DOI: 10.54083/ResBio/5.2.2023/49-55

Res. Bio., 2023, 5(2):49-55

Research Biotica

Crossref

e-ISSN: 2582-6743

June, 2023

Article ID: RB157

Research Article

Understanding Socio-Economic Challenges Facing A2 Out-Grower Sugarcane Farmers in Zimbabwe: Case of Lowveld Area in Masvingo Province

Never Mafuse*, Mathar Timba and Zivenge Emmanuael

Dept. of Agricultural Economics Education and Extension, Faculty of Agriculture and Environmental Sciences, Bindura University of Science Education, PO Box 1020, Bindura, Zimbabwe

Corresponding Author

Never Mafuse

✉: nmafuse@buse.ac.zw

Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?

Mafuse *et al*., 2023. Understanding Socio-Economic Challenges Facing A2 Out-Grower Sugarcane Farmers in Zimbabwe: Case of Lowveld Area in Masvingo Province. *Research Biotica* 5(2): 49-55.

Abstract

Production of sugarcane in the out grower farming community has been decreasing and remained well below the expected standards. This study sought to investigate the reasons contributing to decline in sugarcane production of out grower farmers in the Lowveld area of Zimbabwe. The specific objectives of the study were to identify the socio-economic factors affecting sugarcane production, to measure technical efficiency of the sugarcane farmers and to measure the costs and returns of sugarcane (profitability). A sample of farmers 100 was randomly selected and was interviewed with a structured questionnaire. Results from the study revealed that farm size, credit access, farming experience, age and extension contacts significantly affected sugar cane yield. The mean technical efficiency of the farmers was 0.69. 36% of the farmers have technical efficiency ranging from 0.7 to 0.75. Farmers selected for the study have average annual revenue of \$ 5,652.5 ha^{-1}, variable costs of \$ 5,320 ha^{-1} giving them an average gross profit of \$ 332.5 ha^{-1}. The research concluded that the farmers are technically efficient. It is recommended that, farmers should be linked to more extension agents and also to form cooperatives.

Keywords: A2 farmers, Efficiency, Gross margin, Profitability, Sugarcane production

Introduction

Sugarcane (*Saccharum officinarum*) is a crop of major importance in the tropical climates. Brazil is the world's largest sugarcane producer, followed by India (which is also the world's largest consumer), the European Union, Thailand and China (Rudorff *et al.*, 2010). Sugarcane belongs to the grass family *Poaceae,* an economically important seed plant family that includes maize, wheat, rice sorghum and many forage crops (Vettore *et al.*, 2003).

Sugarcane is used to produce sugar which is traded on the international market and farmers have to content with the price fluctuations offered by this market and including competition from beet sugar and natural sweeteners. Because of its economic importance in major producing countries governments are forced to offer subsidies to their sugar farmers and protect their sugar industry from foreign competition. According to Vettore *et al.* (2003), Brazil is the world largest exporter and Thailand; hence, the global market is dominated by Brazil, Thailand, China and India. These countries produce enough sugar for their consumption and export to international markets.

The world sugar industry produces over 160 million tonnes of sugar annually. The most important sugar producing countries in tropical Africa includes Mauritius, Kenya, Sudan, Zimbabwe, Cote Devoir, Ethiopia, Malawi, Zambia, Nigeria, Cameroon and Zaire with Nigeria being the largest producer (Girei and Giroh, 2012).

Sugarcane production is important to the economy of Zimbabwe as it contributes to the Gross Domestic Product (GDP), employment creation and foreign currency generation (Chandiposha, 2013). The production of sugarcane is done in many parts of the country but mostly in the Lowveld area of Chiredzi and Mwenezi Districts in Masvingo Province, where it is grown under irrigation. Green fuel also produces sugarcane in Sabi Valley and Chisumbanje areas for ethanol manufacturing.

Article History

RECEIVED on 07th January 2023 RECEIVED in revised form 15th April 2023 ACCEPTED in final form 20th April 2023

The livelihood of people in the South Eastern Lowveld of Zimbabwe and surrounding areas relies much on the sugar industry (Chandiposha, 2013). Sugar produced in this part of the country is consumed locally and the remainder is exported generating substantial foreign currency from sale of sugar, ethanol and other by products like molasses filter cake and biogases (Clowes and Breakwell, 1998; Esterhuzein, 2012).

