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SOCIO-ECONOMIC DETERMINANTS OF SUGARCANE PRODUCTION AMONG SMALL SCALE FARMERS IN NYANDO SUGARBELT OF KENYA

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ABSTRACT

Sugar industry in Kenya supports livelihood of 25% of the population both directly and indirectly. The industry accounts for about 15% of Agricultural Gross Domestic Product and is a major employer for most households in Western Kenya. Sugarcane outputs in Kenya have been on the decline from a modest 73 tons to 55 tons per hectare between the years 2009 and 2014. This decline has attracted researchers to this area of study; however, most studies have mainly focused on agricultural determinants without regard to the socio and economic determinants of cane production. This study therefore sought to establish socio-economic determinants of Sugarcane production among small scale farmers in Nyando Sugar Belt. The study was anchored on Production Theory and a total of 375 cane farmers responded to the questionnaires used to collect primary data. Secondary data were from farmers' records. Reliability of the research instruments were ascertained through test-retest method. Multiple regression was used to ascertain the direction and magnitude of influences of the study variables on cane output. The study revealed that variable input costs (land preparation $\beta=0.455$ at p-value=0.000, fertilizer application cost $\beta=0.168$ at p-value=0.000, weeding and weed control cost $\beta=0.398$ at p-value=0.000 and seed cane and planting cost $\beta=0.479$ at p-value=0.000) had significant positive effect on cane output. Gender was also found to have a significant effect on cane output at $\beta=0.093$ and p-value=0.010. It is recommended that more investments be made on land preparation, fertilizer application, weeding and weed control and seed cane and planting to improve cane output. The study also recommends for interventions targeting female headed households to enhance cane output.

KEYWORDS:

Socio-economic, Sugarcane, Production, Kenya

1.0 BACKGROUND OF THE STUDY

Production is the creation of utility for sale. It is a very important economic activity since the standard of living of citizens depends on the volume and variety of goods and services produced in a country (Mishra 2008). Belang and Abebao (2004) identified increasing global food demand and technological practices as key challenges facing agricultural sector. McCalla (2001) identified growing population, prevalence of rural poverty and sustainable management of natural resources as key challenges affecting agriculture in the 21st century. Thus, to reduce poverty there is need to improve on profitability and productivity of small scale farmers.

According to Enete and Amusa (2010) climate change is the most serious environmental threat to fight against hunger, malnutrition, disease and poverty in Africa mainly through its impact on agricultural productivity. As planet warms, rainfall patterns shift and extreme events such as floods and drought became more frequent resulting into poor and unpredictable yields (Zoellick, 2009).It is projected that crop yield in Africa may fall by 10 - 20% by 2050 or even up to 50% due to climatic changes(Jones and Thornton, 2003). According to Cargill (2015) the challenges facing Africa food system are lack of critical inputs, inaccessible credit facilities, lack of property rights, poor infrastructure and lack of off farm income. Thus, to achieve food security there is need for greater funding in agricultural infrastructure development, provision of irrigation, capacity building of farmers and development of high yielding and drought resistant crops.

Although economic theory suggests that relative importance of agriculture declines as economy grows, agriculture is still critical for such transformation to occur. Evidence as accumulated strongly suggests that agriculture is a dynamic sector that responds positively to price incentives and that other policies which tax agriculture reduces investments in the sector (Mundlack, 1985).

In Kenya, agriculture is the mainstay of the country's economy providing 75% of industrial raw materials and 57% of national income. The agricultural sector absorbs over 50% of the labour force and is dominated by small scale farmers who account for 75% of agricultural output (KESREF, 2009). The sugar sector is the 3rd most important contributor to Gross Domestic Product (GDP) after tea and coffee (KSB, 2008). The sugar industry is a major contributor to the agricultural sector and support of livelihood of 6 million people directly and indirectly or at least 25% of the Kenyan population. The subsector accounts for about 15% of the agricultural GDP; it is a dominant employer and source of livelihood for most households (KSB, 2008). Area under cane is approximately 123,622 hectares out of which 111,189 hectares are in the hands of small scale farmers and the balance of 12,433 hectares constitutes nucleus estate. In 2008, the industry employed about 500,000 people directly or indirectly in the sugarcane business chain from production to consumption (Bracing for COMESA: Kenyan Sugar industry bulletin, 2008).

In addition, the sugar industry saves Kenya over USD 250 million in foreign exchange annually and contributes significant tax revenue to the exchequer. In the Sugar Belt, the sugar industry contributes to infrastructure development through road construction and maintenance, construction of bridges and towards provision of various social amenities. The industry also contributes towards environmental and energy conservation thereby attracting donor support through grants (Kenya Sugar Board strategic plan 2008-2012). Due to the importance of the sugar industry, Kenya government continues to provide subsidized fertilizers to the farmers to enhance cane output. Cane farming has of late been threatened due to the eminent end of Common Market for Eastern and Southern Africa (COMESA) safeguards expected in February 2019, wherein the sugar industry will be expected to operate under a liberalized trade regime. In such environment, the industry will have to enhance its competitiveness along the entire value chain and reduce production costs by 39% to be in line with other COMESA sugar producing countries (KSB, 2008). During the year 2012/2013, sugarcane production in Kenya stood at 600,179 metric tons which represents 54% of the factory capacity against an annual demand of 841,957 metric tons and production potential of about 1 million metric tons at 89% factory capacity. The deficit was compensated mainly through importation from sugar surplus countries such as Egypt, Thailand, South Africa, Saudi Arabia, Sudan, Zambia and Madagascar (KSB, 2008).

Productivity levels for many crops are below potential and for some agricultural produce, yield and value over 5year period has either remained constant or are on decline. In the case of sugarcane in Kenya, yield levels declined from a modest 73 tons per hectare to 55 tons per hectare between the years 2009 and 2014 (Agricultural sector development strategy (ASDS) 2009-2020). This is in contrast with the world sugarcane production statistics which recorded an increase of 17.68% from 1,323.65 million metric tons in 2004 to 1,557.65 million metric tons in 2008(FAO stat. 2008).

