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

BY

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been presented for examination in Maseno University or any other University.

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God bless you all.

DEDICATION

To my family for unwavering support and encouragement.

To God be the Glory.

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 the socio-economic determinants of sugarcane production among small scale farmers within the Nyando Sugar Belt. Specifically, the study sought to examine the effect of cost of variable inputs, farmer educational level, land ownership and gender on cane output. The study was anchored on Production Theory and was guided by correlation design. The target population was 12,057 small scale cane farmers within the Nyando Sugar Belt, 384 cane farmers were randomly sampled out of which 375 responded to the questionnaire. The data for this study was both primary and secondary. Questionnaires were used to collect primary data and secondary data obtained from farmers records. Reliability of the research instruments was ascertained and Cronbach alpha coefficient of 0.868 obtained confirming the reliability of the research instrument. Data analysis was done through descriptive and inferential statistics, measures of central tendencies was used to summarize responses in numerical forms, multiple regression to ascertain the direction and magnitude of influences of the study variables on cane output and Pearson correlation to ascertain the bi-variate association between the study variables and significance of the variables. Coefficient of determination R^2 was 0.758 which indicated that 75.8% variation in cane output was explained by all explanatory variables. The F value was 164.641 and was significant indicating that the regression model was well fitted. The study revealed that variable input costs (land preparation cost β=0.455 at p-value=0.000, fertilizer application cost β =0.168 at p-value=0.000, weeding and weed control cost β=0.398 at p-value=0.000 and seed cane and planting cost β=0.479 at p-value=0.000) had significant positive effect on cane output. Land ownership and Gender was also found to have a significant effect on cane output at β= -0.064 and p-value=0.049 and at β=0.093 and p-value=0.010 respectively. 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 landowners and female headed households to enhance cane output.

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LIST OF ACRONYMS

ANOVA	Analysis of Variances
ASDS	Agricultural Sector Development Strategy
CD	Cobb-Douglas
CES	Constant Elasticity of Substitution
COMESA	Common Market for Eastern and Southern Africa
CU	Customs Union
EAC	East African Community
ERSWEC	Economic Recovery Strategy for Wealth and Employment Creation
EU	European Union
FAO	Food and Agricultural Organizations
GDP	Gross Domestic Product
GOK	Government of Kenya
KESREF	Kenya Sugar Research Foundation
KSB	Kenya Sugar Board
MOALF	Ministry of Agriculture, Livestock and Fisheries
MSC	Mumias Sugar Company
MT	Metric Tonnes
OLS	Ordinary Least Squares
RSD	Ratoon Stunting Disease
SDGs	Sustainable Development Goals

SPSS	Statistical Packages for Social Sciences
TC/HA	Tons of Cane Harvested per Hectare
UN	United Nations
VIF	Variance of Inflation Factor

OPERATIONAL DEFINITIONS OF TERMS

COMESA Safeguards: Rules and policies initiated to control importation of cheap sugar from the COMESA growing countries to protect the local industries.

Early and high maturing varieties: Sugarcane varieties that mature over relatively shorter periods of between 12 to 14 months.

Agricultural factors: Land size, land fertility, crop husbandry, climatic factors, timing of harvest

Economic factors: Variable input costs

Variable input costs: Land preparation, fertilizer application, weeding and weed control and seed cane and planting costs.

Land preparation cost: Expenses incurred on land preparation activities

Fertilizer application cost: Expenses incurred on fertilizer application

Weeding and weed control cost: Expenses incurred on weed control activities

Seed cane and planting cost: Expenses incurred on seed cane and planting

Social factors: Farmer educational level, land ownership and gender.

Traditional varieties: Sugarcane varieties that mature over a longer period, usually 18 to 24 months

Cane output: Amount earned from tonnage of cane harvested

Immature cane: Sugarcane harvested before maturity date.

Plant crop: The first cane harvest after planting

Ratoon crop: Cane harvest subsequent to the first harvest

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Production is basically an activity of transformation which converts factor inputs into outputs. Thus, with the transformation of inputs, utility of the goods or materials increases. 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 become 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 strongly suggests that agriculture is a dynamic sector that responds positively to price incentives and that other

policies which tax agriculture reduce investments in the sector (Mundlack, 1985). Based on economic theory, as economy grows importance of agriculture increases since it provides raw materials to support industrialization. This reliance on agriculture can cause economic stagnation and poverty due to the country's dependence on rainfall for agricultural production. Without adequate irrigation, households must find other ways of minimizing their risks to achieve maximum outputs both at subsistence and commercial levels.

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). Sugarcane is a perennial crop belonging to the grass family that thrives in hot temperatures and low rainfall areas but need a lot of water to grow (Clowes and Breakwell, 1998). Thus, favorable climatic conditions are necessary for improvement in cane output.

Sugarcane is one of the most important crops in the world because of its strategic position and immense uses in the daily life of any nation as well as for its industrial uses. Sugarcane contributes about 75% of the total world sugar requirements while the remaining 25% come from sugar beet (Onwema and Sinha, 2003). Due to greater importance of sugar, there is the need to expand sugarcane production. The average worldwide yield of sugarcane crop is estimated at 70 tons per hectare with Peru recording a higher average of 133 tons per hectare, Guatemala 104 tons per hectare, Colombia 101 tons per hectare, Philippine's 94 tons per hectare and Australia 81 tons per hectare. The main determinants of cane production in these countries as identified include favorable cane prices, favorable weather conditions, increased acreage under cane, the use of irrigation, increased investments in sugarcane production and application of inorganic fertilizers (FAO Stat. 2014).

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). The small-scale sugarcane farmers provide employment through the entire value chain and hence decline in cane output will result into high unemployment levels. 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). These statistics explain the reason for the focus on small scale farmers in Nyando Sugar Belt, Kenya.

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). The reduction in average cost of production can be realized through increase in output/yield. This research therefore examines the socio-economic determinants of sugarcane production to reduce production bottlenecks leading to increase in cane output.

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). The focus of this research is to ascertain the possibility of shift in sugarcane production from import oriented to export oriented through enhancement in cane output by examining the socio-economic determinants of cane output.

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). There is therefore the need to examine the determinants of cane output.

Sugarcane farming has been practiced in Western Kenya for nearly forty years (Netondo et al, 2010). The importance of the sugar sector was re-enforced by Mahlangu and Lewis, 2008 in their study of small-scale cane growers in Ntumeni, South Africa where they observed that sugarcane production is an important livelihood strategy to generate badly needed income to support livelihoods. Sugarcane farming is one of the major cash crops grown within the Nyando Sugar Belt. A study in Nyando Sugar Belt revealed that cane farming is major source of income to the farmers with 81.3% of Nyando farmers deriving their income from cane farming (Odenya et al, 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, Nyando Sugar Belt since it has recorded greater decline in cane output. Nyando Sugar-belt is mainly wetland area prone to frequent flooding leading to damage to property and environmental degradation. The main river found in Nyando Sugar-belt is river Nyando, 70% of population living within the belt live below the poverty line and depend on the wetland resource for economic benefits by growing sugarcane, maize, cassava, tea, and

coffee (Osuga, 2015). Nyando Sugar Belt cuts across Kisumu, Kericho and Nandi counties with a total of 12,057 registered cane farmers.

Crop productivity or yield is a function of environment, plant, management and socio-economic factors and their interactions; and maximum yield in an environment is possible only when all these factors are at optimum levels (Nand et al, 2010). Studies have been done on the influence of socio-economic factors on production. Joel (2005) found that acreage is among the factors that had positive relationship with banana output. Southavilay et al, (2010) found that some socio-economic factors such as farm size and maize farming experiences, had a significant effect on maize production. This implies that if any one of these factors were changed (in- creased/decreased), it could influence maize production output. Margaret (2013), found that land size greatly affected coffee production.

Most researchers have concentrated on the agricultural determinants of sugarcane production, technology improvements, bio-diversity and managerial factors thereby ignoring the socio-economic determinants which are the other known factors in economic theory. Studies in other areas have shown that socio-economic factors have an influence on production of various crops such as bananas, groundnuts, cotton, coffee and maize. This study therefore focused on socio-economic determinants of cane production namely; cost of variable inputs, farmer educational level, land ownership and gender among small scale farmers in Nyando Sugar Belt, Kenya.

1.2 Statement of the Problem

The Kenyan sugarcane industry like in most sugar producing countries all over the world is a major employer of about 500,000 people directly or indirectly in the sugarcane value chain and contributor of about 15% of the agricultural GDP in the economy. Currently the industry supports approximately 250,000 small scale farmer households who supply over 92% of cane to millers from three countrywide Sugar Belts namely; Western, South Nyanza and Nyando. The sugar sector is the 3rd most important contributor to Agricultural Gross Domestic Product (GDP) after tea and coffee. Despite the importance of the sub sector, countrywide sugarcane output has

been on decline and stands at 65 tons per hectare which is far below potential yield of 100 tons per hectare leading to longer closure of sugar factories in Kenya. In the year 2014 for example, cane crushed by Mumias Sugar Company reduced from 2.318 million metric tons in 2010 to 1.926 million metric tons. Similarly, in the year 2008 the average cane output was 72.9 TC/HA with the highest cane outputs of 86.0 TC/HA from South Nyanza Sugar Belt and the lowest cane outputs of 60.3 TC/HA recorded in Nyando Sugar Belt, making Nyando Sugar Belt the worst in sugar cane output decline in Kenya. From existing literature, studies have established; low pricing of cane, land size, land fertility, crop husbandry and timing of harvest as the key determinants of cane output production. However, these factors are limited to agricultural determinants without regards to socio and economic factors which are the other known factors in economic theory that determine agricultural production practices. The purpose of this study was to investigate the socio and economic determinants of Sugarcane production among Small Scale farmers in Nyando Sugar Belt, Kenya.

1.3 General Objectives of the Study

The general objective of the study was to investigate the socio-economic determinants of Sugarcane production among Small Scale farmers in Nyando Sugar Belt, Kenya.

The specific objectives of the study were:

1. To examine the effect of variable input costs on cane output among the small-scale farmers in Nyando Sugar Belt, Kenya.
2. To determine the effect of farmer education level on cane output among the small-scale farmers in Nyando Sugar Belt, Kenya.
3. To evaluate the effect of land ownership on cane output among the small-scale farmers in Nyando Sugar Belt, Kenya.
4. To examine the effect of gender on cane output among small scale farmers in Nyando Sugar Belt, Kenya.

1.4 Research Hypothesis

The following null hypotheses were tested during the study:

1. H_0: $\alpha_i=0$ where i=1-4, Variable input costs (land preparation, fertilizer application, weeding and weed control, and seed cane and planting costs) have no effect on cane output among small scale farmers in Nyando Sugar Belt, Kenya.

2. H_0: $\alpha_5 =0$ Farmer education level has no effect on cane output among small scale farmers in Nyando Sugar Belt, Kenya.

3. H_0: $\alpha_6=0$ Land ownership has no effect on cane output among small scale farmers in Nyando Sugar Belt, Kenya.

4. H_0: $\alpha_7=0$ Gender has no effect on cane output among small scale farmers in Nyando Sugar Belt, Kenya.

1.5 Scope of the Study

The study focused on sugarcane output in the Nyando Sugar Belt. Nyando Sugar Belt had been chosen because a relatively greater decline had been recorded in comparison to the other sugar belts in the Western region of Kenya. According to KSB statistics, the average cane output in 2008 was 72.9 tons per acre, with the highest cane output of 86.0 tons per acre being recorded in South Nyanza Sugar Belt and the lowest cane output of 60.3 tons per acre recorded in Nyando Sugar Belt (KSB, 2008). The study was limited to the assessment of the effect of four factors on sugarcane production namely, cost of variable inputs, educational level of farmers, land ownership and gender. Similarly, a sample of 384 cane farmers from cluster population was randomly drawn during the study to ascertain the socio-economic determinants of cane output. A larger sample size had been chosen considering the total population of cane farmers in Nyando Sugar Belt was estimated at 12057. Data was collected between June and July 2018.

1.6 Justification of the Study

The findings of the study provide additional insight towards improvement of cane output within the Nyando Sugar Belt, Kenya and within East African region. Understanding of the socio-economic determinants of cane production assist farmers overcome obstacles leading to improvement in cane output. The study leads to increased contribution of the sugar sub-sector to the country's Gross domestic product and hence long run sustainability of the sugar sector.

The study provides empirical evidence regarding the key variables which affect sugarcane production in Nyando Sugar Belt and thus, assist Sugar Company's management and policy makers in formulating policies in sugar sub-sector especially on cane production. The study contributes in identifying areas requiring support within Nyando Sugar Belt in order to realize the Sustainable Development Goals (SDGs) such as poverty eradication and enable the country to realize its dream of being a newly industrialized country by 2030.

The study benefited the researcher by gaining firsthand information on the socio-economic determinants of cane production in Nyando Sugar Belt and is a source of literature to academia on cane production.

1.7 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 are inherent in 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 (CD) 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 function had been chosen for the study since it is an old established function widely used by scholars to ascertain production efficiencies, 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). The choice of CD production function was also due to its superiority on theoretical and econometric grounds for determining the effect of variable inputs on output.

A Cobb-Douglas production function was used to estimate input – output relationship. It is generally non-linear homogenous production function specified as;

$$Q = f(L, K), = AL^{\alpha}K^{\beta} \quad \ldots\ldots(1.1)$$

Where; A= Technical coefficient, L= labour units and K= capital units

The General form of Cobb-Douglas production function is as given below;

$$Yi = \alpha_0 X_{1i}^{\alpha 1} X_{2i}^{\alpha 2} X_{3i}^{\alpha 3} X_{4i}^{\alpha 4} X_{5i}^{\alpha 5} X_{6i}^{\alpha 6} X_{7i}^{\alpha 7} e^{\mu i} \quad \text{.....(1.2)}$$

Where: Yi =Cane output per acre per farmer

X_{1i} = land preparation cost per acre per farmer.

X_{2i} = fertilizer application cost per acre per farmer.

X_{3i} = weeding and weed control cost per acre per farmer

X_{4i} = Seed cane and planting cost per acre per farmer

X_{5i} = farmer educational level

X_{6i} = land ownership.

X_{7i} = gender.

α_0 is the intercept whereas, α_i are parameters of the regression model to be estimated.

The function 1.2 above was then translated into logarithm form and equation 1.3 obtained to make it linear for ease of interpretation of parameters as below;

$$\ell nYi = \alpha_0 + \alpha_1 \ell nX_{1i} + \alpha_2 \ell nX_{2i} + \alpha_3 \ell n X_{3i} + \alpha_4 \ell n X_{4i} + \alpha_5 \ell n X_{5i} + \alpha_6 \ell n X_{6i} + \alpha_7 \ell n X_{7i} + \mu_i \text{.....(1.3)}$$

Adapted and Modified from Odondo et al (2013).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents discussions and critique on studies on sugarcane production worldwide and narrowing down to Kenya and other related literatures. The gaps in those studies particularly with reference to the research objectives are also highlighted. The chapter also provide a review of productions functions that could provide foundation for the study.

2.2 Theoretical review

This section attempted to review the available production functions to determine their suitability as a foundation for the study. A critical review of the functions was done also considering the related studies conducted by different scholars. The fixed proportion, least cost combination, constant elasticity of substitution and Cobb-Douglas production functions are reviewed in this section.

2.2.1 Leontief Production function

Fixed proportion production function was devised by Nobel laureate Wasscily Leontief. The production function is expressed as Q = Min (aK, bL) and Q = aK or bL whichever is smaller. It is the simplest among all production functions and is widely used. The theory is premised on the concept of constant returns to scale; double inputs to realize double outputs. Thus, the two factors of production labour and capital must be used in fixed proportions to achieve a given level of output (Franc, 1991). This theory has been criticized on the basis that it only considers two factor inputs, labour and capital, does not consider scarcity of factors of production and its assumption of constant returns to scale.