According to the sugar industry statistics, around 6,250,000 MT of raw cane was produced in Zimbabwe, with average yield approaching 100 tonnes ha^{-1}. The second largest output was 4,621,465 MT recorded in 2002 at an average of 105.3 tonnes ha^{-1} and out-growers contributed 1,250,501 MT to the total production at an average of 103 tonnes ha^{-1} (Tongaat Hulett, 2017). The out-grower farming community, which was born out of land reform programme, is playing a vital role in the production of sugarcane. Statistics from Tongaat Hullet and Hippo Valley Milling Group indicate that 156,691 tonnes of sugar which was processed in 2002 from the cane was delivered by the out-growers at an average of 12, 9 tonnes of sugar ha^{-1}.

The out-grower farmers' contribution to sugar production has however decreased. Over the years after 2002 the industry statistics indicates that the yield declined due to a host of factors underpinned by the poor performance of the country's economy. With the introduction of the multiple currency system in 2010, the farmers have been on the rebound mostly on the area under production but yields remained well below the industry record of 103 tonnes of cane ha^{-1} achieved in 2002.

This continuous decrease in sugar production has led to a decrease in sugar exports (Sikuka, 2017) and an increase in the price of sugar at the domestic market (Tongaat Hulett, 2016). Consumption rate especially in the rural communities has decreased since they cannot afford to buy sugar at the current domestic market price. Moreover, the country is sometimes importing refined sugar from South Africa to meet the demand in the local markets. Zimbabwe is no longer exporting more than it used to do and this has hindered the country from earning more foreign currency. Production of other products like ethanol produced from molasses, a by-product of sugar production has also decreased. According to Chidoko and Chimwai (2011), production of the sugar industry affects the whole nation in terms of foreign currency earnings, production of ethanol, employment creation, and generation of electricity, molasses and other by-products.

Materials and Methods

The study was conducted in Hippo Valley Estate, post resettlement areas established under the fast track land reform programme. It is located in Chiredzi in the lowveld of region V. This region is characterized by low and erratic rainfall less than 450 mm annum^{-1} and the temperatures are very high about 35 °C on average. Due to these weather conditions sugarcane production is done under irrigation within a 12-month cycle. According to Clowes and Breakwell (1998), sugarcane grows well in low altitudes with hot summers and short cold winters. Tongaat Hulett owns about 50.8% of the Hippo Valley Estates and the rest is occupied by A2 out grower farmers with land ranging from 10 to 50 ha each.

Analytical Tools

In order to achieve the objectives of this study, the following models were employed, linear regression analyses, stochastic production frontier analysis and farm budgeting analysis (Gross Margin). The Statistical Package for Social Sciences (SPSS) software was used for linear regression and descriptive statistics for gross margin analysis. FRONTIER 4.1 software was used for stochastic production frontier analysis to estimate the technical efficiency scores of the farmers in the study area.

Linear Regression

The aim of the study was to determine whether there is a relationship between the socioeconomic factors and the yield of sugarcane production. The multiple regression equation used is as follows:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \beta_9 X_{9i} + \beta_{10} X_{10i} + e_i$$

Where,

Y_i = sugarcane yield,

β_0 = constant or y-intercept,

β_s = coefficient to be determined,

X_{1i} = credit access,

X_{2i} = age,

X_{3i} = farm size,

X_{4i} = farming experience,

X_{5i} = household size,

X_{6i} = extension contacts,

X_{7i} = occupation,

X_{8i} = gender,

X_{9i} = marital status,

X_{10i} = level of education,

e_i = stochastic error.

Stochastic Production Frontier Analysis

The stochastic production frontier analysis was used and the FRONTIER 4.1 programme was used to estimate the different technical efficiencies of each farmer. Stochastic production frontier analysis has been widely used to study technical efficiency in various settings since its introduction by Aigner *et al.* (1977). The approach has two components: a stochastic production frontier serving as a benchmark against which firm efficiency is measured, and a one-sided error term which has an independent and identical distribution across observations and captures technical inefficiency across production units (Liu and Myers, 2009). According to Margaritis and Psillaki (2007), stochastic Production Frontier Analysis indicates the maximum expected output for a given set of inputs. It is derived from the production theory and based on the assumption that output is a function of inputs and the efficiency of the producer in using these inputs. It is also the ability of the farmer to employ best practices and operate on the production frontier. It therefore indicates the maximum potential output for a given set of inputs. The difference between observed output and the potential output is generally attributed to a combination of inefficiency and random error. A general stochastic production frontier function is as follows:

$Y = \beta_0 X_1 \beta_1 X_2 \beta_2 X_3 \beta_3 X_4 \beta_4 X_5 \beta_5 X_6 \beta_6 X_7 \beta eu$

