to report evidence related to resource use and farm productivity.

METHODOLOGY

The study area/data collection

This study was conducted in the Eshowe-Entumeni areas of the Zululand cane growing regions in the Amatikulu mill supply region which stretches from the sea to Entumeni and Eshowe areas, with a haul distance ranging from 0 to 80 km. The mill crushes about 1.5 million tonnes of cane per year of which 150 000 tonnes of sugar is made, 60 000 tonnes of molasses and, 30 000 tonnes of fibres as an input to the animal feed plant (Department of Transport, 2009).

The Eshowe-Entumeni area was purposively chosen for this study because the farms operate in a homogenous agro-climatic conditions and sugarcane is the major crop enterprise in the area. A sample of 31 large-scale farms were used for the study, these are farms that deliver in excess of 5000 tonnes of sugarcane annually. A production cost survey data on 27 registered cane growers in the area was obtained from the South African Cane Growers Association (SACGA), additional data were also obtained from four neighbouring farmers in the area and the Eshowe Farmers Association to supplement data obtained from SACGA.

Analytical tools

Production function analysis

Given the increasing input prices in the sugarcane industry and management objective to minimize costs, a double-log production function was estimated using the total sugarcane harvested in tonnes (per hectare) as dependent variable subject to the production costs. This was used to determine the major factors that are affecting sugarcane production, and to estimate input elasticities and returns to scale. A production function is expressed in its implicit form as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, \varepsilon)$$

Where:

Y = Total sugarcane harvested (tonnes/ha)
X_1 = Farm size (hectares)
X_2 = Farm staff cost (Rands/ha)
X_3 = Chemicals cost (Rands/ha)
X_4 =Fertilizer cost (Rands/ha)
X_5 =Fuels and lubricants cost (Rands/ha)
X_6 =Mechanical maintenance cost (Rands/ha)
e = Random error term

The corresponding double-log production function can be expressed as:

$$LogY_i = \beta_1 + \beta_2 LogX_{2i} + \beta_3 Log_{3i} + \beta_4 LogX_{4i} + \beta_5 LogX_{5i} + \beta_6 LogX_{6i} + \varepsilon_i$$

In this model the partial slope coefficients are $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, and \beta_6$. These measure the elasticity of Y with respect to X_i (i = 1, 2, 3, 4, 5, 6) holding other X's constant.

Explanatory variables and their measurement

The explanatory variables included in the model are farm size (that is, the area of land devoted to sugar cane, it is measured in

Table 1. Description of the expenditure group categories and sub-categories.

Expenditure	Item	Notes
Farm staff:	Salaries	Cash earnings of farm clerks, mechanics etc., but not management staff
	Wages	Cash earnings including bonuses, of permanent and seasonal labour
	Other labour costs	Includes medical, protective clothing, compound expenses, recruiting costs, Workman's Compensation Assurance (WCA), pension/provident fund contributions, training expenses, Unemployment Insurance Fund (UIF) contributions, etc.
	Rations	All food stuffs purchased for farm staff (e.g. meat, groceries, milk, etc).
Chemicals:		Pre- and post-emergent chemical weed killers, ripeners, etc.
Fertilizer:		Chemical fertilizers, lime, compost, filter cake, manure, etc; also cost of soil and leaf analysis
Fuel and lubricants:		Petrol, diesel, oils, greases, hydraulic fluids etc.
Maintenance: mechanical	Tractors / trailers	Tractor, trailer, crawler and bulldozer repairs and maintenance, spare parts and servicing charges
	Motor vehicles	Car, lorry and motor cycle repairs and vehicle maintenance, spares and servicing charges
	Implements	Repairs and spares for ploughs, cultivators, planters, fertilizer distributors, trailers, cranes, etc.
	Tyres / Workshop / Spares	All tractor, motor vehicle and implement tyres, welding rods, tools, radios and general workshop expenses.

Source: SACGA, 2008/09b.

Table 2. Farm and input use characteristics.

Parameter	Mean	Median	Min.	Max.	SD
Output (tonnes)	13 304	10 490	5 348	58000	9 715
Area (Ha)	280.9	205	104	1124	221.1
Staff (R)	626 857	417 751	64 350	3031300	683 777
Fertilizer (R)	549 114	357 610	126 723	3115165	589 620
Chemicals (R)	161 630	101 333	25 742	915000	178997
Fuels and Lubricants (R)	329 939	230 061	64 625	110 0596	280 707
Mechanical maintenance (R)	224 328	167 475	33 150	941 323	189 922

hectares). Other explanatory variables are stated in financial terms (that is, Rands/hectare), these are, farm staff, chemicals, fertilizer, fuel and lubricants, and mechanical maintenance. The description of the expenditure group categories and sub-categories are illustrated in Table 1.