According to KSB statistics, the average cane output in 2008 was 72.9 TC/HA with the highest cane outputs of 86.0 TC/HA being recorded in South Nyanza Sugar Belt and the lowest cane outputs of 60.3 TC/HA recorded in Nyando Sugar Belt (KSB, 2008). These statistics explains the reason for the choice of the study area. The purpose of this research was to investigate the socio-economic determinants of sugarcane production among small scale farmers in Nyando Sugar Belt, Kenya. Most researchers have concentrated on the agricultural determinants of sugarcane production, technology improvements, bio-diversity and managerial factors thereby ignoring the socio- economic determinants opined in economic theory.

2.0 THEORETICAL FRAMEWORK

Production theory is the study of production or the economic process of converting inputs into outputs. It explains the principles in which firms take decisions on how much commodity it sells, how much it produces and how much raw materials it will use to achieve a given level of production. Production theory encompasses production function, technical and economic efficiencies analysis.

Production function attempts to ascertain the maximum amount of output that can be produced from a specified set of inputs given existing technology. The function may be expressed in the form $Q = f(L, K)$, some factor inputs assumed fixed in the short run and hence only variable inputs determine output. However, in the long run all factors are assumed variable within the confines of technology and therefore determine output.

Technical efficiency is achieved when maximum output is produced with a given combination of inputs whereas economic efficiency is achieved when a firm is producing a given output at the lowest possible cost (Mishra, 2008).

The objectives of firms in production theory are to maximize profits and to achieve this goal, costs should be minimized. In the short run, the only way to maximize profits is to minimize cost since output is fixed due to capacity constraints.

Production theory has been criticized on the basis that production function is not derived from observations or practice; it is over simplified and assumes no changes in the rest of the economy, it neglects changes in techniques of production and pays no attention to risks and uncertainties which becloud all business decisions. Despite these criticisms the theory is considered as conditions of an economy that tends towards rather than conditions that are always instantaneously achieved (Dorfman et al, 1987).

This study was anchored on production theory particularly Cobb-Douglas production function which depicts the relationship between input factors and output. The analysis of the sugarcane input and output in mathematical form enabled the researcher to gain a deeper understanding of the determinants of cane production. The theory had been chosen since it is flexible, easy to use, has good empirical fit across many data sets and allows for regression under Ordinary Least Squares (OLS) in logarithm form (Clainos and Ledwin, 2011).A Cobb-Douglas production function was used to estimate input – output relationship. It is a non linear homogenous production function of the form Q = f(L, K) and $Q = AL^{\alpha}K^{\beta}$.

3.0 RESEARCH METHODOLOGY

Research Design

The study adopted correlation research design which enabled in-depth search for information from the respondents regarding the socio-economic determinants of sugarcane production in Nyando Sugar Belt, Kenya. This design was chosen since it would enable the researcher to depict relationships among study variables in an appropriate manner. It was flexible and allowed for analysis of data in quantitative form (Kothari, 2004).

Study Area

The study was carried out in the Nyando Sugar Belt of the Western region of Kenya, which was experiencing decline in cane output compared to other Sugar Belts as evidenced through reduction in both areas under cane and acreage harvested. The tonnage of cane harvested per hectare was 49.90 tons in Nyando compared to 60.45 and 70.62 tons in Western and South Nyanza Sugar Belts respectively in 2013 (KSB, 2013).

Nyando Sugar Belt lies between longitudes 34^{O}, 01' and 35^{O}, 03'E and latitudes 0^{O}, 02'N and 0^{O}, 02'S. It covered an area of, 449sq.km and comprised of the following three counties, namely, Kisumu, Nandi and Kericho. The number of households in Nyando Sugar Belt was 540,926 (National population census report, 2009). The cane farmers' population in these counties was estimated at 5, 195, 4,332 and 2,530 for Kisumu, Nandi and Kericho counties respectively (KSB, 2013).

Target Population

The target population was 12,057 registered cane farmers spread across the three counties, 5, 195, 4,332 and 2,530 in Kisumu, Nandi and Kericho counties respectively (KSB, 2013).

Sample Size and Sampling Technique

The most conservative sample for the study was 384 cane farmers (based on the formulae for determining sample size $n = \frac{z^2 p.q}{e^2}$, where n = sample size, z = standard variate at a given confidence level, e = acceptable error (precision) p=sample proportion of successes, q=1-p, (Kothari C.R.2004) $i.e. \frac{1.96^2 (0.5)(0.5)}{0.05^2}$ at 95% confidence interval and p taken as 0.5) distributed within the three counties in the Nyando Sugar Belt as follows, Kisumu county 165 cane farmers, Kericho county 81 cane farmers and 138 cane farmers drawn from Nandi county out of the total population of cane farmers estimated at 12,057 who carry out sugar cane farming within the Sugar Belt.

Due to uneven spread of farmers across the three counties, proportional cluster sampling was employed. This sampling technique ensured that sufficient number was selected from each group when groups are not equal in size (McMillan, 1999). Given the large size of the population, cane farmers data was obtained from farmer's records, the annual surveys conducted by the Kenya Sugar Board and data maintained by various sugar millers in the region and a sample of 384 cane farmers was randomly selected using Binet Square Method.

County	Target Population	Sample Size
Kisumu	5,195	165
Kericho	2,530	81
Nandi	4,332	138
Total	**12,057**	**384**

Source: KSB Yearbook Statistics, 2013

Data Type and Collection Technique

The data for the study was both primary and secondary. Structured and semi-structured questionnaires were used to collect primary data to enhance complete understanding of the socio-economic determinants of sugarcane production in Nyando Sugar Belt. A sample of 384 cane farmers was selected through clustering of the population due to the wider geographical coverage and interviewed during the study to assess the effect of cost of variable inputs, farmer educational level, land ownership, and gender on sugarcane production in Nyando Sugar Belt.