2.2.2 Least Cost Combination Production function

The least cost combination function focuses on getting the largest value of output from a given cost outlay or factor inputs when combined in an optimum manner. Under this theory of production, the producer attains equilibrium when given the cost price function; he maximizes

his profits based on least cost combination of factors of production (Jhingan, 1991). This theory has been criticized on the basis that it only considers two factor inputs, assumes that factor inputs are homogenous, prices of factor inputs are constant, money outlay is given and perfect competition exists in the factor market. These conditions are not in tandem with business realities and as such the model was not applied during the study.

2.2.3 Constant Elasticity of Substitution Production function

Constant elasticity of substitution (CES) production function was developed by Arrow, Chenery, Minhas and Solow in 1961. The production function is expressed as $Q = A \{(\alpha C^{Ø} + (1- \alpha) L^{-Ø}\}^{-1/Ø}$. It considers efficiency parameter, A, which depends on the level of technology, unlike Cobb Douglas production function which is technology neutral. This theory is based on constant returns to scale and assumes constant elasticity of substitution, 1/1+Ø, ranging from zero to infinity (Jhingan, 1991). Despite several criticisms, this theory has gained wider scope and applicability. Moreover, the theory allows factors to be either substitutes or complementary. This function has however not been adopted for the purposes of this study since the value of efficiency parameter cannot be made independent of changes in output and factor inputs and the problem of aggregation of various production functions.

2.2.4 Cobb-Douglas Production function

A Cobb-Douglas production function is used to estimate input – output relationship. It is a homogenous production function, $Q = f(L, K)$ and $Q = AL^{\alpha}K^{\beta}$ which considers only two factor inputs, labour and capital for the entire output of the manufacturing or production industry. This function was formulated by Charles Cobb and Paul Douglas in 1928 and is widely used in the analysis of various production studies (Adeniji, 1998; Baba, 1999). The function is flexible, easy to use, has a good empirical fit across many data sets and allows for regression under OLS in logarithm form (Clainos and Ledwin, 2011). The function is technology neutral and assumes that productivity does not affect the relative marginal productivity of factor inputs and hence do not alter the relative allocation of factors of production. The function is also desirable because it considered a simplified view of the economy where production output is determined by amount

of labour and capital invested (Cobb and Douglas, 1928). This had been modified to consider all the study variables.

Cobb-Douglas function has however been criticized on the basis that it was not grounded on any knowledge of engineering, technology or production process and is based on constant returns to scale which is not an actuality. Similarly, the constancy of labour and capital over time is doubtful as inputs become scarce over time. The function assumes that all factor inputs are divisible whereas factor inputs such as entrepreneurship may not be divisible. The function may also not apply as effective in a macro environment compared to a micro-environment.

A study by Jamil et al (2014) on factors influencing sugarcane production in Pakistan, a case of Punjab, used Cobb-Douglas production function to ascertain production efficiencies and observed that the theory fits well within the regression model. Similar justifications for use of Cobb-Douglas production function were cited by Adrian et al (2013) in their study of the factors affecting sugarcane production in Pakistan. According to Adeniji (1998) in his study on farm size and resource efficiency in small scale agricultural production; a case of rice farm in Kwara state of Nigeria, the use of Cobb-Douglas production function was mainly due to a priori expectation that variable inputs positively influence output.

According to Clainos et al (2011) Cobb-Douglas production function is superior on theoretical and econometric grounds for determining the effects of variable inputs and thus their justification for its application in their study. Mandla et al (2012) in their study of productivity of smallholder sugarcane farms in Swaziland; the case of Konati Downstream Development Program employed Cobb-Douglas production function mainly because it produces straight estimate of production elasticities with esteem range of inputs. The choice of this production function for this study was because it is an old and established theory widely used in the analysis of various production studies. The production function is also flexible, easy to use, has a good empirical fit across many data sets and allows for regression under Ordinary Least Squares (OLS). The review of studies conducted by researchers as cited above also indicated wider application of Cobb-Douglas production function.

2.3 Empirical Review

This section reviewed relevant literature relating to Sugarcane production globally and narrowing down to the Nyando Sugar Belt of Kenya. The review mainly focused on the four socio-economic determinants of cane production namely, cost of variable inputs, farmer educational level, land ownership and gender factor.

2.3.1 Relationship between Cost of Variable Inputs and Output

Clainos and Ledwin (2011) carried out an investigation of economic factors affecting productivity of small-scale sugarcane farmers in Zimbabwe. The researchers identified lack of equipment, low factory prices of cane, high transport and haulage costs, limited training, failure to plough out old cane and unavailability of inputs as critical for enhanced cane productivity. The researcher adopted descriptive survey design. This study did not consider variable input costs.

A study by Mandla and Maker (2012) on the determinants of sugarcane profitability; the case of smallholder cane growers in Swaziland, identified distance to mills, change in production quota, yield per hectare and sucrose content and farmers experience. However, this study was based on descriptive and inferential research designs. The researcher adopted purposive sampling technique and multiple regression in the analysis and data interpretation. This study did not consider cost of variable inputs.

According to Cheesman (2006) in his study of the environmental impact of sugarcane production in the coastal regions of North and South Durban, South Africa, sugarcane farming had completely transformed large tracts of land leading to reduced acreage available for other crops such as wheat, maize and sorghum. The study employed descriptive research design and re-enforced the relationship between land acreage and cane output.

Ramulu (1994) in his study of supply response of sugarcane in Pradesh state of India concluded that there was a significant and positive influence of price and yield in cane production. The researcher adopted correlation research design throughout the study. This study considered cane factory price which is externally influenced by world sugar prices. According to Sundara (1998) in his study of sugarcane cultivation in New Delhi, India, inputs are consumed in cane

production in the following proportions; labour 45 percent, pesticide 4 percent, Fertilizer 14 percent, Seed cane 14 percent, Machine hours 17 percent and interest 4 percent. The researcher adopted descriptive research design during the study. This study attempted to ascertain if the same conclusions regarding proportionality of variable input costs hold in the case of Nyando Sugar Belt, Kenya. Fritz, et al (2009) in his study of Costs and Returns for sugarcane production in Southern Florida observed that cost of inputs in sugarcane farming are very much determined by the age of farm machinery, no of ratoon crops as well as other factors that result into different production systems with unequal input and output levels. The study was based on correlation design and the researcher's conclusion that variable input costs does not determine cane output was subjected to test during the study.

Rice et al. (2006) in their study of sugarcane outputs in Florida concluded that use of proper soils, application of fertilizers and chemicals and proper maintenance of the farms contribute to enhancement in cane output. This study was based on descriptive research design. Harb and Columba (2010) in their study on Financial and Economic feasibility of sugarcane production in Latin America identified fertilizers, weed control, soil sampling, use of treated seed cane and herbicides as critical to the enhancement of sugarcane outputs. The study was based on descriptive research design. Netondo et al (2010) in their study of effects of sugarcane farming on diversity of vegetable crops in Mumias Division, Western Kenya found out that 68% of land was under sugarcane and the remainder under subsistence agriculture. The researchers employed purposive sampling and concluded that decline in sugarcane acreage was due to high cost of inputs, poor payment, delayed payment, delayed harvesting, cane spillage, manipulation of weighbridge, poor harvesting techniques, poor quality seed cane and risk of burning. The researchers adopted Just and Pope stochastic production function during the study.

Kweyu (2013) in his research on factors influencing withdrawal of farmers from sugarcane production, a case of Mumias District, Kakamega County identified the following factors; high input costs, lack of incentives, food insecurity and delayed payments. This study was based on descriptive survey method. Test – retest method was used to ascertain reliability of the research

instrument and Statistical Package of Social Sciences (SPSS) used to facilitate analysis of data. According to Nyoro (2004) in his study of Kenya's Entrepreneur's in Domestic Maize production, fertilizer, labor and land preparation costs make up the largest percentage of total production cost. This study was based on descriptive research design.

According to Anangwe (2014) in his study of the socio-economic factors influencing fertilizer use among sugarcane farmers in Mumias District, Kenya observed that decline in cane output was attributed to inadequate fertilizer usage. The researcher adopted descriptive research design during the study. Purposive sampling technique was adopted by the researcher and linear regression model employed during the study. This study therefore sought to ascertain whether inadequate fertilizer application is due to cost of fertilizer.

The above studies did not consider the four variable input costs namely, land preparation cost, fertilizer application cost, weeding and weed control cost and seed cane and planting cost which were subject of this study. Similarly, most of the studies were conducted in different environments and thus, the conclusions from those studies may not be generalized to the current study area. The research design adopted was mainly descriptive; however, for this study both descriptive and inferential analysis tools were used. This study also sought to address the weaknesses in research methodology inherent in the above studies.

2.3.2 Relationship between Farmer Educational Level and Output

Nuthall and Padilla (2009) in their study on the technical efficiency in the production of sugarcane in Negro, Phillipines found out that extension education is an effective way of improving technical efficiency in production of sugarcane. The researchers adopted descriptive research designs during the study. This study did not consider the effect of farmer education level on improved technical efficiency in cane production. The study was based on production theory, specifically variable returns to scale and linear programming was used. Ibrahim et al (2012) carried out a study of socio-economic factors affecting groundnut production in Nigeria, they identified lack of capital and extension services as contributing to about 78% of problems in groundnut farming. The researchers found out that experienced farmers are less involved in

groundnut production. It was also observed that cost, availability and lack of technical know-how are responsible for poor use of inputs. The researchers adopted descriptive research design and gross margin and benefit analysis employed during the study. According to Reddy (1998) in his study of production and economic analysis of Fiji sugar industry in Chipowa, Zimbabwe, sugarcane farming was carried out by the elderly, mostly male with women only taking over after the death of their husbands and that cane farmers were not highly educated. His study was based on descriptive research design. This study sought to establish whether conclusion regarding farmer educational level holds true in the case of Nyando Sugar Belt, Kenya.

The study by Girei and Giroh (2012) on the factors affecting sugarcane production in Numan area, Nigeria identified inadequate land and inadequate credit as major constraints in sugarcane production. The study also considered socio-economic characteristics of famers such as age, gender, farmers experience, farmer's educational level and family size. The findings of the study on the socio-economic characteristics of the farmers were that 60% of the farmers were males, 69% aged between 31 to 40 years, 53 % of the farmers had a family size of 6 -10 persons, 40% of the farmers had farming experience above 15 years and 37.5% of majority of farmers possess primary level of education. The study adopted both descriptive statistics and production function analysis and random sampling technique was adopted. The study by Clainos and Ledwin (2011) on economic factors affecting productivity of small-scale sugarcane farmers in Zimbabwe identified lack of equipment, low factory prices of cane, high transport and haulage costs, limited training and unavailability of inputs as critical for enhanced cane productivity. The researcher adopted descriptive survey design.

A study by Adrian et al (2013) on the factors' affecting sugarcane production in Pakistan identified cost of inputs; land preparation, fertilizer, seed cane, weeding and irrigation as key determinants of sugarcane returns. The study identified high price of inputs, low price of outputs, delay in payments and lack of scientific knowledge as major problems in sugarcane production. The researchers adopted survey methodology in the collection of primary data since it is commonly used in the field of social sciences and effectiveness examined through Cobb-Douglas

production function. According to Tilman et al (2002) in their study on Agricultural sustainability and intensive production practices observed that incentives are necessary to enable farmers carry out more farming activities.

Adetiba (2005) in his study of productivity and technical efficiency among small scale fish farmers concluded that education was key to enhanced productivity among farming households. A study by Kehinde (2005) on efficiency of sawn wood production and distribution in Nigeria concluded that education was key to enhanced productivity among farming households. Farmers with higher levels of formal education were found to be more knowledgeable and able to adopt new technologies. According to Benor et al (1997) education plays a significant role in the adoption rate of new technologies by creating a positive mental attitude.

Kokeyo (2013) in his study on the assessment of the factors affecting contract farming, the case of sugarcane production in Migori county, Kenya observed that farmers involvement in sugarcane contracts is influenced by farm distance to the factory, ownership of the assets, risk avoidance, household size and farmer education level. The researcher concluded that contracted sugarcane farmers are not necessarily better off than non-contracted farmers from welfare perspective. This is because non-contracted farmers were more food secure since they have more land available for food crops. The researcher applied descriptive research design and used stratified sampling technique in the selection of sample to facilitate collection of primary data. The binary probit model was used to estimate participation in contract farming. According to Ariga et al (2008) in their study on trends and patterns of fertilizer use by small scale farmers in Kenya, fertilizer adoption in Kenya is steadily on the increase although certain factors still hinder fertilizer adoption rates leading to reduction in agricultural yield. The researcher identified little irrigation, varieties unresponsive to fertilizer, lack of credit, non-availability of fertilizer, lack of government support and weak market infrastructure as contributing to low fertilizer usage.

A study conducted by Nyoro et al (2004) on Domestic maize production attributed decline in maize production to lack of credit facilities, high cost of credit, and variation in soil fertility, soil slope, and lack of ready access to fertilizer supplies, erratic weather patterns and lack of

technical knowhow among farmers. This research was based on descriptive design. Jamoza et al (2013) in their study on baseline survey on the status of sugarcane production technologies in Western Kenya concluded that sugarcane output was low and varied across and within zones. The researchers found out that average sugarcane output was 64 tons per hectare as opposed to potential yield of more than 100 tons under rain fed conditions. The main reasons for low sugarcane output was attributed to conventional tillage, minimal soil tests, use of poor quality seed cane, manual weeding, lack of new seed cane varieties and lack of awareness. The researcher used stratified random sampling and SPSS to facilitate data analysis. According to Odenya (2008) in his study on the adoption of improved sugarcane varieties in Nyando sugar-belt, observed that despite efforts to multiply and distribute treated seed cane, there is still low adoption by farmers leading to reduced acreage under cane and hence lower output. The researcher adopted field approach during the study but did not fully explore the reasons for low adoption of improved sugarcane varieties.

According to Phillip (2016) in her study on occurrence of Ratoon Stunting Disease (RSD) in Nyando sugar belt and its management by Hot water treatment, sugar cane output has been on decline mainly due to pests and diseases. RSD is considered the most serious disease of sugarcane worldwide contributing to yield loss of up to 50%. The researcher found out that awareness of the disease was at 35%, prevalence at 67% and disease incidence at 25%. The researcher used Analysis of Variances (ANOVA) for both data analysis and interpretation. Kidula (2007) in her study of influence of women involvement as labourers in sugarcane contract farming on household food crop production in Mumias Division observed that most farmers have no assured food security and so many of them withdraw from sugarcane farming in favour of other food crops. This study was based on descriptive research design. Therefore, the researchers observed that gender factor influences cane output.

Obiero (2013) in his study of socio-economic factors affecting farm yield in Siaya District, Siaya County, Kenya observed that farmers learn production by doing which does not necessarily depend on the level of formal education. This study was however not specific to sugarcane

production. This study sought to establish whether the same conclusion on farmer educational level hold in the case of sugarcane production in Nyando Sugar-Belt.

The above studies did not consider the effect of farmer educational level on output which was the subject of this study. The focus of most of the studies was the need to enhance agricultural extension services without regard to farmer educational level. Similarly, most of the studies were conducted in different environments and on different crops and thus, the conclusions drawn may not suffice in the case of sugarcane production in Nyando sugar-belt. The research design adopted was mainly descriptive; however, this study adopted both descriptive and inferential analysis tools. The study also sought to cure the weaknesses in methodology noted from the above studies.

2.3.3 Relationship between land ownership and output

According to Cheesman (2006) in his study of sugarcane farming in Durban, South Africa, he found out that sugarcane farming had completely transformed large tracts of land leading to reduced acreage available for other crops such as wheat, maize and sorghum. The study employed descriptive research design and re-enforced the positive relationship between land acreage and cane output.

Girei and Giroh (2012) identified inadequate land and inadequate credit as major constraints in sugarcane production in Nigeria. Due to inherent scarcity of land as a factor of production and the fact that land acreage diminishes with increases in population, a study needs to go beyond land availability to consider issues of land ownership and its effect on cane output. The study adopted both descriptive statistics and production function analysis. According to Muntema and Blackden (2001) in their study on gender and poverty in Africa, observed that females in sub-saharan Africa have limited access to and control of assets and other resources such as land, technology, financial services and labour compared to males. Lack of control over these resources makes women passive participants in sugar production. This study adopted descriptive research design and mainly focused on the effect of gender on sugarcane production.