RESULTS AND DISCUSSION

Farm characteristics, input use and costs

Farm characteristics in the sampled area are presented in Table 2. The average farm size under cane cultivation is 280 ha, with an average of 233 ha (83%) being harvested and an average output of 13 000 tonnes per season. The minimum and maximum farm sizes are 104 and 1 124 ha respectively with corresponding outputs of 5 348 and 58 000 tonnes per season, indicating that an increase in farm size will result in an increase in the average output.

The input costs range on average between R160 000 and R630 000 with farm staff and fertilizer cost being the most predominant cost item. The high farm staff cost is

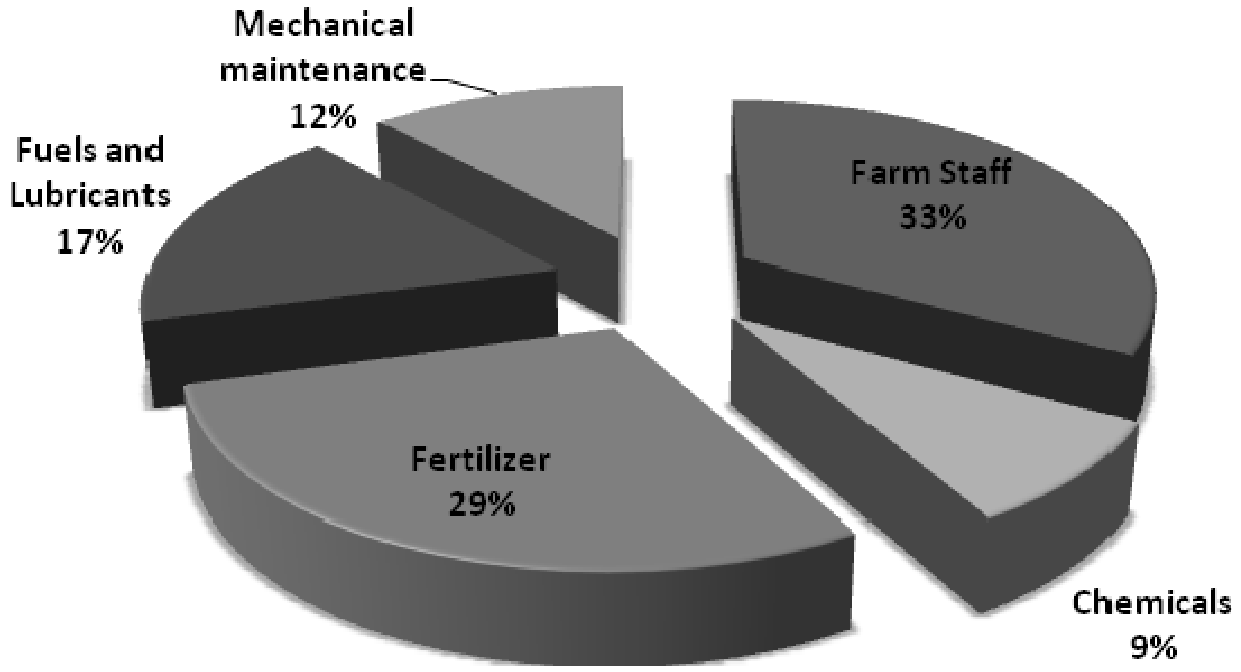

Figure 1. Relative shares of selected input costs in the Eshowe - Entumeni areas.

due to the labour intensive nature of the sugar industry, thus great quantities of labour are needed. Labour legislation also increased the minimum wage which has increased the financial and uncertainty costs. The fertilizer costs are relatively high as a result of the increases in oil prices in 2008/09 season. Moreover, the same applies to chemicals, fuels and lubricants, and machinery/maintenance costs; however, these costs are not highly inflated.

Figure 1 shows the relative proportion of the selected input costs. Farm staff and fertilizer costs represent 33 and 29% of the input costs respectively, together making up 62% of the total input costs. This is consistent with previous years' SACGA cost survey reports where farm staff, fertilizer and mechanical maintenance are the major cost item. There is an average increase of 15% rise in all inputs accounted for in this study compared to the 2007/2008 season.