Secondary data was obtained from farmers' records, agricultural data maintained by the sugar millers, surveys conducted by the Kenya Sugar Board, publications from the internet, Journals and government resource center.

Data Analysis

In this study both descriptive and inferential statistics were used in analyzing the data and testing of the research hypothesis. Standard deviation and variance were used to measure the deviations of all the important variables. Since the study sought to determine the relationship between cane output to the various factors, data were analyzed through correlation and regression analysis.

Econometric Model and Specification

Cobb-Douglas stochastic frontier production model used during the study was adapted from Odondo et al (2013) as specified below in its general form;

$$Y_i = B X_{1i}^{\alpha_1} X_{2i}^{\alpha_2} X_{3i}^{\alpha_3} X_{4i}^{\alpha_4} X_{5i}^{\alpha_5} X_{6i}^{\alpha_6} X_{7i}^{\alpha_7} e^{ui} \quad \text{....(3)}$$

The model 3 above was then log transformed and equation 4 obtained to make it linear for ease of interpretation of parameters as below;

$$\ln Y = \alpha_0 + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + \alpha_5 \ln X_5 + \alpha_6 \ln X_6 + \alpha_7 \ln X_7 + \mu_i \ldots\ldots\ldots\ldots (4)$$

Where; $\alpha_0 = -\ln B$,

Land tenure and gender were considered as dummy variables and thus not log transformed.

4.0 RESULTS AND DISCUSSION

Relationship between Cane output and Independent variables

The bi-variate association between Cane output and independent variables; land preparation cost, fertilizer application cost, weeding and weed control cost, seed cane and planting cost, farmer educational level, land ownership and gender and bi-variate association between independent factors are as shown in the table 1.

The bi-variate association between Cane output and land preparation cost is 0.516 and p-value 0.000 which is significant at 5%. Thus, 51.6% increase in cane output is associated with unit change in land preparation cost. Farmers should invest more in land preparation to achieve greater output other factors held constant.

The bi-variate association between Cane output and fertilizer application cost is 0.477 and p-value 0.000 which is significant at 5%. Thus, 47.7% increase in cane output is associated with unit change in fertilizer application cost. Farmers should invest more in fertilizer to achieve greater output ceteris paribus.

The bi-variate association between Cane output and weeding and weed control cost is 0.427 and p-value 0.000 which is significant at 5%. Thus, 42.7% increase in cane output is associated with unit change in weeding and weed control cost. Farmers should invest more in weeding to achieve greater output other factors remaining constant.

The bi-variate association between Cane output and seed cane and planting cost is 0.524 and p-value 0.000 which is significant at 5%. Thus, 52.4% increase in cane output is associated with unit change in seed cane and planting cost. Farmers should invest more in seed cane and planting to achieve greater output ceteris paribus. This means that cost of variable inputs (land preparation cost, fertilizer application cost, weeding and weed control cost and seed cane and planting cost) affect cane output. Therefore, the null hypothesis is rejected and alternative hypothesis that cost of variable inputs affect cane output confirmed. This finding is consistent with economic theory and priori expectation that cost of variable inputs affect cane output.

The bi-variate association between Cane output and farmer educational level is -0.027 and p-value 0.605 which is insignificant at 5%. Thus, 2.7% reduction in cane output is associated farmer educational level. This means that farmer education level does not in any way affect sugar cane output. Therefore, the null hypothesis is accepted. This is consistent with the findings of Obiero (2013) in his study of socio economic factors affecting farm yield in Siaya District, Siaya County, Kenya. The in-significance of education level implies that farmers learn production by doing which does not necessarily depend on the level of formal education.

The bi-variate association between Cane output and land ownership is 0.075 and p-value 0.145 which is insignificant at 5%. Thus, 7.5% increase in cane output is associated land ownership. This means that land ownership does not in any way affect sugar cane output. Therefore, the null hypothesis is accepted. This contrasts with Dlamini and Masuku (2011) in their study of land ownership and productivity who although studied maize, found out that land ownership influenced maize productivity. The difference in conclusion could be attributed to cultural differences between the areas of study as well as the study crop.

The bi-variate association between Cane output and gender is 0.038 and p-value 0.468 which is insignificant at 5%. Thus, 3.8% increase in cane output is associated gender. The null hypothesis is therefore accepted that gender has no effect on cane output. This is consistent with the findings of Mangasini et al (2013) who although studied groundnut production found out that gender did not affect groundnut production in Tabora region.

The bi-variate association between independent variables land preparation cost and fertilizer application cost was 0.536, land preparation cost and weeding and weed control cost was 0.600, land preparation cost and seed cane and planting cost was 0.732, fertilizer application cost and weeding and weed control cost was 0. 592. These values are all above 0.5, a likely indication of existence of the problem of multi-collinearity.

Multi-collinearity is a state of high interrelations or inter-association among independent variables. It exists whenever two or more predictors in a regression model are moderately or highly correlated. Moderate multi-collinearity may not be a problem. However severe multi-collinearity is a problem because it increases the variance of the coefficient estimates and makes the estimates very sensitive to minor changes in the model. The result is that the coefficients become unstable and difficult to interpret. Whenever multi-collinearity is present in data, the statistical inferences made about the data may not be reliable. It also makes it tedious the assessment of relative importance of the independent variables in explaining variations caused by the dependent variables (Mugenda, 2003).