The study by Tarimo and Takamura (1998) on sugar production, processing and marketing in Tanzania and based on descriptive research design, found out that sugar production was far below the country's annual demand. The study found out that the country could be a net exporter of sugar if constraints limiting production at the farm level were removed. The constraints identified in this study include unreliable rainfall, low yielding seed cane and poor crop husbandry practices. Clainos and Ledwin (2011) identified lack of equipment, low factory prices of cane, high transport and haulage costs, limited training and unavailability of inputs as critical for enhanced cane productivity. The researcher adopted descriptive survey design. Reddy (1998) in his study of Fiji sugar industry in Chipowa, Zimbabwe found out that 73% of the land was leased from the owners and that ownership insecurity negatively impacts on farm investment and productivity. The study adopted descriptive research design. This study was meant to ascertain if the same conclusion holds in the case of Nyando Sugar Belt, Kenya.

Dlamini and Masuku (2011) in their study of land tenure and land productivity in maize production in Swaziland, found out that land ownership influenced maize productivity. This study sought to establish whether the same conclusion hold in the case of sugarcane production in the Nyando sugar-belt.

According to FAO report (2008) secure land ownership and property rights can drive poverty reduction, rural development and global food security in developing countries. Farmers with clear land ownership are motivated to invest in their operations and increase production beyond subsistence farming. Thuo (2005) in her study on the influence of extension services and enterprise diversification on household food security among small scale farmers in Muhoroni Division of Nyando District observed that farmers experience food insecurity due to over reliance on sugarcane which matures within a period of 18 to 24 months. Thus, decline in cane production was attributed to food insecurity by the researcher. This study was based on descriptive research design. The study by Wawire et al (2006) on cost reduction strategies in sugarcane production in Kenya observed that farmers attitude towards contract sugarcane farming is one of the causes of declining trend in cane production. The researchers observed that

sugarcane input costs have been increasing over time resulting into high domestic sugar prices in comparison to other sugar producing countries. The findings of the study regarding the cost components of inputs was that cane transport 28%, labour 22%, fertilizer 9%, seed cane 13%, land preparation 10% and levies 18% but may vary depending on the zone. This study adopted descriptive research design.

The study by Odenya et al, (2008) in Nyando opines that as households increase there was a general trend of land diminishing. The researcher adopted both descriptive and correlation research designs. The researchers concluded that there was inadequate land for sugarcane and food production in Nyando Sugar Belt. Dindi (2013) in her study of managerial factors influencing sugarcane production by farmers in Mayoni division, Mumias District confirmed decline in sugarcane production among contracted out grower farms from 137 tons per acre in 1973 to 18 tons per acre in 2010. This study mainly focused on contract farming, food security, extension services and financial management as key factors influencing sugarcane production. The researcher adopted descriptive research design throughout the study. A paper on Economic recovery strategy for wealth and employment creation (ERS WEC) observed that inefficiencies in the production processes can be attributed to lack of access to credit, poor agronomical practices, land infertility, inadequate land acreage and lack of technical knowhow among farmers.

To address the issue of cane output at the factory level, the government has directed the sugar sub-sector to diversify into power generation and ethanol production in readiness for the end of COMESA safeguards (Report of the Parliamentary departmental committee on Kenya sugar industry crisis, 2015). This report has mainly focused on factory price of cane thereby ignoring land ownership which is subject of this study. It was observed that there is need to increase irrigated sugarcane production in Kenya particularly in the Tana River basin, Nyando basin, Gem and Yalla swamps and Nzoia basin. It is estimated that potential irrigable land in these three basins alone is in the range of 700,000 hectares. Studies indicate that yields from irrigated fields range from 120-150 TC/HA compared to 70-100 TC/HA from rain fed fields (Log

Associates, 2009). This study mainly focused on the need to adopt irrigation to increase area under cane and hence enhance cane output.

The above studies did not consider the effect of land ownership on output which was the subject of this study. The focus of most of the studies was the effect of gender on land ownership and the effect of land acreage on output thereby ignoring the effect of land ownership on output which was considered by the current study. Similarly, most of the studies were conducted in different environments, on different crops and there was no priori expectation regarding land ownership influences on output. The current study also sought to address weaknesses in methodology identified in the above studies.

2.3.4 Relationship between gender and output

Reddy (1998) found out that sugarcane farming in Chipowa, Zimbabwe was carried out by the elderly, mostly male with women only taking over after the death of their husbands and that cane farmers were not highly educated. This research was meant to ascertain if the same conclusion on gender factor holds among small scale farmers in Nyando Sugar Belt, Kenya. Reddy's study adopted descriptive research design. Aina et al (2015) in their study on Economic analysis of sugarcane production in Moro local government area of Kwara state of Nigeria sought to find out socio-economic characteristics of cane farmers, costs and benefits associated with sugarcane and factors affecting sugarcane production in Kwara state of Nigeria. He found out that 65% of farmers were male, 70% aged between 31 and 40 years and 75% with sugarcane farming experience exceeding 10 years. The current study was meant to ascertain if the same conclusion in respect of gender holds true in the case of Nyando Sugar Belt, Kenya. This study adopted both descriptive and correlation designs during the study.

Despite women's increasing prominent role in agriculture, they remain severely disadvantaged in terms of access to productive resources. African culture generally discriminates against women in areas of inheritance of land and thus difficulties have always been experienced in their expanding of farming activities (Anyanwu and Agu, 1996). A Study conducted by Freitas (2005) on evaluation of the effects of entrance of sugarcane into settlement in Sao Paulo, Brazil among

small scale farmers revealed that these families tend to experience economic stagnation. The study adopted descriptive research design.

Clainos and Ledwin (2011) carried out an investigation of economic factors affecting productivity of small-scale sugarcane farmers in Zimbabwe to identify economic challenges facing farmers, explore ways of overcoming them and advise on policy interventions. The researchers identified lack of equipment, low factory prices of cane, high transport and haulage costs, limited training and unavailability of inputs as critical for enhanced cane productivity. The researcher adopted descriptive survey design.

A study by Ramulu (1994) concluded that there was a significant and positive influence of price and yield in cane production in Pradesh state of India. This study considered cane factory price which is externally influenced by world sugar prices. The researcher adopted correlation research design throughout the study. Asif et al (2005) in their paper on sugar policy analysis, a case of Charsadda and Mardon districts, Pakistan found out that sugarcane production is encouraged by policy incentives towards sugar export promotion and not import substitution. Thus, the need to produce sugar in the most cost-efficient manner to be able to compete with other world players. Anderson et al. (1989) in their study on variability of grain yield in London cited factors such as input variation, seed varieties, weather conditions, technology and improved information flow as the main causes of yield variability. This study adopted correlation research design. According to Edmeades et al (2008) in their study on divergent tolerance in maize, an energy reality in United States of America concluded that farmers input mix is a source of difference in yields. Thus, access to inputs is a determining factor of yield success. This study was based on descriptive research design.

Fritz et al (2009) observed that cost of inputs in sugarcane farming are very much determined by the age of farm machinery, no of ratoon crops as well as other factors that result into different production systems with unequal input and output levels. The study was based on descriptive design and production function analysis. Rice et al (2009) suggest that sugarcane outputs are improved with use of proper soils, application of fertilizers and chemicals and proper

maintenance of the farms. There is need to apply adequate plant nutrients based on the recommendation of soil test results. This study adopted descriptive research design. According to Upton (1996) in his study in United States of America, on the economics of tropical farming system observed that weeds in sugarcane resist light, nutrients and moisture and serves as an alternative host for many insect pests. These pests reduce yield and adversely affects cane quality. This study was based on descriptive research design.

A paper presented by the Zimbabwe sugar association observed that sound fertilizer practices which include, right fertilizer selection, application of right amounts, timing of application and correct placement to ensure nutrients remain in moist zone would guarantee optimum crop growth (Zimbabwe sugar association, 1982: 62). Clowes (1998) in his study of Zimbabwean sugar production agrees that inputs are very important in achieving higher yield. He identified seed, fertilizer, irrigation, and transport cost and ratoon management as key elements to be managed for efficient sugarcane production. This study was based on descriptive research design and inferential statistics. Sundara (1998) observed that costs incurred in sugarcane cultivation depend on the level of crop management by the farmer, their economic conditions and credit availability. He observed that lower input costs will certainly save costs but reduce profitability. The researcher adopted descriptive research design during the study.

Nuthall and Padilla (2009) in their study found out that extension education is an effective way of improving technical efficiency in production of sugarcane in Phillipines. Therefore, there is need to deploy more extension staff to realize improvement in cane output. The researchers adopted descriptive research designs during the study. Adrian et al (2013) in their study, identified cost of inputs; land preparation, fertilizer, seed cane, weeding and irrigation as key determinants of sugarcane returns thereby ignoring gender factor which is subject of this study. The researchers adopted descriptive research design and production functional analysis during the study. Thuo (2005) in her study observed that farmers experience food insecurity due to over reliance on sugarcane which matures within a period of 18 to 24 months. Thus, decline in cane

production was attributed to food insecurity by the researcher. This study was based on descriptive research design.

Mangasini et al (2013) in their study of socio-economic factors limiting small holder groundnut production in Tabora region, Tanzania found out that gender did not affect groundnut production. The current study sought to establish whether the same conclusion hold about sugarcane production in Nyando sugar-belt.

Kweyu (2013) in his research on factors influencing withdrawal of farmers from sugarcane production, a case of Mumias District, Kakamega County identified the following factors; high input costs, lack of incentives, food insecurity, lack of technical know-how and delayed payments. This study was based on descriptive research design. According to Ambani et al. (2015) in their study on the influence of selected factors of motivation of women participation in contract sugarcane farming in Mumias Division, Kakamega county, Kenya concluded that most women were influenced by property ownership, membership of advocacy bodies and representation in investment institutions. Cross sectional design was employed during the study and Cronbach's alpha coefficient used to test validity and reliability of the research instrument. Descriptive and inferential statistics was employed in data analysis and interpretation.

Kidula,(2007) in her study observed that most farmers have no assured food security and so many of them withdraw from sugarcane farming in favour of other food crops. This study was based on descriptive research design. Therefore, the researcher observed that gender factor influences cane output. This study is meant to establish whether the same is true for Nyando Sugar Belt, Kenya. According to Kokeyo (2013) farmer's involvement in sugarcane contracts is influenced by farm distance to the factory, ownership of the assets, risk aversiveness, household size and farmer education level.

A study by Onyuka (2017) on socio-economic determinants of groundnut production in Ndhiwa District, Kenya studied farmers age, gender, household size, farmers experience, previous household income and farm acreage. He adopted purposive multi-stage sampling technique and

concluded that gender, formal education, farmers years of experience and household's previous income affected groundnut production. The current study sought to establish whether the same conclusion on farmer educational level and gender hold in the case of sugarcane production in Nyando sugar-belt.

The above studies did not consider the effect gender factor on output which was one of the subjects of this study. The focus of most of the studies was involvement of women in Agriculture and proportion of each gender in production processes and thus, ignored the impact of gender on output. Similarly, most of the studies were conducted in different environments, on different crops and there was no priori expectation regarding gender influences on output. Therefore, conclusions from the above studies may not hold in the case of sugarcane production in Nyando sugar-belt. The study also sought to address weaknesses in methodology identified from the above studies.

Review of the above literature revealed that the research objectives under consideration during this study were not considered or exhaustively addressed by various scholars. Most studies considered farmers' experience and land acreage thereby ignoring farmer educational level and land ownership which was subject of this study. Studies on input costs did not consider the four aspects of land preparation, fertilizer application, weeding, seed cane and planting costs. Similarly, on gender most scholars concluded that farming was dominated by males but did not consider the effect of gender on output. According to Yussuf et al (2013) in their study of profitability and adoption of water-melon technologies, males dominated farming system. The current study also sought to establish whether the same applies in the case of sugar cane production in Nyando Sugar Belt.

The above studies were conducted in different environments and in some cases using different crops. This study was therefore carried out in Nyando Sugar Belt and focused on sugarcane production. The study also sought to address weaknesses in methodology identified from the above studies.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the procedures and techniques that were used during the study. It provides an explicit description of the research design, population, sample size and the sampling procedures and a basis for planning, selecting and developing research instruments and the data analysis techniques used during the study.

3.2 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).

3.3 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 covers 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).

3.4 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)

3.5 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.2010) $i.e.\frac{1.96^2(0.5)(0.5)}{0.05^2}$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.

Table 3.1: Target Population and Sample Size

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

3.6 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 (Appendix 1). 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.

3.6.1 Test for Reliability

According to Grinnel (1993) reliability measures the degree of accuracy in the measurement that an instrument provides. According to Mugenda and Mugenda (2003) research instruments are expected to yield same results with repeated trials under similar conditions. Test-Retest method was used by the researcher to determine reliability of the research instrument.

A pilot study was undertaken for pre-testing of the questionnaire. Pre-testing assisted the researcher to ascertain reliability of primary data to be collected. A sample of 10 respondents from across the Nyando Sugar Belt, 4 from Kisumu, 4 from Nandi and 2 from Kericho counties, was used during the pilot study. The choice of 10 respondents was informed by Umbach (2005) who proposed the use of 5-10 people in questionnaire pre-testing. Similarly, reliability was enhanced through self-administration of the questionnaire as well as random comparison of primary data with records maintained by the farmers and Sugar millers throughout the study. Cronbach's Alpha Coefficient was also computed to ascertain reliability of the research instrument. According to Mohsenand and Dennick (2011) there were varying reports on the

acceptable value of the Cronbach's alpha ranging from 0.70 to 0.95. However, higher values were indicative of more reliable instruments.

3.6.2 Test for Validity

According to Best and Kahn (2003) an instrument is valid when it measures what it claims to measure. Validity is the extent to which differences found with a measuring instrument reflect true differences among those being tested. Anastancia (1982) asserts that validity is the quality that an instrument or tool used in research is accurate, correct, true, meaningful and right. The researcher used content validity for purposes of this research

3.7 Data Analysis and Presentation

In this study both descriptive and inferential statistics were used in analyzing the data and testing of the research hypotheses. More specifically because the study involved analysis of several variables and whether they affect cane output. Measures of central tendencies such as mean, mode and median were used. 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 was analyzed through correlation and regression analysis and determination of Karl Pearson's product moment coefficient which was used to determine the relationship between the variables analyzed. Durbin-Watson, F and t- test statistics and standard error was used during the study and hypothesis tested at significance level of 0.05. The information was presented in the form of tables, graphs and charts and results of the ordinary least squares models. Statistical Package for Social Sciences (SPSS) was used to analyze and summarize the data for ease of interpretation.

3.7.1 Diagnostic tests

Variance of inflation factor (VIF) was used to test multicollinearity. Various recommendations for acceptable levels of VIF have been published in literatures. Recommended maximum VIF value of 5 (c.f. Kennedy, 1992; Rogerson, 2001) and even 4 (c.f. Pan and Jackson, 2008).

3.7.2 Econometric Model and Specification

Cobb-Douglas stochastic frontier production model used during the study was as specified below in its general form;

$$Yi = \alpha_0 X_{1i}^{\alpha 1} X_{2i}^{\alpha 2} X_{3i}^{\alpha 3} X_{4i}^{\alpha 4} X_{5i}^{\alpha 5} X_{6i}^{\alpha 6} X_{7i}^{\alpha 7} e^{ui} \quad \ldots\ldots(3.1)$$

The model 3.1 above was then log transformed and equation 3.2 obtained to make it linear for ease of interpretation of parameters as below;

$$\ell nYi = \alpha_0 + \alpha_1 \ell nX_{1i} + \alpha_2 \ell nX_{2i} + \alpha_3 \ell n X_{3i} + \alpha_4 \ell n X_{4i} + \alpha_5 \ell n X_{5i} + \alpha_6 \ell n X_{6i} + \alpha_7 \ell n X_{7i} + \mu_i \ldots\ldots(3.2)$$

Where: Yi =Cane output per acre per farmer

X_{1i} = land preparation cost per acre per farmer.