A comparison of the average increases in cost of production for 2007/08 and 2008/09 seasons in the Eshowe- Entumeni areas with that of sugar industry for 2007/08 are presented in Figure 2. There is an increase for all input costs in the 2008/09 season, except for chemical inputs which is below that of the previous season, but above the industry average. The percentage increases above the previous seasons, within the area, were 15.5, -20, 20.7, 15 and 18% for farm staff, chemicals, fuels and lubricants and mechanical maintenance, respectively.

A five percent increase in operating expenditure was reported for the 2007/08 season, which did not reflect the true dynamics of input costs for the season. There were relatively high cost increases in cane transport, fertilizer and mechanical maintenance. These increases were minimised by a reduction in fixtures maintenance costs as well as a slight reduction in farm staff costs which was unexpected. The latter reduction could have been caused by the shrinking gap between actual wages paid and the minimum wage rate (SACGA, 2007/08c).

With regards to the performance of the farms, the average yield on the farms in the study area was 52 t/ha. This yield is consistent with the average yield of 49 t/ha reported for the mill supply areas that do not operate under irrigation conditions. The net farm income was higher in the 2008/09 season compared to the 2007/08 season, respectively earning R10 580 and R9 474 per hectare (SACGA, 2007/08b). The input costs are expressed in Rands per hectare (R/Ha) terms which show the relative cost per hectare, this is similar to the cost per tonnes (R/tonnes), but because tonnes harvested per hectare differ across seasons and farms, the cost per hectare is relevant in this case to make inferences about land use.

The analysis in Table 3 shows that to produce an average of 52 t/ha in the Eshowe-Entumeni areas, farmers would spend an average of R2 230 on farm staff, R1 954 on fertilizer, R1 174 on fuel/lubricants (these are the most predominant cost items) and an average of R575.20 and R798.32 on chemicals and machinery maintenance, respectively. The t-test for equality of means show that output and all the explanatory variables are statistically significant at the one percent level.

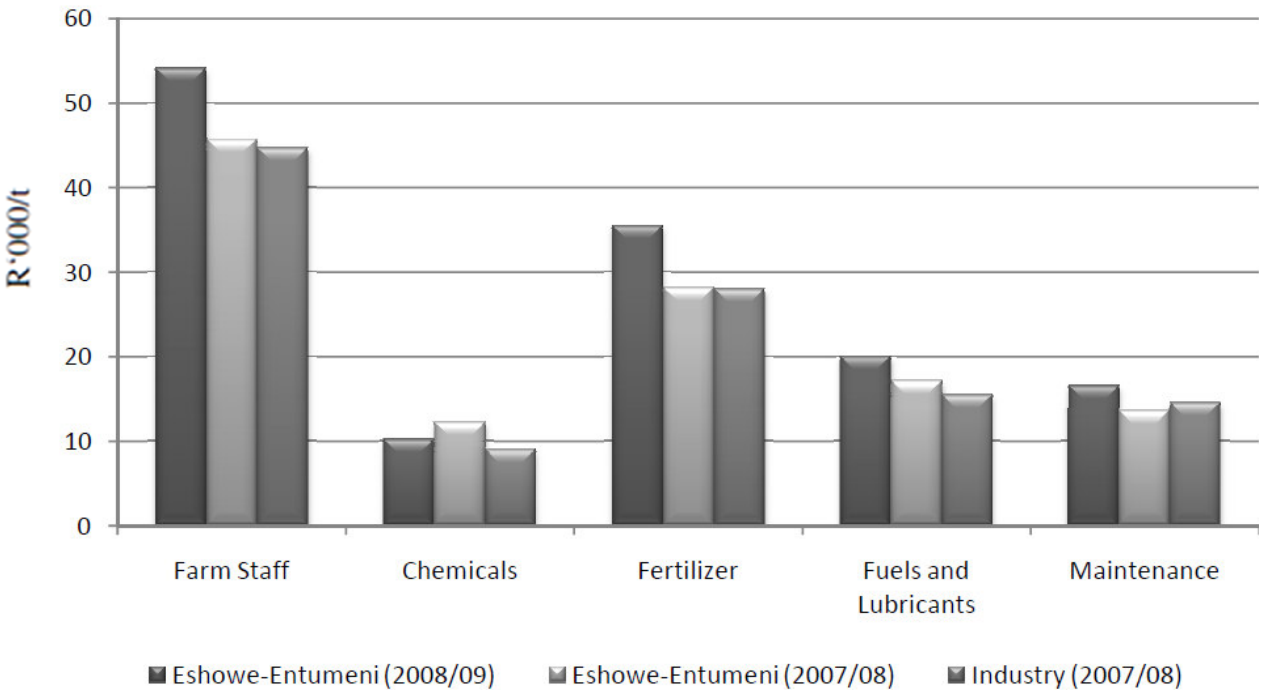

Figure 2. A comparison of average costs of selected inputs (R/ton).