Table 1

Correlations

		Sugarcane production revenue per acre (KES)	Education level of the respondent	Land ownership	Gender of respondent	Land Preparation Cost	Fertilizer Application Cost	Weeding and Weed Control	Seed Cane and Planting Cost
Sugarcane production revenue per acre (KES)	Pearson Correlation	1							
	Sig. (2-tailed)								
	N	375							
education level of the respondent	Pearson Correlation	-.027	1						
	Sig. (2-tailed)	.605							
	N	375	375						
Land ownership	Pearson Correlation	.075	.152**	1					
	Sig. (2-tailed)	.145	.003						
	N	375	375	375					
Gender of respondent	Pearson Correlation	.038	-.039	.035	1				
	Sig. (2-tailed)	.468	.457	.505					
	N	375	375	375	375				
Land Preparation Cost	Pearson Correlation	.516**	-.070	.014	-.016	1			
	Sig. (2-tailed)	.000	.175	.781	.753				
	N	375	375	375	375	375			
Fertilizer Application Cost	Pearson Correlation	.477**	-.051	.016	.007	.536**	1		
	Sig. (2-tailed)	.000	.326	.764	.894	.000			
	N	375	375	375	375	375	375		
Weeding and Weed Control	Pearson Correlation	.427**	-.117*	-.023	-.037	.600**	.592**	1	
	Sig. (2-tailed)	.000	.023	.652	.475	.000	.000		
	N	375	375	375	375	375	375	375	
Seed Cane and Planting Cost	Pearson Correlation	.524**	-.058	.070	-.023	.732**	.435**	.474**	1
	Sig. (2-tailed)	.000	.261	.176	.663	.000	.000	.000	
	N	375	375	375	375	375	375	375	375

Determinants of Cane Output

The relationship between the several factors and cane output was analyzed and the findings were as shown in Tables 2 and 3.

The regression shows an adjusted R^2 (Coefficient of determination) of 75.4%. This means that 75.4% of the variation in cane output can be explained by the independent variables in the model. The R of 87.1% (the Pearson Correlation Coefficient) shows that the correlation between the dependent and independent variables is high. The model F- value of 164.641 is significant at 5% (p-value = 0.000) which implies that the independent variables significantly explained the variation in the dependent variable at the 5% level.

The Durbin-Watson test d=1.464 which is between the two critical values of $1.5<d<2.5$ and therefore we can assume that there is no first order linear autocorrelation in the data (absence of auto correlation). As a rule of the thumb, residuals are uncorrelated if Durbin Watson statistic is approximately 2. A value close to 0 indicates strong positive autocorrelation while a value close to 4 indicates a strong negative autocorrelation.

The linear regression has the null hypothesis that there is no linear relationship between the variables but from the Table 4, we have F=164.641 and 7 degrees of freedom, the test is highly significant therefore we can assume that there is a linear relationship between our variables.

Table 2: Model Summary on determinants of cane output

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.871	.758	.754	.290469019	1.464

a. Predictors: (Constant), Land Preparation Cost, Fertilizer Application Cost, Weeding/weed Control Cost, Seed cane and planting Cost, Education Level, Land Ownership and Gender
b. Dependent Variable: Cane output

Table 3: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	97.238	7	13.891	164.641	.000
Residual	30.965	367	.084		
Total	128.202	374			

Dependent Variable: Cane output

a. Predictors: (Constant), Land Preparation Cost, Fertilizer Application Cost, Weeding/weed Control Cost, Seed cane and planting Cost, Education Level, Land Ownership and Gender

The coefficient matrix for the regression model was tabulated as shown in Table 4. Land preparation cost had a coefficient of 0.455 at p-value of 0.000, which is less than 0.05 indicating a significantly positive relationship with cane output. The null hypothesis that land preparation cost does not affect cane output was rejected, and the alternative hypothesis that land preparation cost affects cane output was confirmed.

Fertilizer application cost had a coefficient of 0.168 at p-value of 0.000, which is less than 0.05 indicating a significantly positive relationship with cane output. The null hypothesis that fertilizer application cost does not affect cane output was rejected, and the alternative hypothesis that fertilizer application cost affects cane output was accepted.

Weeding and weed control cost had a coefficient of 0.398 at p-value of 0.000, which is less than 0.05 indicating a significantly positive relationship with cane output. The null hypothesis that weeding and weed control cost does not affect cane output was rejected, and the alternative hypothesis that weeding and weed control cost affect cane output was confirmed.

Seed cane and planting cost had a coefficient of 0.479 at p-value of 0.000, which is less than 0.05 indicating a significantly positive relationship with cane output. The null hypothesis that seed cane and planting cost does not affect cane output was rejected, and the alternative hypothesis that seed cane and planting cost affect cane output was accepted.

Based on the above results, land preparation costs, fertilizer application costs, weeding and weed control costs and seed cane and planting costs significantly positively influenced cane output, thus the more the investment in these activities the higher the cane output. The finding on costs is consistent with the priori expectation that cost of variable inputs affect cane output. The alternative hypothesis that cost of variable inputs affects cane output was therefore confirmed.

Farmer educational level had a coefficient of 0.001 at p-value of 0.976 which is greater than 0.05, indicating an insignificant positive relationship with cane output. The null hypothesis that farmer educational level does not affect cane output was accepted, and the alternative hypothesis that farmer educational level affects cane output was rejected. This is consistent with the findings of Obiero (2013) in his study of socio economic factors affecting farm yield in Siaya District, Siaya County, Kenya. The in-significance of education level implies that farmers learn production by doing which does not necessarily depend on the level of formal education.

Land ownership had a coefficient of -0.064 at p-value of 0.049, indicating an insignificant negative relationship with cane output. The null hypothesis that land ownership does not affect cane output was accepted, and the alternative hypothesis that land ownership affects cane output was rejected. This contrasts with Dlamini & Masuku (2011) in their study of land ownership and productivity who although studied maize, found out that land ownership influenced maize productivity. The difference in conclusion could be attributed to cultural differences between the areas of study as well as the study crop. Since land ownership was coded as 1= Owner and 0=Lease and based on the coefficient, it implies that cane output will be lower for the owner and higher for lease.