X_{2i} = fertilizer application cost per acre per farmer.

X_{3i} = weeding and weed control cost per acre per farmer

X_{4i} = Seed cane and planting cost per acre per farmer

X_{5i} = farmer educational level

X_{6i} = land ownership.

X_{7i} = gender.

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

3.8 Ethical Consideration

Confidentiality of the respondents was guaranteed during the research by ensuring that respondents remain anonymous. Quality, integrity, independence and impartiality was observed during the research and participation was voluntary. Ethical approval was received from Maseno University Ethics Review Committee before administration of the questionnaires.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents results of the socio-economic determinants of sugarcane production in Nyando Sugar-belt, Kenya, which covered three counties namely Kisumu, Kericho and Nandi counties. The results are based on the four study objectives which were to examine the effect of variable input cost namely land preparation cost, fertilizer application cost, weeding and weed control cost and seed cane and planting cost, the effect of farmer educational level, the effect of land ownership and the effect of gender on cane output among small scale farmers in Nyando Sugar Belt.

4.2 Response rate

A total of 384 cane farmers chosen to participate in the study were randomly drawn from the three counties of the Nyando sugar belt. The study managed to collect data from 375 respondents out of the targeted 384 respondents. The response rate of 98% was considered appropriate as it conforms to the views of Jonson and Owens (2003) who asserted that in most instances a response rate of 20% is too low while 80% is a de factor standard.

4.3 Reliability of the questionnaire

Data collection for this study was through questionnaires and analysis of cane farmers records. Test-re-test method was used to determine reliability of the research instrument. A sample of 10 respondents was used in the pilot study and a Cronbach alpha coefficient of 0.868 obtained as shown in Table 1. According to Mohsen and Dennick (2011) there were varying reports on the acceptable value of the Cronbach's alpha ranging from 0.70 to 0.95. The computed coefficient fall within the range of values and thus, an indication that the data collection instrument was relatively reliable.

Table 4.1: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.696	.868	40

4.4 Validity of the questionnaire

To enhance validity of the research instrument, a team of five experts in the area of agricultural economics were given the instrument for scrutiny and any amendments in the content were done in accordance with the research objectives.

4.5 Socio-Economic Characteristics of the Study Respondents

The study established the socio-economic characteristics of the respondents, including their gender, age, highest academic qualification, marital status, years of experience in cane farming, household size, land ownership, size of land owned, reasons for planting sugarcane and plant cycle.

Results on gender indicated that, of the 375 respondents, a majority 77% were male while 23 % were female. This is shown in Table 2. The presence of many male respondents in the study may be explained by the fact that culturally in the dominant communities within the Nyando sugar belt; men are the leaders of the family and mostly take up family decisions which include sugarcane cash crop farming. A female only takes charge of the farms upon the demise of their spouse. The finding on head of household is in line with African culture where males are the head of households. The head of households were the ones who make major decisions that affect production. The findings on male: female ratio agrees with Yusuf et al (2013) who although was looking at watermelon observed that males dominated farming system.

Table 4.2 also shows the gender of households by county. In Kisumu county, 80.9% of respondents were males and 19.1% were females. In Kericho county, 67.9% of respondents were males and 32.1% were females. In Nandi county,78.6% of respondents were males and 21.4%

were females. Male farmers were highest in Kisumu county at 80.9% and lowest in Kericho at 67.9%. Female farmers were highest in Kericho at 32.1% and lowest in Kisumu at 19.1%.

Table 4.2: Gender of Household Head by county

County		Gender of Household Head by County		Total
		Male	Female	
Kisumu	% within County if households	80.9%	19.1%	100.0%
		127*	30*	157*
Kericho	% within County if households	67.9%	32.1%	100.0%
		53*	25*	78*
Nandi	% within County if households	78.6%	21.4%	100.0%
		110*	30*	140*
Total	% of Total	77.0%	23.0%	100.0%

Note* Denotes frequencies
Source: Field data 2018

Results on age as a socio-economic characteristic of the respondents indicated that majority (56 %) of the respondents fell in the 41-60 years age bracket. A total of 31% were between 21-40 years; 12 % were aged over 60 years while 1% were aged less than 20 years. This is shown in Table 4.3. Nonetheless, data were collected across all age groups, implying that the study represented the perspectives of sugar cane farmers in all the age groups. According to Oucho (1996), in his report on urban migrants and rural development in Kenya, age brackets are sub-divided into young (less than 30 years), middle age (31-55 years) and old (above 55years). From the Table 4.3, majority of the cane farmers fell within middle age.

The study by Oucho found that those districts contributing to rural-urban migration experienced net gains in male population after age 40 years. This may likely explain the presence of 56 % of age 41-60 years and 12 % of 61 years and above among the study respondents. The finding on

average age was consistent with that of Onyuka (2017) who although studied groundnut production found that the mean age of household heads in Kenya was 45 years. With a significant number of farmers being middle age, the future of sugarcane farming in the study area can be said to be guaranteed. Interventions should be targeted at this age group

Age plays a significant role in farming as it determines the strength of the farmers ability to carry out tedious and rigorous work (Yusuf et al. 2013). The older the farmer, the more experience in farming and probably the fewer resource allocation mistakes in production.

Table 4.3 also showed that the number of household heads in the age group of 41 to 60 years was highest in all the three counties. Nandi county had the highest proportion of household heads over 60 years of age at 17.9% while Kisumu had the lowest at 6.4 percent. Kericho county had the highest proportion of household heads between 21 to 40 years of age at 32.1% while Nandi had the lowest at 25 percent.

Table 4.3: Age of Household Head by County

County		Age bracket of household head				
		(less than 20 yrs)	(21-40 yrs)	(41-60 yrs)	Over 60 yrs	Total
Kisumu	% within county	0.6%	36.9%	56.1%	6.4%	100%
	of household	01*	58*	88*	10*	157*
Kericho	% within county	0.0%	32.1%	55.1%	12.8%	100%
	of household	0*	25*	43*	10*	78*
Nandi	% within county	1.4%	25.0%	55.7%	17.9%	100%
	of household	02*	35*	78*	25*	140*
Total	% of total	0.8%	31.5%	55.7%	12.0%	100%
		03*	118*	209*	45*	375*

Note * Denotes frequencies

Source: Field data, 2018

Results on household size as a socio-economic characteristic of the respondents showed there were a total of 311 males and 234 females within the family composition.

From Figure 4.1 on specific number of male family members, 17 respondents had no Male family members, 2 respondents had 8 male family members with majority of the respondents (95) having 3 male family members. Many male family members within the household would imply lower land acreage available for farming activities due to increase in demand for land for settlement. The large number of males within the households may possibly imply increased poverty levels and hence farmers inability to invest more in cane production.

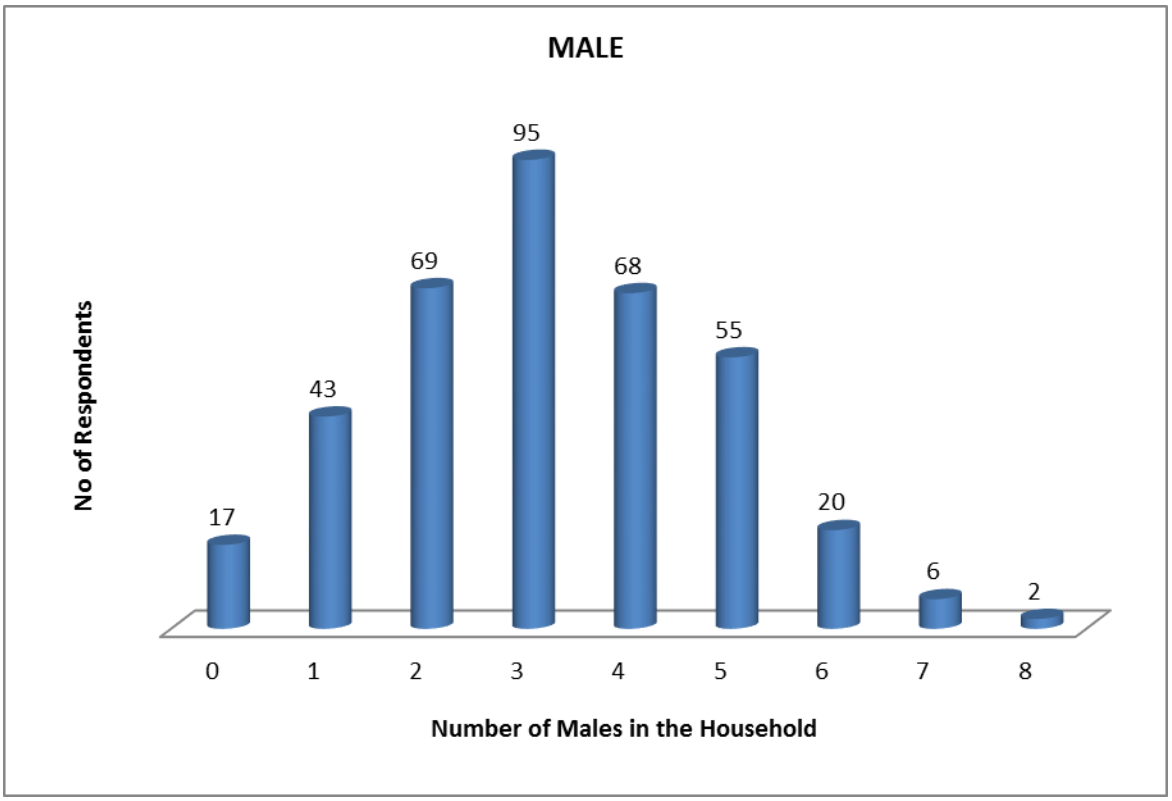

Figure 4.1: Number of Male Family Members in the Sample

From Figure 4.2 on specific number of female family members, 36 respondents had no female family members while one respondent had as high as 7 female family members with majority of the respondents (90) having 2 female family members.

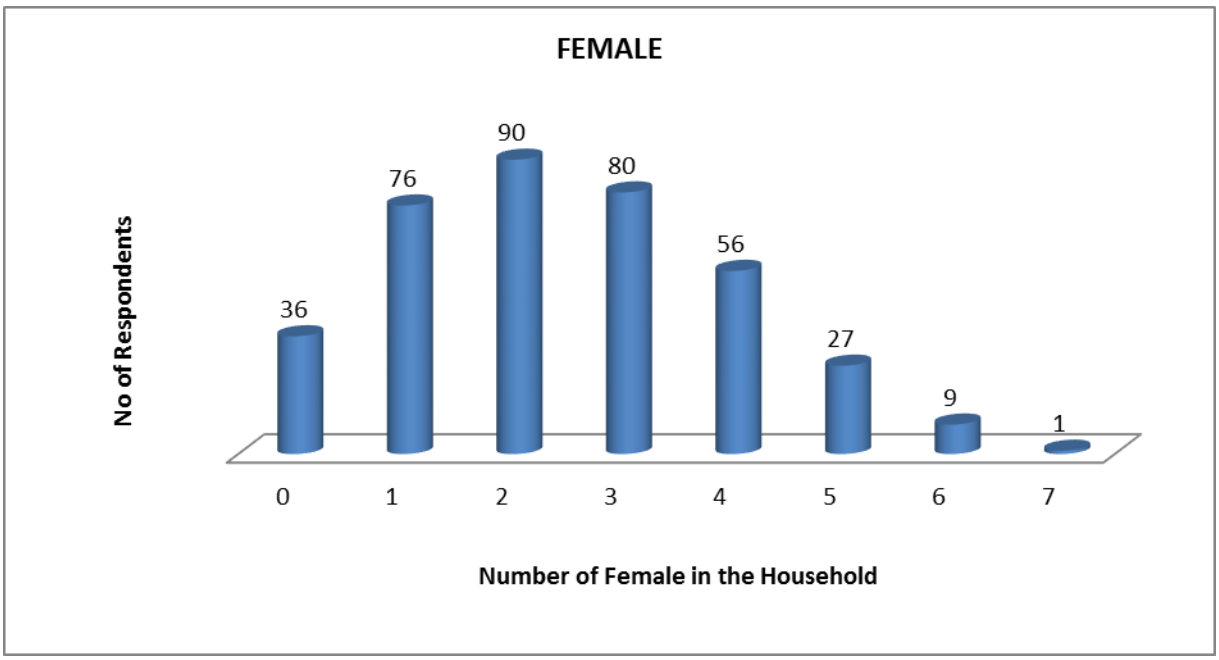

Figure 4.2: Number of Specific Female Family Members in the Sample

Results on farmer educational level as a socio-economic characteristic of the respondents as shown in Table 4.4 revealed that majority, 45 % of the respondents had a secondary school certificate, 35 % of the respondents had attained tertiary level of education, 13 % had attained a degree level of education and 7 % had primary level of education. Nonetheless, majority of the respondents were well educated and knowledgeable, thus were able to understand and respond to questions. It has been confirmed that education plays significant role in the adoption rate of technologies by creating positive mental attitude (Benor et al, 1997). Adetiba (2005) and Kehinde (2005) also confirm that education was key to enhanced productivity among farming households in various agro-ecological zones in Nigeria.

Farmers with higher levels of formal education are more likely to be knowledgeable and able to adopt technologies and make sound production decisions Any intervention that relies on education levels is therefore more likely to succeed in Nyando sugar belt.

As shown in Table 4.4, across the three counties, it was found that the number of people with tertiary level of education was low in Nandi county at 25.7% while Kisumu county had the highest number of house- hold heads with tertiary education at 42 percent. Nandi county had the highest number of household heads with primary education at 10.7% while Kericho county had the lowest number of household heads with primary education at 3.8 percent. Nandi county had the highest number of household heads with secondary education at 52.2% while Kisumu county had the lowest number of household heads with secondary education at 37.6 percent. Kisumu county had the highest number of household heads with university education at 15.9% while Kericho county had the lowest number of household heads with university education at 10.3 percent.

Table 4.4: Household Head Level of Formal Education by County

County		Level of Formal Education				
		(Primary)	(Secondary)	(Tertiary)	University	Total
Kisumu	% within of household	4.5% 07*	37.6% 59*	42.0% 66*	15.9% 25*	100% 157*
Kericho	% within county of household	3.8% 03*	47.4% 37*	38.5% 30*	10.3% 08*	100% 78*
Nandi	% within of household	10.7% 15*	52.2% 73*	25.7% 36*	11.4% 16*	100% 140*
Total	% of total	6.7% 25*	45.1% 169*	35.2% 132*	13.0% 49*	100% 375*

Note * Denotes frequencies

Source: Field data, 2018

Results on marital status indicated that majority (80%) of those interviewed, were married and 10 % were single and 10% widowed. This is shown in Figure 4.3. Married farmers are likely to carry out intensified cane farming to support their livelihood and enhanced parental obligations.