Table 3. Resource use and performance indicators.

Land use	2007/08	2008/09	t-values (2008/09)
Area under sugarcane cultivation	303	281	7.07
Area of sugarcane harvested	191	233	4.22
Percentage of area harvested	63	83	17.34
Performance indicators			
Average yield (Tonnes/ha)	45	52***	21.83
Net income (R/Ha)	9 473.95	10 580.35***	20.12
Input costs (R/Ha):			
Farm staff	2 041.29	2 230.80***	22.81
Chemicals	547.80	575.20***	17.46
Fertilizer	1 256.51	1 954.10***	17.04
Fuels and Lubricants	1 465.23	1 174.20***	15.88
Machinery maintenance	765.28	798.32***	18.67

***Significant at 1%.

Elasticities of production

The empirical result of the ordinary least square of the double-log equation is presented in Table 4. A problem exists with the farm staff variable since much of the wage component is directly related to cane yield. This is especially the case where labour is paid on a per tonne basis. This variable cannot be excluded from the model as labour categories are not given separately and being a major resource on sugar-cane farms. Inflation of production coefficients may be a result of the cost component that varies with the yield. Caution should thus be taken in interpreting this coefficient (Ortmann, 1985).

The double-log function showed that farm size has the highest input elasticity coefficient of 0.635, while farm staff, fertilizer, chemicals, fuels/lubricants and mechanical

Table 4. Estimates of the double-log production function for Eshowe-Entumeni areas.

Parameter	Variable (Logarithmic)	s.e	t-statistics	*p* value
Constant	2.007***	0.449	4.47	<.001
Farm size	0.635***	0.155	4.09	<.001
Farm Staff	-0.046***	0.018	-2.60	0.551
Fertilizer	0.098***	0.032	3.06	0.532
Chemicals	0.159**	0.080	1.98	0.304
Fuels and Lubricants	-0.122*	0.071	-1.05	0.304
Mechanical Maintenance	0.022*	0.012	1.82	0.857
∑bi	0.7463			
R^2	0.814			
F. pr	<0.001			
df	30			

***, ** and * denote statistical significance at the 1, 5 and 10% levels, respectively.

Table 5. Marginal physical product (MPP) and value of marginal product (VMP)* of Inputs.

Parameter		MPP	VMP
Farm size	(δY/δA)	31.82424	(-)
Farm Staff	(δY/δS)	-0.00131	-2.63901
Chemicals	(δY/δC)	0.00280	5.62974
Fertilizer	(δY/δF)	0.01573	31.63372
Fuels and Lubricants	(δY/δFL)	-0.00569	-11.44780
Mechanical maintenance	(δY/δM)	0.00144	2.90477

*In terms of 2008/09 prices (-) based on the rental value of land – not included.

maintenance have elasticities of -0.046, 0.098, 0.159, -0.122 and 0.022, respectively. This implies that a 10% increase in farm size from the current 281 to 309 ha, is expected to increase average yield of sugarcane by 0.65%, holding all other factors constant. This is not surprising as the productivity, per farmer, was the fourth highest in the sugar industry in the 2007/08 season. Also, a 10% increase in the cost of farm staff from its present average value of R2 230 to R2 453 per hectare would have an associated decrease of 0.05% in the average yield of sugarcane, other factors held constant. However, a 10% increase in the cost of fuels and lubricants from its present average value of R1174.20 to R1291.62 per hectare would result in a decrease in the average yield of sugarcane by 0.12%, holding all other factors constant.