Gender had a coefficient of 0.093 at p-value of 0.010, which is less than 0.05 indicating a significant positive relationship with cane output. The null hypothesis that gender does not affect cane output was rejected, and the alternative hypothesis that gender affect cane output was confirmed. This finding agrees with the finding of Onyuka, (2017) who although studied groundnut production in Ndhiwa District, Kenya found out that gender significantly affected groundnut production. This however contrasts with the findings of Mangasini et al (2013) who although studied groundnut production found out that gender did not affect groundnut production in Tabora region. Since gender was coded as 1=Males and 0=Females and based on the coefficient, it implies that cane output will be higher for the males and lower for the females.

Table 4: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	-2.670	.526		-5.071	.000		
Land Preparation cost	.455	.050	.383	9.050	.000	.368	2.720
Fertilizer Application cost	.168	.046	.121	3.654	.000	.595	1.679
Weeding/weed control cost	.398	.049	.284	8.054	.000	.529	1.889
Seed Cane and Planting cost	.479	.073	.248	6.535	.000	.457	2.187
Education Level	.001	.019	.001	.031	.976	.961	1.041
Land ownership	-.064	.032	-.052	-1.976	.049	.965	1.036
Gender	.093	.036	.067	2.588	.010	.993	1.007

A multiple regression model was used. Variables were assumed to be related to each other linearly and that they were normally distributed. The model of the above findings was given as:

$$Y = -2.670 + 0.455x_1 + 0.168x_2 + 0.398x_3 + 0.479x_4 + 0.001x_5 - 0.064x_6 + 0.093x_7$$

The independent variables in the model were tested for multicollinearity, and they showed no serious level of multicollinearity based on coefficients output Collinearity statistics obtained VIF value of between 1.007 and 2.720, meaning that the values obtained lie between 1 and 10 this means that there is no multicollinearity symptoms. These values are within the recommended maximum VIF value of 5 (c.f. Kennedy, 1992; Rogerson, 2001) and even 4 (c.f. Pan and Jackson, 2008). This is further confirmed by tolerance of between 0.368 and 0.993, which are greater than 0.05.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and Recommendations

The conclusions and recommendations were based on the research findings which were addressing the research objectives.

The first objective was to determine how variable input costs affected cane output. The findings revealed that cost of variable inputs; land preparation cost, fertilizer application cost, weeding and weed control cost and seed cane and planting cost significantly and positively affected sugarcane production in Nyando Sugar-belt. Proper and timely land preparation activities resulted into increased cane output. Therefore, farmers should invest more in land preparation to realize greater cane output. Similarly, farmers who applied more quantities of fertilizer obtained increased cane output. Cane output was generally lower within the study area as most farmers only applied fertilizer once.

Proper and effective weed control resulted into increased cane output. Most farmers in Nyando Sugar-belt used a combination of manual and chemical weeding for effective weed control and to minimize amount spent on weeding. Farmers should invest more in weed control to achieve increased cane output. Similarly, acreage under cane and hence cane output increased because of availability of cheap and affordable seed cane. There is need to invest more in seed cane and planting costs to boost cane population and hence greater cane output. Therefore, financial support and subsidies in land preparation, weeding and weed control and seed cane and planting besides fertilizers would lead to improvement in cane production in Nyando Sugar-belt. This conclusion is consistent with Netondo (2012) who in his study of sugarcane farming in Mumias District, Kenya, found out that decline in cane acreage and hence cane output was due to high cost of inputs.

High cost of production continues to hinder cane production. There is need for subsidy towards land preparation costs, weeding and seed cane and planting cost in addition to fertilizer cost which has attracted government support lately. Subsidy targeting the main variables in cane production will lead to increased acreage under cane, increased cane output in Nyando sugar belt and long-term sustainability of the Sugar sector. Similarly, factory cane prices should be improved to enable farmers meet the high cost of farm inputs. There is need for increased financing of the sugar sector to enable farmers meet the high cost of variable inputs.

The second objective of this study was to determine whether farmer education level affected cane output. The findings revealed that farmer educational level did not affect sugarcane production in Nyando Sugar-Belt, Kenya. This finding was supported by the fact that majority of the respondents had secondary level of education and below. Reddy (1998) in his study of sugarcane farming in Zimbabwe also found out that cane farmers were not highly educated. The insignificance of educational level implies that farmers learn production by doing which does not necessarily depend on the level of formal education. However, the involvement of more educated members of the society could enhance adoption rate of new cane varieties and good crop husbandry leading to improvement in Sugarcane output.

There is need to intensify farmer extension services within the Nyando sugar belt to realize greater cane output through improved farm technologies. Sugar millers and agricultural officers should work out ways of providing extension services to more farmers and tailor them according to the farmer characteristics such as farmer educational level. Nuthall and Padilla (2009) in their study of sugarcane production in Philippines also concluded that extension education is an effective way of improving technical efficiency in sugarcane production.

The third objective of this study was to determine whether land ownership affected cane output. The findings revealed that land ownership did not affect sugarcane production in Nyando Sugar-Belt, Kenya. The research revealed that cane output decreased among land owners and increased among leases. This was mainly because leases incur fixed costs towards lease of the land which they must recover from cane production. Therefore, leases double their efforts in cane production to meet the entire cost of production. The leases in the study area most likely had adequate resources and were able to invest more in cane production leading to increased output.

This conclusion is supported by the fact that majority of the respondents in this study were leases. This conclusion is however inconsistent with Reddy (1998) in his study of sugar industry in Zimbabwe who concluded that most sugarcane farms were leased and that farm ownership negatively affected productivity. However, involvement of more land owners in cane production could result into improvement in ratoon management leading to higher cane output. Similarly, land ownership could improve access to credit from financial institutions leading to more investments towards sugarcane production.

Most farmers in Nyando Sugar-belt were leases who cannot access credit or loans due to lack of collaterals or land title deed. There is need for flexible loaning terms targeting leases to enhance cane output in Nyando Sugar-belt, Kenya. Similarly, farm owners should be encouraged to venture into sugarcane production through attractive factory cane prices as well as increased financial support.