The production function was estimated using the total yield of sugarcane in tonnes ha^{-1} as the dependent variable subject to the production inputs. In order to use the least square procedure for estimating and easy interpretation, the production function was liberalized so that it becomes linear in its parameters.

$$InY_i = \beta_{0i} + \beta_1 InX_{1i} + \beta_2 InX_{2i} + \beta_3 InX_{3i} + \beta_4 InX_{4i} + \beta_5 InX_{5i} + \beta_6 InX_{6i} + B_7 InX_{7i} + u$$

Where the subscript *i* indicate the i^{th} farmer in the sample (i = 1, 2, 3, 4, ………, 100)

Where,

Y_i = sugarcane output,

β_0 = constant or y-intercept,

$\beta_{1i,}$ $\beta_{2i,}$ $\beta_{3i,}$ $\beta_{4i,}$ $\beta_{5i,}$ β_{6i} and β_{7i} = output elasticities to be estimated,

X_1 = fertilizers [Ammonium Nitrate (AN)],

X_2 = Fertilizers [Single Super Phosphate (SSP)],

X_3 = Fertilizers [Muriate of Potash (MOP)],

All the fertilizers AN, SSP and MOP are measured in kg.

X_4 = water (total amount of water measured in mega litres used for irrigation),

X_5 = electricity (total number of watts used for irrigation),

X_6 = labour (wage $year^{-1}$),

X_7 = chemicals (are measured in litres and they include both herbicides and pesticides),

u = stochastic error (associated with random factors outside the farmers control such as topography and weather it also captures inefficiency).

The major inputs used in sugarcane production have been used as independent variables in the equation, the dependent variable being yield or output of sugarcane. Their quantities being used by farmers was used to measure how efficient each farmer is in using this resources.

Gross Margin Analysis

Farm budgeting analysis is one of the most analytical tools is used in farm management investigations to determine the performance standards of a farm enterprise. Wahu *et al.* (2017) used the gross margin analysis to estimate the costs and returns of sugarcane production in Adamawa State in Nigeria. In a research titled costs and returns of sugarcane production at different size groups of farms in Meerut district in India by Kumar *et al.* (2014), the gross return was used as an analytical tool to estimate the costs and returns of cane production. Nazir *et al.* (2012) carried out a research to find out the profitability of sugarcane production in the major growing areas of Pakistan and used the gross margin analysis to estimate costs and returns of cane production. Olujenyo (2008) used the gross margin analysis to estimate the costs and returns of maize production in Akokoland in Nigeria.

Though it has some limitations, gross margin analysis was used as proxy indicator to measure profitability of sugar cane production. Gross margin is simply the difference between revenue and the total variable costs in production incurred by the farmer.

The model for gross margin analysis was expressed as follows:

$GFI = TVP = TR = TPP \times P_X$

$GM = GFI - TVC \; TVP = TPP \times P_X = GFI$

Where,

TR = Total revenue (\$ ha^{-1})

GFI = Gross farm income (\$ ha^{-1})

TVP = Total value of production (\$ ha^{-1})

TPP = Total physical product (tonnes ha^{-1})

P_X = Unit market price of the product (\$ ha^{-1})

TVC = Total variable costs (\$ ha^{-1})

GM = Gross margin (\$ ha^{-1})

All the calculations on revenue, variable costs and profit were done ha^{-1}.

Descriptive statistics was used to estimate the mean, mode, and median, standard deviation minimum and maximum of the expenses, revenue and profits that farmers are earning ha^{-1}.

Results and Discussion

Socio-Economic Factors Affecting Sugarcane Production

To investigate the socio-economic factors affecting sugarcane production, the linear regression model was used and the yield of sugarcane was used as the dependent variable in the equation. The equation below shows the relationship between the yield of sugarcane and the socioeconomic factors affecting the quantity of sugarcane.

Yield = 867.08 - 438.30 credit access - 17.85 age + 62.24 farm size + 41.46 farming experience - 19.38 household size + 139.07 extension contacts + 24.78 occupation + 122.61 gender - 202.94 single - 139.08 married + 249.46 no formal edu + 151.47 primary edu + 278.43 secondary edu.

In the equation the dependent variable is yield and the independent variables include age, gender, and marital status, level of education, access to credit, extension contacts, occupation, farm size, household size and the farmers experience in cane production. Widowed under-marital status and tertiary level under the level of education were not included in the equation because they were used as reference variables or base when dummies were created.