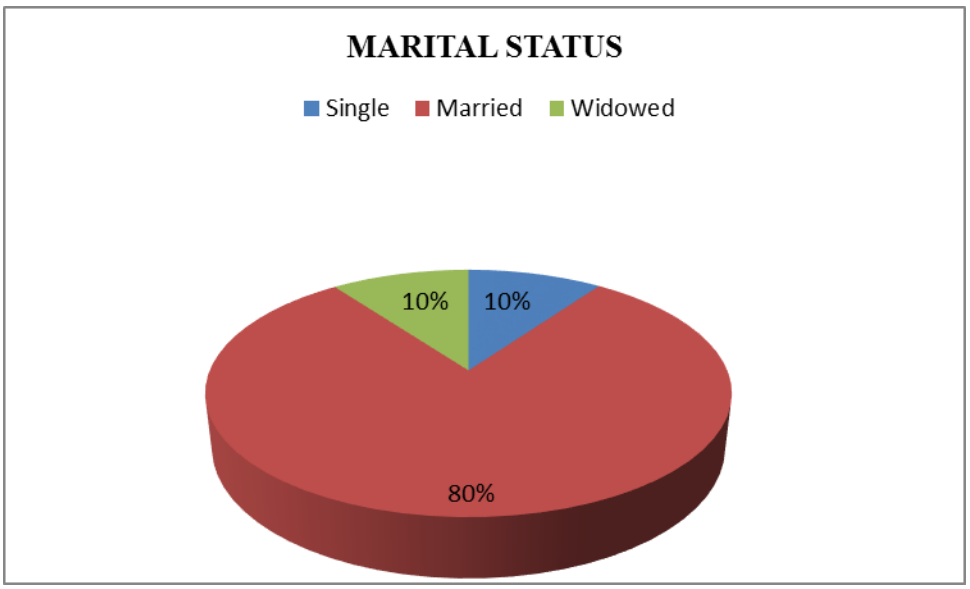

Figure 4.3: Percent of Respondent's Marital Status

Results on farmers' years of experience as a socio-economic characteristic of the respondents showed that majority (159) of the respondents have been planting sugarcane for less than five years or between six to ten years, while only 57 had done sugarcane farming for over 10 years. This is shown in Table 4.5.

The number of years the farmer has engaged in sugarcane production is a proxy used to show experience in sugarcane farming. The years of experience in sugarcane farming was found to be less than 5 years and between 6 to 10 years within Nyando Sugar Belt with a majority (42.4 percent) of the respondents.

The long years in sugarcane farming implies that farmers in the study area have good knowledge of sugarcane farming. Their long stay in the sugarcane production indicates likely good returns that keep them in the sugarcane farming for a long period of time or lack of alternative crops.

As shown in Table 4.5, Kericho county had the highest number of famers with over 10 years' experience at 20.6 percent followed by Nandi and Kisumu at 14.3 percent and 13.4 percent respectively. Respondents with 5 to 10 years' experience were found mainly in Kisumu county at 46.5% followed by Kericho county at 39.7 percent and Nandi county at 39.3 percent. Respondents with less than 5 years' experience were found mainly in Nandi county at 46.4% followed by Kisumu county at 40.1 percent and Kericho county at 39.7 percent.

Table 4.5: Household Heads years of experience by County

County		Household heads years of experience			
		(Less than 5)	(5-10 yrs)	(Over 10 yrs)	Total
Kisumu	% within county	40.1%	46.5%	13.4%	100%
	of household	63*	73*	21*	157*
Kericho	% within county	39.7%	39.7%	20.6%	100%
	of household	31*	31*	16*	78*
Nandi	% within	46.4%	39.3%	14.3%	100%
	of household	65*	55*	20*	140*
Total	% of total	42.4%	42.4%	15.2%	100%
		159*	159*	57*	375*

Note * Denotes frequencies

Source: Field data, 2018

Results on sugarcane farm acreage indicated that most of the respondents (98 %) were small scale farmers while 2% were medium scale. None of the respondents fell in the large-scale category. This is shown in Figure 4.4. The small acreages under cane in the study area could be attributed to population increases as well as possible shift away from cane farming due to reduced returns. Small scale farmers most likely incur higher costs of production due to lack of

economies of scale. Land was not a constraint to sugarcane production as evidenced by the finding that not all land was put under cane.

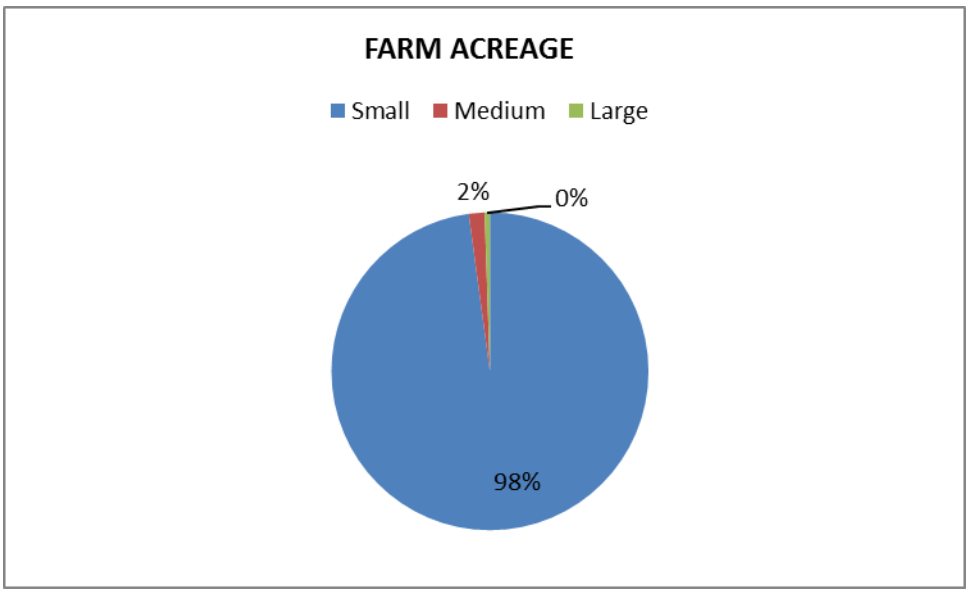

Figure 4.4: Percent of Respondents by Size of Land under Sugarcane Production

Results on land ownership as a socio-economic characteristic of the respondents indicated that majority of the sugar cane farmers (66 percent) leased land while 34 percent owned land which they used for cane production. This is shown in Figure 4.5. The presence of most leases in sugarcane production could most likely be attributed to their ability to put in the huge resources needed in sugarcane production. Reddy (1998) in his study of Fiji sugar industry in Chipowa, Zimbabwe, also found that 73% of the land was leased from the owners for cane production.

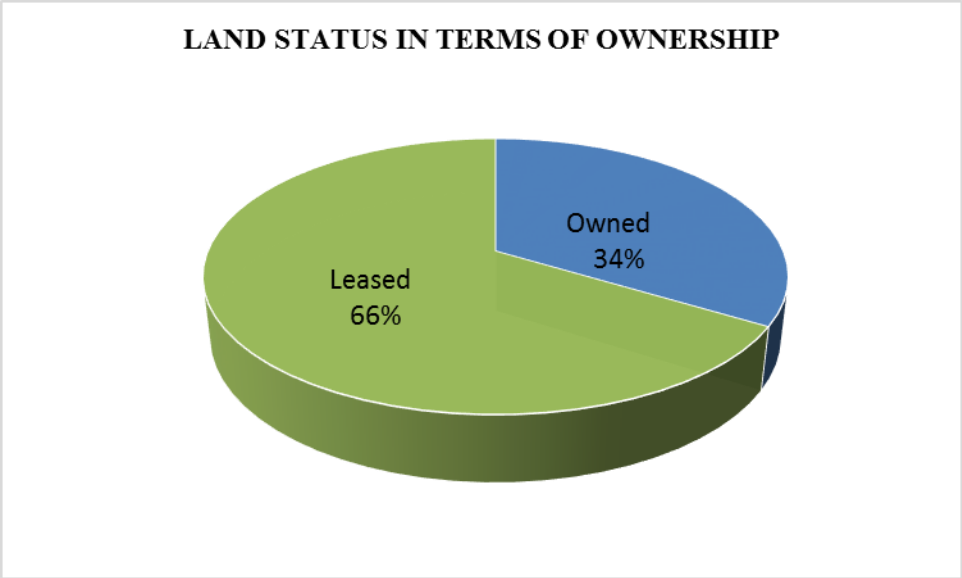

Figure 4.5: Percent of Respondents by Status of Land Ownership

As shown in Figure 4.6, the results on the reasons for growing sugarcane indicated that a majority (53%) of the respondents planted sugarcane for commercial use while a slightly lower percentage 47 %, planted sugar cane for basic or subsistence purposes. This finding is in tandem with the fact that sugarcane as a cash crop is mainly grown for commercial purposes. The increased percentage growing cane for subsistence purposes could likely be explained by the presence of most small-scale farmers among the study respondents.

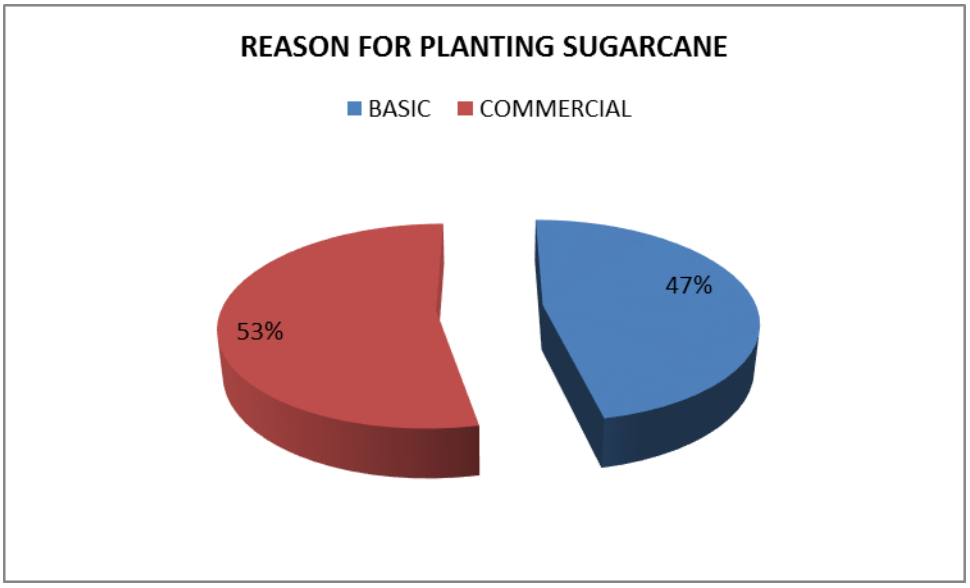

Figure 4.6: Percentage of Respondents for Reasons of Planting Sugarcane

As shown in Figure 4.7, the results on sugarcane plant cycle as a socio-economic characteristic of the respondents indicated that a majority (46.7%) of the respondents had plant cane, 38.1% of the respondents had ratoon cane and 15.2% of the respondent had both plant and ratoon cane in their sugarcane farms. With a significant number of farmers having plant cane, the future of sugarcane farming in the study area can be said to be guaranteed. It has been observed by researchers that with proper ratoon management, sugarcane crop can be harvested between 7 to 10 times (KSB, 2008). Ratoon crop requires considerably lower financial investment and thus affordable to most cane farmers.

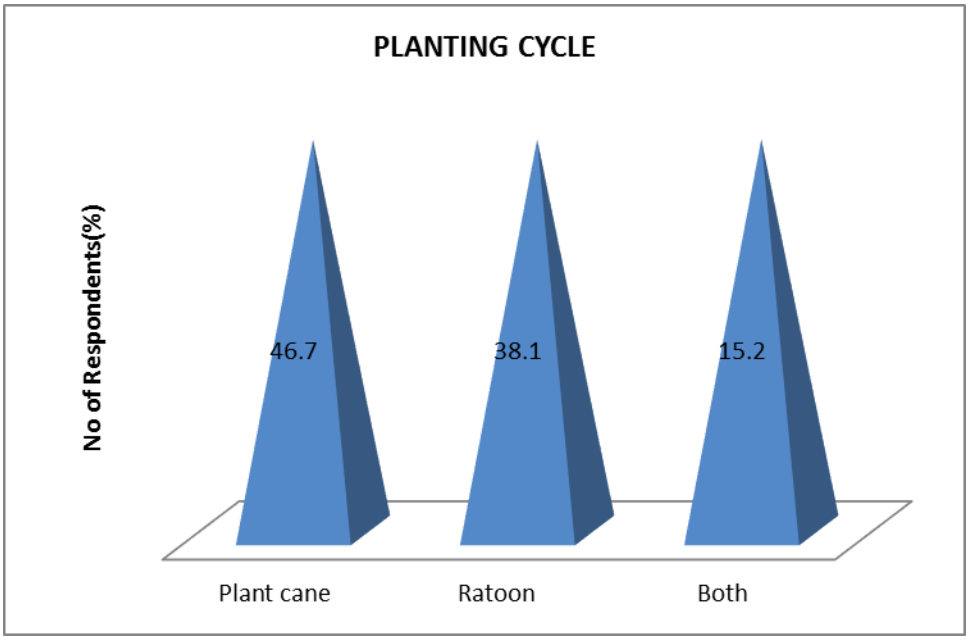

Figure 4.7: Planting Cycle

4.6 Perception among the respondents on Cane output

The respondents were asked to indicate whether cane output has been increasing or decreasing, their willingness to expand sugarcane production and the factors that affect cane production either positively or negatively in the questionnaire. The study findings are as detailed below.

Most respondents (350) representing 93 percent indicated that between the years 2009 and 2014 there was a reduction in cane output while only 25 Respondents representing 7% indicated that there was an increase in cane production. This is shown in Figure 4.8.

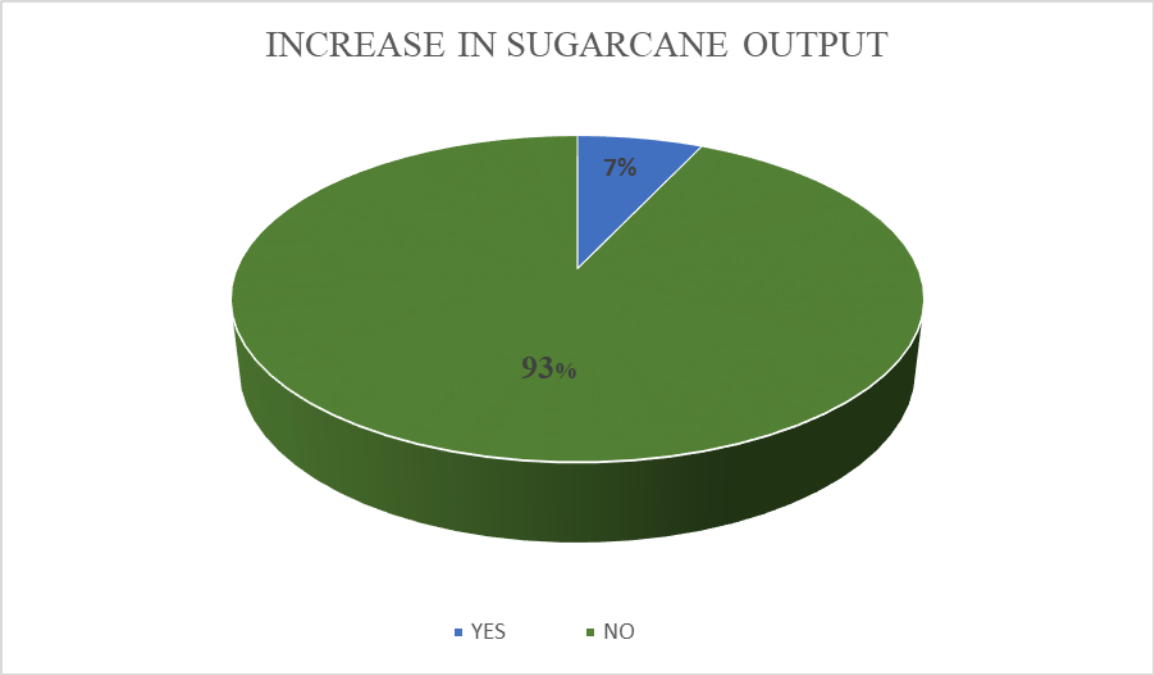

Figure 4.8: No of Respondents on increase in Cane output

The respondents attributed the low sugar cane output to harsh weather conditions like low rainfall which negatively affected the cane output, depleted fertility; Costly farms inputs and delayed payments which affected the morale of sugar cane farmers.

The respondents, who indicated that cane output had been declining over the 5 years, were asked whether they were willing to expand sugar cane production. Most respondents (54.4 % representing 204 farmers) were not willing to expand cane production as shown in Table 4.6, the main reasons for their unwillingness were attributed to low cane output, delayed payments, poor management in Milling institutions and high costs of production. A low number of respondents (171 in number representing 45.6 % of the respondents) said that they were willing to expand cane production because there were good returns from their produce.