The fourth objective of this study was to determine whether gender affected cane output. The findings revealed that gender significantly affected sugarcane production in Nyando Sugar-belt, Kenya. The research revealed that male headed households realized increased cane output compared to female headed households. This conclusion is supported by the fact that majority of respondents in this study were males. Males are more likely to have access to more resources for production process than females. Similarly, cane farming is tedious, requires a lot of energy and strength mainly possessed by males. The conclusion on gender is consistent with Onyuka (2017) who although studied groundnut production also found out that male headed households posted greater output than female headed households.

However, involvement of more women in sugarcane production could lead to increase in cane output due to their higher ability to save and re-invest in cane production. There is need to encourage women involvement through affirmative actions aimed at improving access to low cost funding for acquisition of farm inputs as well as acquisi

Recommendations for further study

Farmers should invest more in variable input costs for greater output. However, they should be concerned with the need to minimize cost in view of resource constraints that farmers usually face in making production decisions. Therefore, further study should help in ascertaining the optimal variable input costs in sugarcane production.

This study was limited to the four socio-economic factors namely, cost of variable inputs, farmer educational level, land ownership and gender. Further study could be carried out considering other socio-economic factors which were not considered in this study.

This study adopted cross sectional design which has its inherent strengths and weaknesses. There is need to carry out a time series study which although also has its strengths and weaknesses, will take care of seasonal variations and help corroborate the findings of this study.

REFERENCES

1. *Adeniji, J. P. (1998). Farm Size and Resource Efficiency in Small Scale Agricultural Production. A case Study of Rice Farm in Kwara State of Nigeria. Agricultural Journal 23 (2) 43-50.*
2. *Adetiba, T. O. (2005). Productivity and Technical Efficiency among Small Scale Fish Farmers in Ibadan Metropolis. Unpublished M. Sc thesis. Department of Agricultural Economics, University of Ibadan, Nigeria.*
3. *Adrian, N., Ghulam, A. J. &Muntiz, A. J. (2013). Factors affecting Sugarcane Production in Pakistan, Transfer Institute (PARC) Tandojam, Pakistan. Pakistan journal of commerce and social sciences Vol 7 (1)128-140.*
4. *Agriculture Sector Development Strategy (2009 – 2020) GOK, 2009.*
5. *Aina, O. S., Alijola, S., Ibrahim, I., Musa, I. A. & Bappah, T. M. Economic Analysis of Sugarcane Production in Moro local Government Area of Kwara State, Nigeria. International research journal of Plant Sciences, ISSN: 2141-5447Vol 6(1) pp 1-6 June 2015.*
6. *Ambani A.O., Olukindwa, A. & Openda, N.O. (2015). Motivation on Women Participation in Contract Sugarcane Farming in Mumias Division, Kakamega County, Kenya, Egerton University, Kenya.*
7. *Anangwe, C.A.(2014).An Assessment of Socio-Economic Factors Influencing Fertilizer Use among Sugarcane Farmers in Mumias District. Department of Agricultural Economics, University of Nairobi.*
8. *Anderson, J. R., & Hazell, P. B. (1989). Variability of Grain Yields, Implication for Agricultural Research and Policy in Developing Countries, Published for the International Food Policy Research Institute, London. The John Hopkins: University Press Battimore and London.*
9. *Anyanwu, A.C. & Agu, V.C. (1996). Gender Issues and Priorities in Agricultural Extension Delivery System.*
10. *Ariga, J., Betty K., Nyoro, J.& Jayne, T.S. (2008). Trends and Patterns of Fertilizer Use by Small Holder Farms in Kenya, 1997 – 2007, Working paper. Nairobi Tegemeo: Institute of Agricultural Policy and Development, Egerton University, Kenya.*
11. *Asif, K., Khan, M., Muhammad, K.&Ishaq, M. (2005). Sugar Policy Analysis: A case of Charsadda and Mardon Districts – Sarhad Agricultural journal 21 (3): 499 – 502.*
12. *Australian Sugarcane Report (2009). Smart and Principles of Farm Business Management.*
13. *Baba, K. M. (1999). Economics of Resource Use in Irrigated Agriculture. A Case Study of Palm System in Western Area of Bahch State ADP Unpublished MSc. Thesis. Ahmadi Bello University. Nigeria.*
14. *Belang, K. & Abebao, D. (2004) Challenges Facing Agricultural Extension Agents; A case Study from Western Ethiopia.*