The R2 of the model was 0.955 meaning that 95.5% is being explained by the model. 95.5% of the variation in sugarcane yield is being explained by the explanatory variables in the equation. The remaining 4.5% can be attributed to other unknown variable that affect sugarcane production that are not included in the regression equation.

Credit access, age, farm size, farming experience, and number of extension contacts that the farmer has significantly affect the production of sugarcane in the study area.

Table 1: Coefficients and significance of variables

Model	Unstandardized coefficients		Standardized coefficients	T	Sig.
	B	Std. Error	Beta		
Constant	867.078	615.114		1.410	0.167
Credit access	-438.303	178.442	-0.190	-2.456	0.019*
Age	-17.848	7.400	-0.157	-2.412	0.021*
Farm size	62.241	5.578	0.694	11.158	0.000*
Farming experience	41.460	14.202	0.198	2.919	0.006*
Household size	-19.383	14.493	-0.064	-1.337	0.189
Extension contacts	139.068	46.798	0.207	2.972	0.005*
Occupation	24.781	274.694	0.012	0.090	0.929
Gender	122.606	127.425	0.042	0.962	0.342
Single	-202.936	168.916	-0.062	-1.201	0.237
Married	-139.078	123.853	-0.060	-1.123	0.269
formal education	249.460	268.866	0.139	0.928	0.360
Primary education	151.466	270.857	0.059	0.559	0.579
Secondary education	278.426	261.883	0.115	1.063	0.295

(NB: B represents Beta; T statistic is the coefficient divided by its standard error; Sig represents significant)

Credit Access

Credit access significantly affect sugarcane production at 5% level of significance with a significant value of 0.019 Credit access has proved to have a negative relationship with the production of sugarcane which was not expected by the researchers. An increase in the access to credit by one-unit result in a decrease of sugarcane yield by 438.303 tonnes holding all other factors constant. This means that the cost of borrowing is expensive, *i.e.*, the interest rates being charged to farmers by financial institutes are too high leading to an increase in costs reducing sugarcane production.

Age

The age of the farmer has a negative effect on yield of sugarcane as expected. Age has a significant value of 0.021 at 5% level of significance. Results have proved that an increase in the age of the farmer by one-unit result in the reduction of cane yield by 17.848 tonnes Therefore as age increases yield is affected negatively because the farmers are becoming less economic active. Sugarcane farming consumes time more and demands a lot of activities from planting up to harvesting which are tougher in nature than other crops, it takes 10-12 months for cane to reach maturity, thus needs someone who is energetic, hardworking and endurable like the younger farmers. This goes in line with the findings of Sulaiman *et al.* (2015) that the older the sugarcane farmers the more technically efficient they become. Also, Kolawole and Ojo (2007) in their study found out that age is positively correlated to technical inefficiency.

Farm Size

Farm size is positively correlated to the yield of sugarcane as expected. It has a significant value of 0.000 at 1% level of significance. An increase in the farm size by one-unit result in an increase in the quantity of yield by 62.241 tonnes. The larger the area planted and harvested the greater the yield produced. This is in line with the findings of Supaporn (2015) found out that, increase in cultivated area increases sugarcane output. But an increase in the size of the farm sometimes doesn't mean an increase in output as this depends on how efficient the farmer is.

Farming Experience

There is positive relationship between cane yield and farming experience. The variable has a significant value of 0.006 at 1% level of significance. An increase in farming experience by a unit increases yield by 41.460 tonnes. This is because as the farmer gets more experience it means he or she is able to minimise mistakes and learn from the previous mistakes. Farmers who have been in cane production for quite a long period of time have better knowledge on how and when to plant, weeding, fertilizer application and other resource input efficient utilization than those who have recently started. Giroh *et al.* (2011) in their study found out that farming experience affect the yield of sugarcane, the more experience the farmer has the larger the output.

Extension Contacts

The number of extension contacts that the farmer has, has a positive relationship with the yield that the farmer will get. Number of extension contacts has a significant value of 0.005 at 1% level of significance. An increase in the number of extension contacts by one unit increases cane yield by 139.068 tonnes. Therefore, farmers who receive more and regular contacts were more efficient in cane production in the study area. Extension contacts can be received through media such as radio, televisions, newspapers, published journals or write ups or directly through experienced sugarcane farmer, extension agents. According to a research titled 'Analysis of production efficiency of food crop farmers of Bank of Agriculture loan Scheme in Ogun State' by Ambali *et al.* (2012), the number of extension contacts that the farmer has are said to have an effect on the yield that the farmers produces, the more the extension contacts the greater the yield.