Table 4.6: Frequency of farmers' willingness to expand cane production

Willingness to expand cane production	Frequency	Percent	Cumulative Percent
Yes	171	45.6	45.6
No	204	54.4	100.0
Total	375	100.0	

The respondents were asked whether they were willing to have alternative crops in their sugarcane farms in the questionnaire. Most respondents (53.0 % representing 199 respondents) felt that they would have an alternative crop in their sugarcane farms while a low number of respondents (176 in number representing 47.0 % of the respondents) said that they would not have an alternative crop in their sugarcane farms as shown in Table 4.7.

The main reasons for their willingness to have alternative crop could likely be attributed to low cane output, delayed payments, poor management in Milling institutions, high costs of production and longer maturity period associated with sugarcane farming.

Most respondents preferred maize as the alternative whereas others felt that tea, horticulture and dairy farming would bring them higher returns.

Table 4.7: Frequency of farmers' preference for alternative crops

Willingness to switch to alternative crops	Frequency	Percent	Cumulative Percent
Yes	176	47.0	47.0
No	199	53.0	100.0
Total	375	100.0	

4.7 Determinants of Sugarcane Production

Table 8 gives a summary of the factors affecting cane production in Nyando Sugar-belt, the percentage of the respondents and the extent of their agreement with the factor.

Table 4.8: Determinants of Sugarcane Production

	Determinants of cane production	Strongly agree	Moderately Agree	Neither agree nor disagree	Moderately disagree	Strongly Disagree
		1	2	3	4	5
1	Cost of variable inputs influences cane output	90.9	8.3	0.3	0.0	0.5
2	Farmer educational level influences cane output	20.3	28.0	30.3	5.9	15.5
3	Land ownership influences cane output	22.1	15.5	45.3	4.8	12.3
4	Gender influences cane output	17.1	24.0	42.1	3.2	13.6

As shown in Table 4.8, it was found that most respondents 90.9% believed that cost of variable inputs greatly affected cane production, 8.3% believed that cost of variable inputs moderately affected cane production, 0.3% of the respondents were indifferent while 0.5% strongly believed that cost of variable inputs does not influence cane production. This finding is consistent with the economic theory that the higher the investment in variable inputs the higher the cane output ceteris paribus.

About farmer education level, 20.3% of the respondents believed that farmer education level greatly affected cane production, 28% of the respondents believed that farmer education level moderately affected sugar cane production, 30.3% were indifferent, 5.9% of the respondents moderately believed that farmer educational level does not influence cane output and 15.5% strongly believed that farmer educational level does not influence cane output. Majority of the

respondents (51.7%) believed that farmer educational level does not influence cane output. 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 who although did not study sugarcane production, observed that farmers learn production by doing which does not necessarily depend on the level of formal education. Moreover, 52% of the respondents had secondary level of education and below.

On land ownership, 22.1% of the respondents believed that land ownership greatly affected cane production, 15.5% of the respondents believed that land ownership moderately affected sugar cane production, 45.3% were indifferent, 4.8% of the respondents moderately believed that land ownership does not influence cane output and 12.3% strongly believed that land ownership does not influence cane output. Majority of the respondents (62.4%) believed that land ownership did not affect the cane production. This is consistent with our observation that cane production was largely on leased land as shown in figure 5.

About gender, 17.1% of the respondents believed that gender greatly affected cane production, 24.0% of the respondents believed that gender moderately affected sugar cane production, 42.1% were indifferent, 3.2% of the respondents moderately believed that gender does not influence cane output and 13.6% strongly believed that gender does not influence cane output. Majority of the respondents (58.9%) believed that gender did not affect the cane production. This is consistent with our observation that cane production was largely carried out by males as shown in Table 4.2. This finding is also consistent with Mangasini et al (2013) who although studied groundnut production also observed that gender did not affect groundnut production.

When we sought to find out what the respondents thought affected cane production, most respondents believed that favorable climatic conditions coupled with good cane prices, availability of capital for farm inputs and fertile soils would affect cane production.

4.7.1 Cost of Variable Inputs

The actual costs of key variable inputs in cane production i.e. land preparation, fertilizer application, weeding and weed control, seed cane and planting which were subject of the study incurred during the years 2014 and 2015 to generate tonnage harvested in 2015 were obtained from the field as shown in Table 4.9.

Table 4.9: Costs Incurred in Sugarcane Farm per acre

		Land Preparation Cost (KES)	Fertilizer Application Cost (KES)	Weeding/ Weed Control Cost (KES)	Seed Cane and Planting Cost (KES)
Mean		9166.74	4927.68	9487.36	12873.52
Mode		10000	4000	10000	12000
Median		9500.00	4500.00	10000.00	12500.00
Minimum		2000	147	1333	4000
Maximum		22500	36000	24000	25000
Percentiles	25	6000.00	3600.00	7500.00	10500.00
	50	9500.00	4500.00	10000.00	12500.00
	75	11500.00	6000.00	11400.00	14500.00

Source: Field Data, 2018

From Table 4.9, respondents mean spending on land preparation per acre was KES 9,166, modal expenditure was KES 10,000 and median expenditure was KES 9,500. The maximum expenditure on land preparation was KES 22,500 per acre and minimum expenditure was KES

2,000. Land preparation cost included cost incurred in Ploughing, Harrowing and Farrowing activities. The mean, median and mode compare mainly because the costs charged in respect of these activities are largely uniform and standardized within the Nyando Sugar-belt.

Respondents mean spending on fertilizer application per acre was KES 4,928, modal expenditure was KES 4,000 and median expenditure was KES 4,500. The maximum expenditure on fertilizer application was KES 36,000 per acre and minimum expenditure was KES 147.The mean, median and mode compare mainly because the costs charged per unit of fertilizer was largely uniform and standardized within the Nyando Sugar-belt. The amount spent on fertilizer by the farmer depended on the frequency of fertilizer application and level of soil fertility.

The study also found out that the respondents mean spending on weeding and weed control per acre was KES 9,487, modal expenditure was KES 10,000 and median expenditure was KES 10,000. The maximum expenditure on weeding and weed control was KES 24,000 per acre and minimum expenditure was KES 1,333. The mean, median and mode compare mainly because the costs charged for weeding was largely uniform and standardized within the Nyando Sugar-belt. The amount spent on weeding by the farmer depended on the frequency of weeding and weed control method adopted by the farmer. Respondents observed that farmers who adopted both manual and chemical weeding spent less expenditure on weeding and weed control.

Respondents mean spending on seed cane and planting per acre was KES 12,873, modal expenditure was KES 12,000 and median expenditure was KES 12,500. The maximum expenditure on seed cane and planting was KES 25,000 per acre and minimum expenditure was KES 4,000. The mean, median and mode compare mainly because the costs charged per ton of seed cane was largely uniform and standardized within the Nyando Sugar-belt. The amount of expenditure spent on seed cane by the farmer depended on the age of the seed cane as well as the germination rate. The lower the germination rate due to either drought or water-logging the higher the tonnage of seed cane required. Similarly, the more mature the seed cane the lesser the quantities required to plant on an acre sugarcane farm.

The results on frequency of fertilizer application indicated that majority (58%) of the respondents applied fertilizer once, 38% of the respondents applied fertilizer twice and only 4% of the respondents applied fertilizer thrice. This is shown in Table 4.10. Majority of the farmers applied fertilizer once most likely because of lack of adequate funds and high cost of fertilizer. This finding is also consistent with Anangwe (2014) who observed that the decline in Cane output in Mumias District was attributed to inadequate fertilizer usage.

Table 4.10: Frequency of Fertilizer application

Frequency of Fertilizer application	**% respondents**
Once	58%
Twice	38%
Thrice	4%
TOTAL	**100%**

Source: Field Data, 2018

The results on weed control method employed by farmers in Nyando sugar-belt indicated that majority (66.7%, representing 250 respondents) of the respondents applied both manual and chemical weeding while only, 33.3% representing 125 respondents carried out manual weeding. This is shown in Figure 4.9. The increase in chemical weeding is most likely due to effectiveness of chemicals in weed control, the need to minimize cost of weeding by farmers as well as low labor supply because of rural-urban migration within the Nyando sugar-belt.

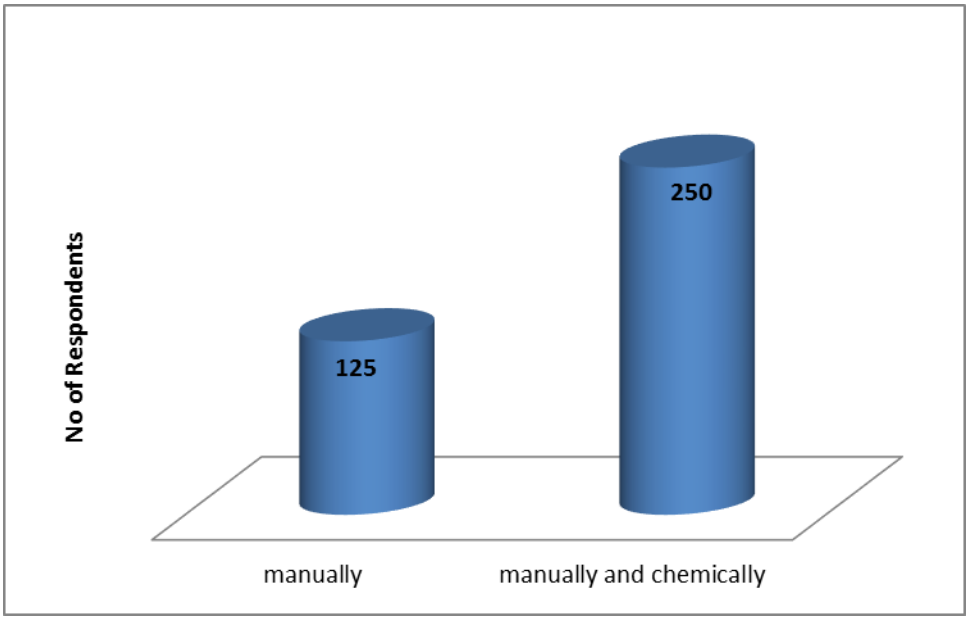

Figure 4.9: Weed control methods

Results on the frequency of manual weeding indicated that majority (46.7%) of the respondents manually weeded thrice, 34.1% of the respondents manually weeded four times, 15.7% of the respondents manually weeded twice and only 3.5% of the respondents manually weeded once. This is shown in Table 4.11. Majority of the respondents (80.8%) carried out manual weeding more than twice. Most farmers had plant cane as shown in Figure 4.7, which requires more weeding as opposed to ratoon which develops canopy faster and therefore requires lesser weeding.

Table 4.11: Frequency of Manual Weeding

Frequency of Manual Weeding	Frequency	Percent	Cumulative Percent
1	13	3.5	3.5
2	59	15.7	19.2
3	175	46.7	65.9
4	128	34.1	100.0
Total	375	100.0	

Results on the frequency of chemical application indicated that majority (88.8%) of the respondents applied chemicals only once while 11.2% of the respondents applied chemicals twice. This is shown in Figure 4.10. The low uptake in chemical usage could most likely be due to high cost of chemicals as well as belief that chemicals may interfere with soil fertility within the Nyando Sugar-belt.

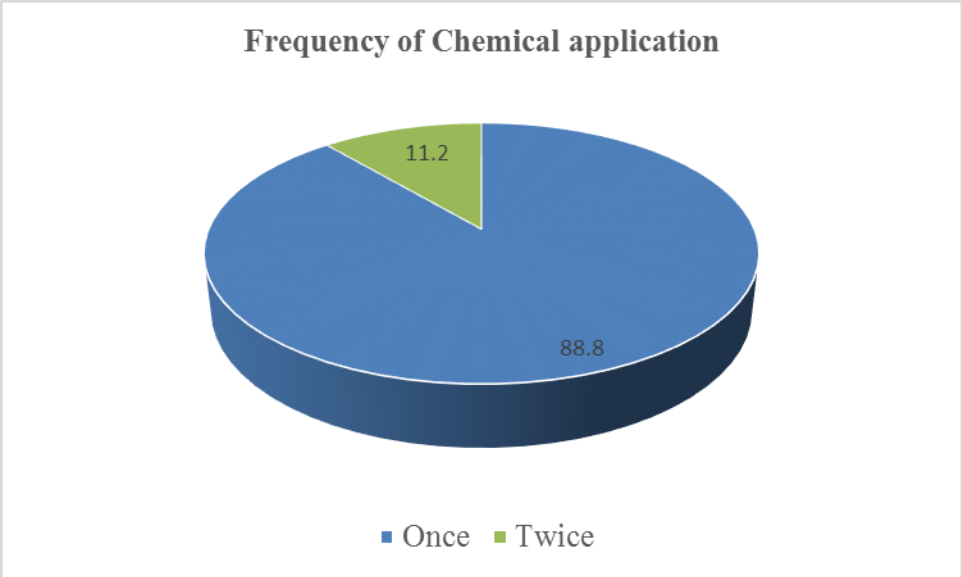

Figure 4.10: Frequency of applying chemicals for weed control

The study sought to find out whether the respondents received any form of subsidy from Government of Kenya, Kenya Sugar Board or Sugar Mills/Factories during the period 2014 – 2015. Results indicated that majority (59.0%) of the respondents did not receive any subsidy and only 41% of the respondents received subsidy in the form of low cost fertilizer. This is shown in Figure 4.11. There is need for subsidy in the areas of land preparation, weeding and weed control and seed cane and planting besides fertilizer to boost cane output which continues to suffer high cost of inputs.

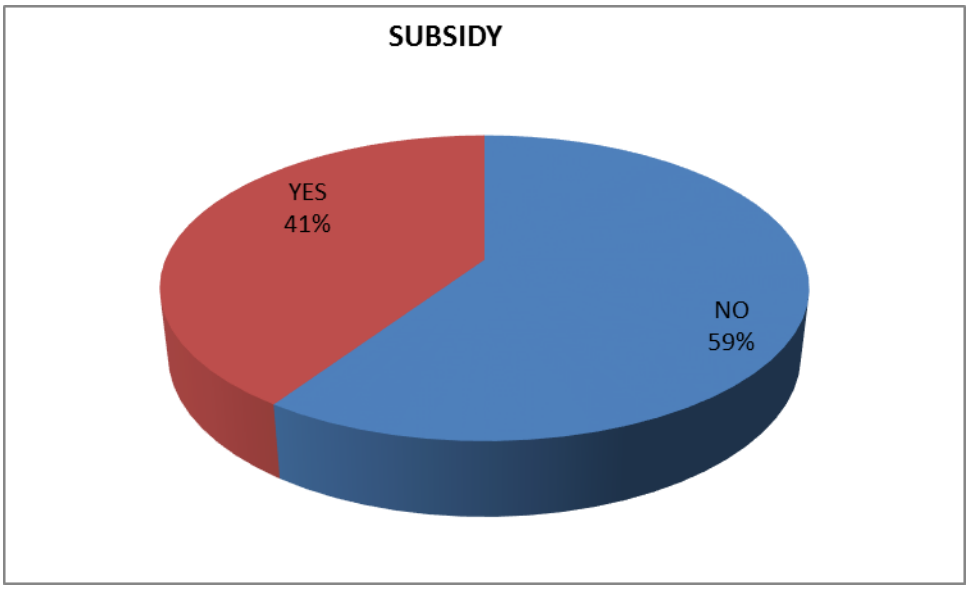

Figure 4.11: Subsidy

4.8 Cane Output

The respondents were asked to indicate the tonnage of cane harvested and the gross revenue earned from their sugarcane farm during the year 2015 in the questionnaire. The results are as shown in Table 4.12. The mean tonnage of cane harvested per acre was 21.55 tons, median tonnage was 20 tons and modal tonnage of 18 tons. The variation in cane output across Nyando Sugar-belt was attributed to variation in weather conditions and soil fertility across the study area. There is need to explore irrigation as an alternative to rain fed farming in sugarcane production with the potential of higher output.