15. Benor, D., Harrison, I. Q., & Barter, M. (1997). Agricultural Extension: The training and Visit System. Washington, DC. The World Bank. Retrieved from http://www.kwarastate.gov.ng/index.php?option=com_content&task=view&id=103&Itemid=103
16. Bogden, A. V. (1977). Tropical Pasture and Fodder Plants.Longman publishers: London.
17. Cheesman, O.D. (2006). Environmental Impact of Sugar Production, Cambridge M.A. Cab Publishers.
18. Clainos, C.& Ledwin, C. (2011). Economic Factors Affecting Productivity of Small Scale Farmers in Lowveld, Zimbabwe. Faculty of Commerce, Great Zimbabwe University.
19. Clowes, M.J & Breakwell, W. L. (1998). Zimbabween Sugarcane Production Manual. ZSAES. Chiredzi.
20. Cobb, C.W. & Douglas, P.H. (1928). A theory of production. American Economic Review 18(1): 139-165. Supplement, papers and proceedings of 40th Annual meeting of the American Economic Association.
21. COMESA. (2008). Kenyan Sugar Industry Bulletin 2008.
22. Dindi, E. (2013). Managerial Factors Influencing Sugarcane Production by Farmers of Mayoni Division, Mumias District. Department of Business Administration, Kenyatta University.
23. Dlamini, D. & Masuku B. (2011). Land tenure and land productivity; A case of maize production in Swaziland. Department of Agricultural Economics and Management, University of Swaziland.
24. Dorfman R, Samuelson P & Solow R. (1987) Linear Programming and Economic Analysis. NewYork, McGraw-Hill Publishers.
25. Economic Recovery Strategy for Wealth and Employment Creation. (ERS-WEC).
26. Edmeades, G.O., Baker, T, Copper, M., Dollan, D., Campos, H. (2008). Divergence Tolerance in Maize; An Energy Reality. ISAAA Brief No. 39.
27. Enete A. & Amusa, T. (2010). Challenges of Agricultural Adaptation to Climate Change in Nigeria, Journal Vol. 4.
28. FAO. (n. d). Land tenure issues in Agricultural Investment. Retrieved on January 17, 2018 from http://www.fao.org/fileadmin/templates/solaw/files/thematic_reports/TR_05B_web.pdf
29. FAO Report of UN (2008). Economic and Social Production Development.
30. Frank, H. R. (1971). 6th Ed. Microeconomics and Behaviour. McGraw Hill. Cornel University.
31. Freitas, F. L. (2005). Evaluation of the Effects from an Entrance of Sugarcane into Settlement in Sao Paulo, Brazil. Scientia Agricola, Brazil.
32. Fritz, M. R, Leslie, B.E, Rice, R.W & Joe, A. (2009).Costs and Returns for Sugarcane Production on Muck Soils in Southern Florida. University of Florida, Journal of American Society of Sugarcane Technology vol.30, 2010.
33. Girei, A. A.& Giroh, D.Y. (2012). Analysis of the Factors Affecting Sugarcane Production Under Out-grower Schemes in Numan Local Government Area Nigeria: Rubber Research Institute, Nigeria.
34. GOK (2008). Sessional Paper of 2008 on Revitalization of Sugar Industry. Government Printer, Nairobi.
35. Grinnel, M. R. (1993). 4th Ed. Social Work Research and Evaluation. Illinois. FE Research Publishers.
36. Gujarati, N.D. (2003).Basic Econometrics Fourth International Edition. McGraw Hill Education: Asia pages 223 – 224.
37. Harb J.C.& Columba C.H. (2010).Financial and Economic Feasibility of Sugarcane Production in Northern Lapaz. Latin America: Canadian Center for Science and Education.
38. Ibrahim U, Dauda H, Mukhtar A.A.& Ayinde, B. T. Socio Economic Factors Affecting Groundnuts Production in Nigeria. International Journal of Food and Agricultural Economics, ISSN 2147-8988 vol. 1 no 1 pp. 41-48, Institute of Agricultural Research, Ahmadu Bello University, Nigeria.
39. Jamill, A., Muhammad K.J., Muhammad, N. &Nazim, M. (2014). Research on Factors Influencing Sugarcane Production in Pakistan. A Case of Punjab, Springer Berlin Heideberg, Publishers.
40. Jamoza J.E., Amolo R.A. & Muturi S.M. (2013). Baseline Survey on Status of Sugarcane Production Technologies in Western Kenya Conference Paper Presented in Brazil, KESREF.
41. Jhingan, M. L. (1991).Advanced Economics Theory. Konark Publishers, Limited.
42. Joel, M. (2005).Analysis of Socio-Economic Factors Affecting the Production of Bananas in Rwanda: A case study of Kanama District. Un- published master's Thesis, University of Nairobi.
43. Kehinde, L. K. (2005). Efficiency of sawn wood production and distribution in Ondo State, Nigeria.Unpublished PhD Thesis. Department of Agricultural Economics, University of Ibadan, Nigeria.
44. Kennedy, P. (1992). A Guide to Econometrics. Oxford, Blackwell.
45. KESREF. (2009) Kenya Sugar Research Foundation Strategic Plan 2009 – 2014.
46. KESREF. (2005) Kenya Sugar Research Foundation Strategic Plan 2005 – 2009.
47. Kidulla, L.L. (2007). Influence of Women Involvement as Laborers' in Sugarcane Contract Farming on Household Food Crop Production in Mumias Division, Kenya. Egerton University: Unpublished Master's Thesis.
48. KNA. (2015). Kenya National Assembly Report of the Departmental Committee on Agriculture, Livestock and Co-operatives on the crisis facing Sugar industry in Kenya, 2015.
49. Kokeyo, P. L. (Nov 2013). An Assessment of the Factors Affecting Contract Farming. The Case of Sugarcane Production in Migori County, Kenya. Department of Applied and Agricultural Economics, University of Nairobi.
50. Kothari, C. R. (2004). Research Methodology, Methods and Techniques. India. New Age Publishers.
51. KSB. (2008) Kenya Sugar Industry Strategic Plan 2008 – 2012.
52. KSB. (2013) Kenya Sugar Board Year Book statistics 2013.
53. Kweyu, W. W. (2013). Factors Influencing Withdrawal of Farmers from Sugarcane Farming: A Case of Mumias District, Kakamega County. Department of Project Planning and Management, University of Nairobi.
54. Mahlangu, I & Lewis, F (2008). Social and Institutional Constraints to the Production of Sugarcane by Small Scale Growers in the Amatikulu Catchment of South Africa 81: 128 – 132.
55. Mandla, B. D. & Maker, B. M. (2012). Productivity of Small Holder Farms in Swaziland. The Case of Konati Downstream Development Programme.