A 10% increase in the cost of fertiliser from its present value of R1954.10 to R2149.51 per hectare will results in 0.098% increase in the yield of sugarcane, while a 10% increase in the cost of chemicals from its present average value of R575 to R632.5 per hectare would lead to an increase the average yield of sugarcane by 0.16%, holding all other factors constant. This is however surprising, but a possible explanation for this could be attributed to the withdrawal of inputs and services by certain milling companies after restructuring of the two-tiered quota payment system, and by declining profitability of cane production (Bates and Sokhela, 2003). Another reason could be because the new freehold growers spent considerably less per hectare on fertiliser and yield-risk reducing chemicals as explained by high transaction costs incurred in purchasing inputs and transporting them to the field. Most of the new freehold growers are generally cash buyers of fertiliser and chemicals due to their low levels of creditworthiness and because they do not benefit from member discounts or terms offered by agricultural co-operatives. Transaction costs in availing inputs in the right quantity and at the right time also lead to timing inefficiencies in production activities and lower application rates (Armitage et al., 2009).

The R^2 value for the double-log function was 0.814 for the large-scale sugarcane farms in the study area. This means that about 81.4% of the variation in the average yield is explained by the explanatory variables included in the model.

Resource use productivity on large-scale sugarcane farms in Eshowe-Entumeni areas

Marginal physical product of inputs

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marginal product (VMP) for the input use for sugarcane production in the Eshowe-Entumeni area is presented in Table 5. The marginal physical products (MPP) of these factors were determined by multiplying the ratio of the geometric mean of sugarcane yield to the geometric mean of each input by their corresponding elasticity coefficients. The value of marginal product (VMP) is calculated by the multiplying MPP by the 2008/09 recoverable value (RV) price of R2011.18.

The magnitude of the marginal value product was compared to recoverable value (that is, VMP/ RV ratio) and this indicates the scope of resource adjustment necessary to attain economic optimum. A ratio greater 1 implies that the output could be raised by using more of a given resource. A ratio less than 1 imply the return to additional input is negative and output could be raised by using less of a given resource. A situation where the VMP equals the RV implied an economic optimum. The estimates of the ratio of the VMP/RV clearly indicate that inputs are used above the economic optimum level; only fertilizer is closest to optimal, but it however remains under-utilized. Farmers are incurring high costs of production on farm staff, chemicals, fuels/lubricants and mechanical maintenance. This implies that the farmers could increase their sugarcane outputs by reducing the costs on farm staff, chemicals, fuels/lubricants and mechanical maintenance and increasing the utilization (cost) of fertilizer. An increase in the use (cost) of fertilizer by R1 could increase total value product by R31.60. It is clear from the estimates of the marginal value productivities (MVP) that inputs combinations are not used optimally thus there is a need for resource adjustments.

Returns to scale

The summation of the elasticities of production for all inputs provides an indication of returns to scale, given that no relevant factors are left out. In this study the returns to scale value was 0.7463 implying a decreasing returns to scale. This value is consistent with the estimates of returns to scale which from 0.95 to1.08 for areas across the sugarcane growing regions of KwaZulu-Natal reported by Ortmann (1985a). However, it is important to note that the data used for this study is aggregated and not a representation of individual units within the areas. It may be suggested that some farm units do realize increasing returns to scale while others realize constant and decreasing returns to scale.

CONCLUSION AND POLICY IMPLICATIONS

From the findings of the study, it can be concluded that there are increasing input costs for sugarcane production in the Eshowe-Entumeni areas. The implication of this increasing input costs will impact on the structure, performance, and the growth of the industry. The result of the study had indicated a decreasing return to scale and inefficiencies in the resource use allocation. There is therefore the need for farmers to identify areas where the effects of the increased input costs can be reduced and improve the relative efficiencies of resource use. To fully tap the potential of increase productivity and reduce input costs, this study proffers the following recommendation:

Farm staffs costs (wages) is the most predominant cost item for sugarcane production, there is a need for government to consider making labour legislation more flexible to avoid raising the relative costs associated with permanent labour to levels that encourage the use of substitutes, like machinery and casual labour. Also, sugarcane producers in South Africa are dependent on oil and fertilizer imports, and therefore major investment and development of energy-saving measures and renewable energy resources are crucial for survival. Strategically, the cane growers should consider recycling of nutrients and energy contained in cane by-products (e.g. trash, molasses, vinasse, filter cake, etc) to reduce dependency on volatile imports, and to undertake procurement of fertilisers in bulk. Environmentally beneficial and cost reducing sustainable agronomic practices (such as, trashing, reduce tillage, green manuring, and biological farming) that reduce dependence on imported energy should be encouraged. Management attention to the best application techniques of inputs through extension services is important to increase input use efficiency.

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