The gross revenue from cane is the product between tonnage harvested and ex-factory cane prices. The gross mean revenue per acre from cane was Ksh. 71,791, gross modal revenue of Ksh. 60,000 and gross median revenue of Ksh. 63,000. The ex-factory prices are set by KSB taking into out fluctuations in world sugar prices based on demand and supply forces.

The respondents indicated that the major factors that affected cane production were poor weather conditions, while fertile soil, good ratoon maintenance and application of fertilizer were some of the factors that promoted good cane output. There is need to educate farmers on good ratoon maintenance practices as well as timely application of adequate and right fertilizer.

The respondents faced various challenges in 2015 for production of cane which included arson, water logging, low capital and harvesting logistics. Further, we tried to find out where the government would come in to help farmers have better yields. The respondents observed that the major roles for the government would include; Road maintenance, provision of subsidized farm inputs, offering loans and educating farmers and the most important role being research on sugar cane production.

Table 4.12: Cane Output per acre during the year 2015

N		375	375
Unit of measure		Tons (Harvested)	KES (Gross revenue)
Mean		21.5507	71791.10
Mode		18.0000	60000
Median		20.0000	63000
Percentiles	25	13.000000	45000.00
	50	20.000000	63000.00
	75	27.000000	90000.00

Source: Field Data, 2018

As shown in Table 4.13, analysis across counties showed that Kisumu had the highest mean gross income at KES 78,174 while Kericho had the lowest at KES 64,282. It's only in Kisumu county where the mean was higher than the Nyando Sugar-belt mean. Kericho

county had both the lowest and the highest gross incomes at KES 10,000 and KES 219,000 respectively.

Table 4.13: Gross income per acre under sugarcane in the year 2015 by County

Statistic	County			
	Kisumu	Kericho	Nandi	Nyando Sugar-belt
Mean	78,174	64,282	68,817	71,791
Median	75,000	62,250	60,875	63,000
Mode	40,000	45,000	60,000	60,000
Standard deviation	44,720	36,902	38,302	41,133
Minimum	10,000	10,000	10,500	10,000
Maximum	225,000	219,000	225,000	225,000

Source: Field data, 2018

4.8.1 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 Table 4.14.

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 land preparation cost. This means that there is a strong significant positive association between land preparation cost and cane output. 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 fertilizer application cost. This means that there is a fairly strong significant positive association between fertilizer application cost and cane output. 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 weeding and weed control cost. This means that there is a fairly strong significant positive association between weeding and weed control cost and cane output. Farmers should invest more in weeding and weed control 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 seed cane and planting cost. This means that there is a strong significant positive association between seed cane and planting cost and cane output. Farmers should invest more in seed cane and planting to achieve greater output ceteris paribus. This means that there is a strong positive association between cost of variable inputs (land preparation cost, fertilizer application cost, weeding and weed control cost and seed cane and planting cost) and 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 there is an insignificant weak negative association between farmer education level and cane output. 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 there is an insignificant weak positive association between land ownership and cane output. 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. This means that there is an insignificant weak positive association between gender and 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 4.14: Correlation Matrix

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

4.9 Determinants of Cane Output

The relationship between the several factors and cane output was analyzed and the findings were as shown in Table 4.15 and Table 4.16.

The regression shows R^2 (Coefficient of determination) of 75.8%. This means that 75.8% of the variation in cane output can be explained by cost of variable inputs, farmer education level, land ownership and gender. The R of 87.1% (the Pearson Correlation Coefficient) shows that the correlation between cane output and variable input cost, farmer education level, land ownership and gender 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 4.11, 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 4.15: 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 4.16: 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			

a. Dependent Variable: Cane output

b. 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 4.17. 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 affect cane output was accepted. Farmers should therefore invest more in land preparation activities in order to achieve increased cane output.

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 affect cane output was accepted. Farmers should invest more in fertilizer application to enhance cane output.

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 accepted. Farmers should invest more in weeding and weed control activities in order to achieve greater cane output.

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. Farmers should invest more in seed cane and planting to enhance cane output.

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 affect 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 affect 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 a significant negative relationship with cane output. The null hypothesis that land ownership does not affect cane output was rejected, and the alternative hypothesis that land ownership affect cane output was accepted. This is consistent 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. 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 4.17: Estimated Natural log Regression 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	2720
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. Dependent Variable: Cane output

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:

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

Y is the cane output

x_1 is the cost of land preparation per acre

x_2 is the cost of fertilizer application per acre

x_3 is the cost of weeding and weed control per acre

x_4 is the cost of seed cane and planting per acre

x_5 is farmer education level

x_6 is the land ownership

x_7 is the Gender

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.

4.10 Normality of Data

Normality tests are used to determine if data set is well modelled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed. One measures goodness of fit of a normal model to the data set. Normality and other assumptions should be taken seriously, since when these assumptions do no hold, it is impossible to draw accurate and reliable conclusions about the reality. In the case of large samples above 30, the sampling distribution tends to be normal regardless of the shape of the data (Kothari,2004).

A test was carried out to check on normalcy of data. Table 4.18 shows the mean, median, mode, Standard deviation, Skewness and Kurtosis. The standard error of skewness (0.126) and standard error of kurtosis (0.251) which fall within the range +/-2 which is desirable for the normal distribution of data hence this data follows a normal distribution.

Table 4.18: Statistics

		Sugarcane production revenue per acre (KES)	Cost of land preparation per acre (KES)	Cost fertilizer application per acre (KES)	Cost of weeding per acre (KES)	Cost of seed cane and planting per acre (KES)
N		375	375	375	375	375
Mean		71791.10	9166.74	4927.68	9487.36	12873.52
Median		63000.00	9500.00	4500.00	10000.00	12500.00
Mode		60000	10000	4000	10000	12000
Std. Deviation		41133.385	4022.033	2438.050	3270.724	3665.164
Skewness		1.423	.521	5.975	.208	.524
Std. Error of Skewness		.126	.126	.126	.126	.126
Kurtosis		2.575	.528	70.209	1.146	1.034
Std. Error of Kurtosis		.251	.251	.251	.251	.251
Minimum		10000	2000	147	1333	4000
Maximum		225000	22500	36000	24000	25000
Percentiles	25	45000.00	6000.00	3600.00	7500.00	10500.00
	50	63000.00	9500.00	4500.00	10000.00	12500.00
	75	90000.00	11500.00	6000.00	11400.00	14500.00

4.11 Conclusion on the results

The results reveal that cost of variable inputs, land ownership and gender significantly affect cane output in Nyando Sugar Belt. Farmers should therefore spend more on land preparation, fertilizer application, weeding and weed control and seed cane and planting in order to realize higher cane output. Similarly, more landowners and female headed households should be involved in sugarcane farming in order to realize increased cane output.

CHAPTER FIVE

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary findings, conclusions and recommendations from the study. The study was to investigate the socio-economic determinants of sugarcane production among small scale farmers in Nyando sugar belt, Kenya. The objectives of the study were to examine the effect of variable input costs on cane output, to determine the effect of farmer education level on cane output, to evaluate the effect of land ownership on cane output and to examine the effect of gender on cane output.

5.2 Summary Findings

The study revealed that the mean amount farmers spent on land preparation, fertilizer application, weeding and weed control and seed cane and planting was KES. 9,167, 4,928, 9,487 and 12,874 respectively per acre of cane. Therefore, on average farmers in Nyando Sugar-belt spent KES. 36,456 on variable input cost per acre. The study further revealed that mean tonnage of cane harvested by the farmer was 21.55 tons per acre resulting into gross revenue of KES. 71,791.

The results on farmer education level indicated that 6.7% of respondents had primary level of education, 45.1% had secondary level, 35.2% had Diploma level and 13% had University level of education. The results reveal that majority of the farmers in Nyando Sugar-belt had secondary level of education and below. Most cane farmers were less educated probably as a result of highly educated members migration to towns to seek formal employment.

The results on land ownership revealed that 66% of the respondents were lessees while 34% were landowners. The presence of most lessees could be attributed to their ability to put in the huge resources needed in sugarcane production.

The results on gender indicated that 77% of the respondents were males while 23% of the respondents were females. The presence of majority of male headed households in the study area could be attributed to the culture of dominant communities in Nyando Sugar-belt which requires men to lead in making major decisions that affect production.

5.3 Conclusions

The first objective was to determine whether 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. This conclusion is consistent with a priori expectation that cost of variable inputs affect cane output.

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.

The third objective of this study was to determine whether land ownership affected cane output. The findings revealed that land ownership significantly affected sugarcane production in Nyando sugar-belt, Kenya. The study revealed that cane output decreased among landowners and increased among lessees. This was mainly because lessees incur fixed costs towards lease of the land which they must recover from cane production. Therefore, lessees double their efforts in cane production to meet the entire cost of production. The lessees in the study area most likely had adequate resources and were able to invest more in cane production leading to increased cane output. This conclusion is supported by the fact that majority of the respondents in this study were lessees. This conclusion is consistent 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.

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 study 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 the study area 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.

5.4 Recommendations

It is recommended that Farmers should invest more in land preparation activities in order to realize increased cane output. Similarly, farmers should increase dosage of fertilizer and the number of times for applying fertilizer thereby spending more on fertilizers order to achieve greater cane output. The study revealed that most respondents in Nyando Sugar-belt applied fertilizer in cane production only once probably due to limited resources leading to decline in cane output.

Proper and effective weed control results into greater cane output. Farmers should therefore spend more on weed control by increasing the number of times of weeding and using a combination of both manual and chemical weeding. It is recommended that farmers should purchase quality seed cane in order to achieve increase in 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 cane output was due to high cost of inputs. Subsidy targeting the key variable input cost in sugarcane

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.

It is recommended that more educated people be involved in sugarcane farming due to their ability to adopt modern crop husbandry practices and new cane varieties leading to improvement in cane output. There is need to intensify farmer extension services in view of the education level of most respondents within the Nyando sugar belt to realize greater cane output. 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.

It is recommended that more landowners be engaged in sugarcane farming in Nyando Sugar-belt. The involvement of more landowners in cane production could result into improvement in ratoon management leading to higher cane output. Similarly, land ownership improves access to credit from financial institutions leading to more investments towards sugarcane production. The study revealed that majority of farmers in Nyando Sugar-belt were lessees who cannot access credit or loans due to lack of collaterals. It is recommended that flexible loaning terms targeting lessees be put in place 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.

It is recommended that more women be involved in sugarcane production due to their higher ability to save and re-invest in cane production relative to their male counterparts. There is need to encourage women involvement through affirmative action aimed at improving access to low cost funding for acquisition of farm inputs as well as acquisition of collaterals to be able to access loan facilities from banks and other financial institutions. Similarly, affirmative action

funds by government and non-governmental organization could be invested in cane production through the involvement of female headed households in Nyando Sugar-belt.

5.5 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 such as cane prices, marketability of cane, land size, age of the farmer, farmers previous income and farmers experience.

The current 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.

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APPENDIX I: **RESEARCH QUESTIONNAIRE**

SOCIO-ECONOMIC DETERMINANTS OF SUGARCANE PRODUCTION AMONG SMALL SCALE FARMERS IN NYANDO SUGAR BELT, KENYA

My name is Edwin O. Owiti. I am carrying out research on the socio-economic determinants of sugar cane production among small scale farmers in Nyando Sugar Belt, Kenya. Your views and opinions are important and any information you give will be greatly appreciated. They will be used for academic purposes and treated in strict confidence. This interview will only take about 15 minutes for you to fill in your answers and give me back the questionnaire.

NAME OF YOUR COUNTY: KISUMU/KERICHO/NANDI

……

SECTION A: GENERAL/DEMOGRAPHIC DATA

1. Gender: Male ☐Female ☐
2. Tick appropriately your age bracket. Less than 20 yrs☐21 – 40 yrs☐41 – 60 yrs☐ Over 60 yrs☐
3. Marital status: Single☐Married☐Widowed☐
4. Household size (In terms of specific numbers): Male☐ Female☐
5. Please indicate the highest level of education you have attained.
    a) University level☐
    b) Secondary level☐
    c) Tertiary colleges☐
    d) Primary level ☐
    e) No formal education ☐

6. What is your main reason for growing sugarcane?

_____

_____

7. How many years have you been involved in sugarcane farming?
    a) Less than 5 years☐
    b) 6-10 years☐
    c) 10 years and over☐

8. What is your total farm acreage, where 1ha= 2.5 acres?
    a) Small (1-5 ha) ☐
    b) Medium (5 – 10 ha)☐
    c) Large (Over 10 ha)☐
9. What is the size of your sugarcane farm(s) in acreage? _____

10. What is the status of your land in terms of ownership: Owner☐Leasee ☐

SECTION B: CANE OUTPUT

Q1. In your opinion, what has been the cane output trend between the years 2009 and 2014 in terms of tonnage?

Increasing	
Decreasing	

Q2. What is the reason(s) for your answer in 1 above?

_____

_____

Q3. Are you willing to expand your acreage under sugarcane production?

Yes	
No	

Q4. What is the reason(s) for your answer in 3 above?

_____

_____

Q5. If your answer in 3 above is No, which other alternative crops did you undertake in the years 2014 & 2015? What was your gross income from these crops in 2015?

_____

_____

SECTION C: DETERMINANTS OF SUGARCANE PRODUCTION

This section aims at finding out the determinants of sugarcane production among small scale farmers in Nyando Sugar Belt, Kenya.

Q6. Please indicate how much you agree or disagree with the following statements on a scale of 1 to 5 where 1= Strongly Agree, 2= moderately agree 3=neither agree nor disagree 4= moderately disagree and 5= Strongly Disagree.

TICK IN THE BOX CORRESPONDING TO YOUR ANSWER

	Statements	**Strongly agree**	**Moderately Agree**	**Neither agree nor disagree**	**Moderately disagree**	**Strongly Disagree**
		1	2	3	4	5
1	Cost of variable inputs influences cane output					
2	Gender influences cane output					
3	Farmer educational level influences cane output					
4	Land ownership influences cane output					

Q7. In your opinion what other factors influence cane output in your Sugar Belt/zone?

_____

_____

COST OF VARIABLE INPUTS

This part aims at determining the cost of key inputs in cane production i.e. land preparation, weeding, seed cane and planting and fertilizer application incurred during the years 2014 and 2015 to generate tonnage harvested in 2015 in the case of plant cane.

Q8. What is the harvesting cycle of your sugarcane whose details are given as under?

a) Plant cane ☐
b) Ratoon ☐
c) Both ☐

Q9. Please provide appropriate costs incurred in your sugarcane farm?

Land preparation	Ksh.
Fertilizer application	Ksh.
Weeding /weed control	Ksh.
Seed cane and planting	Ksh.
Others specify	Ksh.

Q10. How much did you spend in the following land preparation activities in your sugarcane farm?

S/No.	**Activity**	**Ksh.**
i.	Ploughing	
ii.	Harrowing	
iii.	Farrowing	
iv.	Others specify	

Q11. How many times did you apply fertilizer in your sugarcane farm?

a) Once ☐

b) Twice☐

c) Thrice ☐

d) None☐

Q12. How did you control weeds in your sugarcane farm?

a) Manually ☐

b) Manually and chemically☐

Q13. If manually how many times did you carry out manual weeding?

a) Once ☐

b) Twice ☐

c) Thrice ☐

d) Four times ☐

Q14. If by use of chemicals how many times did you apply chemicals in your farm?

a) Once ☐

b) Twice ☐

Q15. Approximately how much did you spend on the following in your sugarcane farm?

S/No.	Activity	Ksh.
i.	Seed cane	
ii.	Planting	

Q16. Did you receive any cost subsidy from Government, Kenya Sugar Board or Sugar Mills/Factories during the period 2014 – 2015, if so how much?

_____

SECTION D: CANE OUTPUT

This section aims at exploring cane output/output in Nyando Sugar Belt during the year 2015.

Q17. Please indicate the level of your cane performance/output in the year 2015:

Year	Cane output (tons)	Gross revenue (Ksh.)
2015		

Q18. In your own assessment, please give major reasons for your cane output, above?