56. Mangasini A. Katundu; Mwanahawa L. Mhina; Arbogast G. Mbeiyererwa and Neema P. Kumburu (2013). Socio-Economic Factors Limiting Smallholder Groundnut Production in Tabora Region. Research Report 14/1, Dar es Salaam, REPOA.
57. Margaret, N. G. (2013).Factors affecting Small- Scale Coffee Production in Githunguri District, Kenya. International Journal of Academic Research in Business and Social Sciences, 3(9); 132-145.
58. Mc Calla, A. F (2001). Challenges to World Agriculture in the 21st century, Journal 4 no 3, University of California.
59. McMillan, J. H. (1999). 3rd Ed.Sampling and Statistical Educational Research Fundamental for the Consumer. USA. Harper Collins College Publishers.
60. Mihir S & Vijay P. (2008). Trends in Employment Intensity of Economic Growth in Post Reform Era Across Major Indian States. Rethinking India's Growth Strategy Concept Publication.
61. Mishra T. (2008).Introduction to Managerial Economics, IIT School of Management, Bombay.
62. Mugenda, O. M. & Mugenda, A. G. (2003). Research Methods: Quantitative and Qualitative Approaches.
63. Mukras, M.S, Odondo, J.A., & Momanyi, G.(2013). Determinants of Demand for Sweet Potatoes at the Farm, Retail and Wholesale Markets in Kenya: Advances in Economics and Business1/2, 150-158, Maseno University, Kenya.
64. Mundlack, Y. (1985). Agricultural Growth and Price of Food Report of the Centre for Agricultural Economics. Research working Paper No. 8504.
65. Muntemba, S.& Blackden, C. M. (2001).Gender and Poverty in Africa. Background paper for world Bank Conference on Poverty Alleviation in Africa. Nairobi Kenya: March 6-10, 2000.
66. Nand, K. F., Virupax C. B. and Charles A. J (2010). Growth and Mineral Nutrition in Field crops. Third edition, pages 13-55. CRC Press
67. Netondo, G. W., Waswa, F., Maina, L., Naisiko, T., Masayi, N.&Ngaira, J.K. (2010). Agro-Biodiversity Angered by Sugarcane Farming in Mumias And Nzoia Sugar Belts of Western Kenya. African Journal of Science and Technology vol. 4 no 7 of 2010.
68. Nuthall, P.L.& Padilla, F.M. (2009).Technical Efficiency in the Production of Sugarcane in Central Negros area, Phillipines. Lincoln University.
69. Nyoro, J. K. (2004).Kenya's Entrepreneurs in Domestic Maize Production; Implications for Food Security. Working Paper University of Leiden, Netherlands.
70. Obiero,E.O.(2013).Socio economic factors affecting farm yield in Siaya District, Siaya County, Kenya. Department of Agricultural Economics, University of Nairobi.
71. Odede, S.O. (1992). Requirements' to arrest Downward Economic Trends of the Kenya Sugar Industry into the 21st Century. Proceedings of Kenya Society of Sugarcane Technologists.
72. Odenya,J.O., Ochia, C.O., Korir, C.&Bor, G.K. (2008). Adoption of Improved Sugarcane Varieties in Nyando Sugarcane Zone, Kenya, KESREF, Kisumu.
73. Onwema, I. C. &Sinha, T. D. (2003). Field Crop Production in Tropical Africa: CTA Wageningen. Netherlands.
74. Onyuka,E.O.(2017). Socio Economic Determinants of Groundnut Production in Ndhiwa Sub-county, Kenya. Department of Horticulture, University of Kabianga.
75. Oucho, J.O. (1996)Urban Migrants and Rural Development in Kenya. Nairobi: Nairobi University Press.
76. Pan, Y. & Jackson, R. T. (2008). Ethnic Differences in Relationship between Acute Inflammation and Serum Ferritin in US Adult Males. Epidemiology and Infection; 136, pg 421-431.
77. Phillip E.S (2016) Occurrence of Sugarcane Ratoon Stunting Disease in Nyando Sugar Belt and Management by Hot Water System, Nairobi.
78. Ramulu, M. (1994).Supply response of Sugarcane in Andhra, Pradesh India.Vol X No. 1 pages 116 – 122.
79. Reddy, M.V. (1998).Production and Economic Analysis of Fiji Sugar Industry, Unpublished PHD Desertification, Department of Agriculture and Resource.
80. Rice, R. W., Baucum, L. & Muralles, L. X. (2006). Introduction to Sugarcane Handbook. University of Florida.
81. Southavilay, B., Teruaki N. and Shigeyoshi T. (2010). "Policies and Socio- Economic Factors Influencing Agricultural Production: A case study on maize production in Bokeo Province, Laos", Sustainable Agriculture Research; 2 (1); 70-75.
82. Sundara, B. (1998). Sugarcane Cultivation. Vikas Publishing House, New Delhi.
83. Tarimo, J.P.& Takamura, T.Y. (1998). Sugar Production, Processing and Marketing in Tanzania.Center for African area studies, Kyoto University.
84. Thornton, P.K. & Jones, P. G (2003). The Potential Impact of Climate Change on Maize Production in Africa and Latin America in 2055. Global environmental change 13: 51-59.
85. Thuo, C.M. (2005).The Influence of Extension Services and Enterprises Diversification on Household Food Security among Small Scale Farmers in Muhoroni Division, Nyando District, Egerton University.
86. Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R. &Polasky, S. (2002). Agricultural Sustainability and Intensive Production Practices.
87. Umbach, P.D. (2005). Getting Back to the Basics of Survey Research. New directions in institutional research no. 127:91-100.
88. Upton, M. (1996). The Economics of Tropical Farming Systems, Cambridge University Press, pages 247 – 248.
89. Wawire, N.W., Kahora, F., Shiundu, R., Muturi, S.M., Kipruto, K.B. & Omoto, G. (2006). Cost Reduction Strategies in Sugarcane Production in Kenya, KESREF Bulletin (2008). Bracing for COMESA. A Case of Kenyan Sugar Industry.
90. Wikipedia, Cobb-Douglas.http:/en.wikipedia.org/wiki/cobb-douglas
91. Yusuf, G.F., Lategan S.F. & Ayinde, A (2013). Profitability and Adoption of Water Melon Technologies by Famers in Moro Local Government of Kwara State, Nigeria. Department of Agricultural Economics and Extension, University of Fort Hare, South Africa.
92. Zoellick, R.B. (2009). A climate Smart Future. Nation Newspapers, Vintage Press Limited, Lagos Nigeria