Efficiency Analysis in Sugarcane Production

Technical efficiency (TE) is the ability to maximise output with a given set of limited resources. Technical efficiency is a measure of the deviation of current output from the possible maximum output that can be obtained. A farmer is said to be technically efficient if the estimated technical efficiency is equal to 1 and inefficient if 0. When the technical efficiency is less than 1, (1-TE) is the percentage increase possible in output. Hence, technical efficiency is assumed as the ability of the farmer to increase output to the maximum possible level that can be obtained without a corresponding increase in input use. In other words, technical efficiency can be viewed as reallocation of the present resources in a way that maximises production.

Table 2: Frequency distribution of technical efficiency among sugarcane farmers

Range of technical efficiency	Frequency	Percentage (%)
≤ 0.49	4	4
0.5 – 0.55	6	6
0.56 – 0.59	2	2
0.6 – 0.65	16	16
0.66 – 0.69	14	14
0.7 – 0.75	36	36
0.76 – 0.79	16	16
0.8 – 0.85	4	4
0.86 – 0.89	2	2
≥ 0.9	0	0
Total	100	100

The estimated technical efficiency among out-grower farmers in the study area ranged from 0.35 to 0.87 with a mean of 0.69 technical efficiency, indicating that on average the output produced by Hippo Valley out-grower farming community is 69% of the best practice frontier. Thus, a mean technical efficiency score of 69% outputs on all the farmers in the area can be increased by 31% through a more effective use of their input bundle given their current state of technology they are using.

About 28% of the sugarcane farmers attained less than 0.65 level of technical efficiency and none of the farmers had a technical efficiency which was greater or equal to 0.9. About 6% of the farmers had technical efficiency levels which were greater than 0.8 but less than 0.9. Moreover, the distribution of technical efficiency of the farmers reveals that approximately 42% of the sugarcane farmers had a technical efficiency index below the mean technical efficiency while the remaining farmers were above the mean technical efficiency.

Profitability Analysis in Sugarcane Production

Gross profit is simply the difference between revenue and the total variable costs. Expenses and profit were calculated ha^{-1} for each farmer and then averaged each; revenue was calculated by averaging the total sugar in tonnes that each farmer produce ha^{-1} and then multiply by the price $tonnes^{-1}$ ($ 595). The budget with the gross margin is given below.

Table 3: Average costs and returns ha^{-1} of sugarcane (Gross Margin)

A. Returns	
i) Average output (tonnes of sugar ha^{-1})	9.5 tonnes
ii) Price ($ $tonnes^{-1}$)	$ 595.00
Total Revenue = (i × ii)	$ 5,652.50
B. Variable Costs	Value ($)
a) Fertilizer	798
b) Labour	1109
c) Water	55
d) Electricity	1100
e) Chemicals	230
f) Cuttings '*setts*'	110

The costs incurred in sugarcane production and the financial benefits derived from it were estimated using the gross margin analysis in the table 4. The total average revenue generated per hectare in the study area was $ 5,652.5 and the total variable costs were $ 5,320 giving a gross margin of $ 332.5 ha^{-1}. This result implies that sugarcane production has been reduced as its production level is well below the expected average standards of 100-120 tonnes ha^{-1} that is produced by the Triangle and Hippo Estates.

Conclusion and Recommendations

Sugarcane yield in Hippo Valley is significantly affected by farm size, farming experience, extension contacts, age and credit access. The mean technical efficiency for the farmers in the study area was 0.69 meaning that farmers are not being efficient in production. A greater percentage (36%) of the farmers had technical efficiency ranging between 0.7 and 0.75. Results showed that farmers have average revenue of $ 5,652.5 ha^{-1}, variable costs $ 5,320, therefore having an average of $ 332.5 profit ha^{-1}.

Farmers in the study area have relatively high costs while their mean technical efficiency is very low (0.69). There is under-utilisation of resources by the out-grower farmers in the study area which is leading to high costs being realised by the farmers while yielding very low returns.

Recommendations were made based on the results that have been discussed and the conclusion drawn from the results:

Farmers should have more extension contacts so that they are able to get a lot of information that is useful and updated from different extension agents who have a vast knowledge in sugarcane production. There is need for farmers to link up with different specialists in cane production and also some institutes like the Chiredzi Research Station and the Zimbabwe Sugar Association Experiment station. By doing so their experience in sugarcane farming also increases hence an increase in yield.

Farmers are recommended to do cooperatives so that they can share costs of production. They can also do joint ventures with well-established companies like Tongaat Hulett or try to talk to the European Union so that they do contract farming like what sugarcane farmers in Mkwasine Estate.

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