_____

Q19. What challenges did you encounter in your sugarcane farm during the year 2015?

_____

Q20. What do you think should be the role of government in enhancing sugarcane productivity in your zone?

_____

Thank you so much for taking your time to respond to this questionnaire.

Research Assistant's Name……..……Date……..

I certify that I have checked the entire questionnaire to ensure it has been completed properly.

Signature……

APPENDIX II: FIELD DATA, 2018

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	46000	7000	3200	8000	12000	3	1	1
2	57000	10000	3400	9600	13000	2	1	0
3	32000	6000	3000	6000	12000	3	1	1
4	40000	6500	3000	7500	12000	3	1	1
5	98000	10200	5000	12000	14500	2	0	1
6	100000	11000	5500	12000	15000	1	1	1
7	192000	19500	10000	16500	21500	1	1	1
8	60750	9000	5056	10500	12500	1	1	1
9	183000	19000	9500	16000	18500	2	0	1
10	87000	8222	5000	11500	14000	3	0	1
11	54000	8500	3500	10000	12000	2	1	1
12	47000	7000	3400	8000	12000	3	0	1
13	52500	12200	6400	10000	12500	2	1	1
14	47000	7000	4000	8000	12000	4	0	0
15	112500	12500	6000	14000	16000	1	0	1
16	39750	4250	4000	7000	12000	2	0	0
17	64500	8444	6667	10200	13000	4	1	1
18	60000	8100	4500	10000	12500	3	1	0
19	63000	7800	5500	10500	13000	2	0	0
20	76000	9000	5600	11000	13500	2	1	0
21	46000	4500	3750	8000	12000	3	0	1
22	61500	7500	5333	10000	12500	1	0	1
23	60000	7300	6250	10000	13000	2	1	0
24	70000	8000	4500	10500	13500	2	1	1
25	58000	7250	6000	10000	12500	2	1	1
26	46000	6500	4000	8000	12000	3	1	1
27	87000	10000	5500	11000	14000	2	0	1
28	70500	8050	3667	10000	13000	2	1	1
29	61200	7600	5000	10000	12500	2	0	1
30	70000	7900	5333	10500	13000	3	0	1
31	100000	12500	5556	12000	15000	2	0	1
32	78000	9600	6000	11000	13500	2	1	1
33	75000	9300	5000	10000	14000	3	0	1
34	60000	7100	6000	10000	13000	4	1	1

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
35	76500	9500	6000	10800	13500	1	0	1
36	78000	9550	8000	11000	13500	2	0	1
37	69000	8400	6400	10500	12900	3	0	1
38	48750	3500	3667	10000	12000	1	0	0
39	63000	7600	4500	10000	13000	2	0	1
40	58000	10000	4200	9600	13000	1	0	1
41	25500	3400	2000	5000	12000	4	1	1
42	36000	2800	3500	6000	12000	2	1	1
43	30000	2000	3200	5500	10500	2	1	1
44	71000	10500	4500	11000	13000	2	1	0
45	196000	19800	10000	17000	21000	4	1	0
46	60000	10000	5160	10000	12000	3	1	0
47	147000	15500	7500	14000	18000	2	0	1
48	75000	10000	5500	11000	13500	2	1	1
49	90000	11000	5800	11700	14500	3	1	0
50	64000	9500	5500	10200	11333	1	0	1
51	35000	5000	4000	7000	12000	2	0	1
52	52000	9000	4100	10100	11000	2	1	1
53	58500	10000	4200	10500	12500	2	0	1
54	26250	3800	2500	5000	10500	4	1	1
55	46500	6500	4250	10000	12000	1	0	0
56	42000	4000	3600	8000	11800	3	1	1
57	114750	13000	6500	12000	15500	4	0	1
58	36000	5500	3600	6000	12000	1	0	1
59	76500	10200	5000	10000	13000	2	0	1
60	40000	5000	4400	9600	11000	2	1	1
61	53500	9000	4500	9600	10000	4	1	1
62	55000	9500	4500	10000	12000	2	1	1
63	66000	10000	4600	10500	12500	3	0	0
64	63000	10000	4500	11429	12500	2	0	0
65	50000	7300	4000	10000	12000	3	0	1
66	37000	3600	3000	8000	9000	2	0	1
67	61000	9500	5000	10500	13200	3	1	1
68	100500	12500	6100	12000	15000	3	0	1
69	45000	7000	3500	8000	12000	2	0	0
70	64000	11000	4600	11000	13250	1	1	1
71	40500	7500	3250	8500	11500	2	0	0

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
72	72667	10000	5000	11000	13500	2	0	1
73	95000	11400	6100	11900	14700	2	0	1
74	44000	6500	4000	8000	12000	2	0	1
75	60000	9500	4500	10000	13200	2	0	1
76	90000	12000	5500	11500	14000	2	0	1
77	71000	10500	5000	10400	13000	2	1	1
78	64000	10300	4700	10600	12800	2	0	1
79	49000	8000	4000	10000	12000	3	0	1
80	51000	8600	4000	10000	12000	3	0	0
81	49000	8000	3800	9200	12000	2	1	1
82	40000	7000	3600	9600	10000	3	0	1
83	105000	13000	6400	12000	15300	3	0	0
84	112000	14000	7200	12500	16000	2	0	0
85	25500	3667	4000	7000	8500	1	0	0
86	90000	11000	5333	10000	14400	2	0	1
87	65000	10300	4000	10600	13000	3	0	1
88	10500	3000	1250	2500	7500	2	0	1
89	62000	6667	5667	10000	12000	2	0	1
90	25000	4000	3000	5000	7500	2	0	1
91	210000	21000	10000	17500	23200	2	0	1
92	19333	3500	3200	2500	10000	2	0	1
93	31667	6500	3300	4500	8700	2	0	1
94	133333	12857	7500	13000	17500	2	1	1
95	64500	10000	4000	10200	13000	2	0	1
96	50333	8100	4133	10000	12000	1	1	1
97	17733	3500	3500	2000	9500	3	0	1
98	75000	10000	4800	11000	13500	2	0	1
99	225000	22000	11000	18500	24000	2	1	0
100	150000	16200	8000	6400	19000	2	0	1
101	98167	13000	6000	12000	15000	2	0	1
102	64000	10100	5000	10200	13500	3	1	1
103	34500	5500	3000	5000	10000	3	0	0
104	86250	11200	5500	12000	15000	2	0	1
105	112000	13000	7800	12500	15500	3	1	1
106	75000	10800	5000	11000	13500	2	0	1
107	70000	9800	4800	10800	13000	2	0	1
108	50000	7750	4000	10000	12000	2	0	0

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
109	31000	3750	3500	6000	8000	3	1	1
110	36000	4250	3600	7200	10500	2	0	1
111	74000	11000	5200	11000	13500	3	0	0
112	70000	10000	5000	10700	13200	2	0	1
113	52000	8150	4000	8800	12000	4	1	1
114	61500	10000	4250	10500	13000	1	0	1
115	29667	4000	2500	6000	10000	3	1	1
116	30000	4250	3000	6000	9600	2	0	0
117	58000	9500	4500	10000	12000	2	1	1
118	43000	3800	3400	8000	8000	2	0	1
119	57000	9000	4200	10000	12500	4	0	1
120	55000	8900	4250	9600	12500	2	0	1
121	85500	11200	5500	11400	14000	3	0	1
122	14000	3500	2500	2300	10000	4	1	1
123	194000	19000	10000	16500	21857	2	0	0
124	60000	10000	4200	10000	12500	2	0	1
125	56000	9500	4000	9600	12000	2	0	1
126	37500	6000	3000	7500	6500	4	1	1
127	48750	8000	4000	8000	8000	2	0	1
128	93000	11500	5950	12500	14500	3	0	0
129	31500	4500	2850	5500	12000	4	1	1
130	150000	16000	8000	14000	18000	3	0	1
131	73500	8556	4800	11000	13500	2	1	1
132	117000	13000	6500	13000	17800	3	0	0
133	51000	8250	3333	10000	12000	2	0	1
134	59000	9000	4500	10000	12800	4	0	1
135	90000	11500	6000	12000	14600	3	0	1
136	70500	9500	4700	10500	13000	1	0	1
137	52000	8100	4000	10000	12000	4	0	1
138	39000	6350	3400	8000	7500	2	0	1
139	67000	10000	4800	10800	12500	3	0	0
140	94500	11200	5700	12000	15000	2	0	1
141	75000	10500	5000	11000	14000	2	0	1
142	58000	8800	4000	10000	12000	2	1	1
143	45000	7300	3900	9000	12000	3	0	0
144	91500	12000	5990	12000	14500	1	1	1
145	65000	10000	4700	10500	13200	3	0	0

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
146	76500	10800	5000	11000	13500	2	1	0
147	68667	10000	4900	11000	13400	2	1	1
148	71000	11714	5000	11000	13000	2	0	1
149	34626	3500	2000	6000	9600	2	1	1
150	75000	9000	5500	10000	13500	1	1	1
151	219000	22500	11000	19000	21250	1	0	1
152	112000	12500	7500	12000	15000	3	0	0
153	13333	2500	2000	2000	10000	4	0	1
154	35000	7100	4000	7000	10000	3	1	1
155	78500	10800	6000	11000	15000	3	1	0
156	70000	10000	5500	11000	13750	2	1	1
157	10000	2500	3600	4000	11500	2	0	1
158	105000	12500	6000	12000	15000	3	0	1
159	53000	9000	3600	8000	12000	2	1	1
160	71860	10000	5660	10000	13500	3	1	1
161	105000	12500	8000	12000	15000	3	1	0
162	69200	9500	4660	10000	13500	3	0	1
163	90000	12000	5800	12000	15000	3	0	1
164	94500	13000	6000	12000	15000	3	0	1
165	31000	5500	3600	6600	10000	2	0	1
166	58000	9000	4000	10000	12000	2	0	0
167	58000	8500	3333	10000	11500	2	0	1
168	42000	7500	2000	9500	10000	1	1	1
169	112500	13000	8640	12000	15500	3	1	1
170	112500	13000	7000	12000	15000	2	1	1
171	26833	4000	2600	5000	10000	1	0	0
172	60000	10800	4400	11200	12500	3	0	0
173	115000	12500	7800	12000	16000	2	0	1
174	23170	3500	2400	2500	10000	2	1	1
175	13500	2500	2500	7500	8500	2	0	0
176	34500	3400	3000	6000	7000	3	1	1
177	63000	11000	4200	10000	13000	2	1	0
178	15000	3000	2500	3000	12000	2	1	0
179	20000	4000	2500	4500	10500	2	1	0
180	40000	6500	3500	8000	10000	3	1	1
181	69000	11000	5000	10000	13000	2	1	0
182	20000	4200	3000	5000	9500	3	1	1

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
183	52000	8300	4000	10000	10000	2	0	1
184	78000	11500	5600	11000	13000	3	0	0
185	35250	6000	3400	7200	11000	2	1	1
186	70500	10500	5000	10500	12500	1	0	1
187	61500	4000	4200	10000	12000	1	0	0
188	93000	11600	6000	12000	15000	2	0	1
189	40000	6000	3400	8000	12000	2	1	1
190	130000	14000	7300	13000	17000	3	1	1
191	67500	10800	4900	10500	12500	2	0	1
192	57750	9000	4500	10000	11500	2	1	1
193	22000	4000	3000	5000	10000	3	1	1
194	35000	6100	3500	7200	9000	2	0	1
195	60000	10000	4100	10500	12500	3	0	0
196	42000	6000	3550	7200	12000	2	0	1
197	133500	13500	7200	12900	16800	3	0	1
198	23000	3800	3333	5000	8500	3	1	1
199	150000	16250	7500	14000	18500	3	0	1
200	70000	10800	6250	11000	14000	2	0	1
201	87000	11000	5400	11500	14200	3	0	0
202	32000	6000	4000	6667	10500	4	1	0
203	45000	7500	3800	9000	12000	2	1	0
204	60000	10000	4286	10500	12000	3	0	1
205	45000	8000	3650	9000	12000	2	0	1
206	15000	3000	3000	3000	9000	2	0	1
207	80000	12000	6000	11500	13500	2	0	1
208	30000	4000	3000	6000	8500	2	0	1
209	63333	8667	4500	10500	12500	4	1	0
210	140000	15500	8000	14500	16000	2	0	1
211	98667	11200	6000	12500	15000	3	0	0
212	81000	11250	5000	11500	13500	1	0	0
213	90000	11000	6000	12000	14000	2	0	1
214	63000	10500	4800	10500	13200	3	1	0
215	27667	3917	3333	5000	10000	3	0	1
216	16667	3375	2000	3200	8500	3	0	0
217	70000	10000	5000	11000	12500	3	0	1
218	48000	8000	4000	10000	12000	2	0	1
219	45000	7500	3800	8800	10000	2	0	0

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
220	120000	13500	7000	13500	16200	2	0	1
221	86000	10500	5500	11700	14000	3	0	1
222	68000	10000	5200	11000	13500	3	0	1
223	115500	12000	6500	13500	15500	1	0	0
224	24000	5000	3000	4800	10000	3	1	1
225	85500	12000	5800	12000	15000	1	0	0
226	25000	3667	2600	5000	5000	3	0	1
227	67500	10000	4500	10250	12500	4	0	1
228	51000	10800	4000	10000	12000	2	1	1
229	45000	14000	4000	9000	12000	3	0	0
230	45000	13500	3900	10000	11000	2	0	1
231	40000	12500	3800	9000	10500	3	1	1
232	100000	9333	6000	12500	15000	3	0	1
233	43500	13500	3400	9000	10000	3	1	0
234	79500	11000	4333	11500	13300	1	0	1
235	63000	7560	4800	10500	13000	3	0	0
236	82000	9840	5250	11400	13500	3	0	0
237	50250	8000	4000	10000	12000	2	0	1
238	48000	7500	4000	9000	12000	2	0	1
239	85500	10000	5500	11500	15000	1	0	1
240	105000	12000	6000	15000	14480	2	0	1
241	91688	11500	5900	12500	14000	2	0	1
242	118800	13500	6500	13500	17000	2	0	1
243	75000	10000	5000	11500	13500	3	0	1
244	36750	5200	3500	4000	11200	3	1	1
245	84000	10000	5000	12000	14000	2	1	1
246	87000	11500	5100	12000	14000	2	0	1
247	91250	12000	6000	12200	14000	2	0	1
248	93333	12000	6100	12200	14250	2	0	1
249	130000	12800	7500	13500	16400	2	1	1
250	225000	22000	12000	18500	24000	3	1	1
251	100000	12000	6000	12500	14000	2	1	1
252	125000	13556	7000	13500	16500	3	0	1
253	215000	21000	10500	19500	22000	1	1	1
254	175000	18500	9000	16500	20000	2	1	1
255	150000	15000	8000	15000	18000	3	0	1
256	220000	21000	11000	18700	21000	2	1	1

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
257	124500	12800	7500	14000	16500	4	1	0
258	97500	12000	6000	12500	15000	2	1	1
259	162000	16500	8200	15000	18000	3	0	1
260	83567	10000	5000	8500	14000	1	0	1
261	30000	6000	4000	5000	10000	1	0	1
262	80000	10000	5000	8000	13000	2	0	1
263	77233	9500	4750	7900	12500	3	0	1
264	213333	20000	10000	15000	21000	3	0	1
265	120000	12500	6500	11000	15000	4	1	1
266	86667	8333	5800	9000	14000	3	1	1
267	90000	8500	6000	9000	14000	3	1	1
268	150000	15000	8000	12500	15000	2	0	1
269	200000	20500	10000	15000	22000	3	0	1
270	70000	10000	6400	9000	12500	2	1	1
271	45571	9500	3200	6000	10000	2	0	1
272	54063	8500	3280	7500	10000	2	1	1
273	87875	15000	5000	8500	14000	1	0	1
274	30000	13333	3200	5267	7500	3	0	1
275	75000	10000	5000	9000	12500	1	1	1
276	195000	12149	10000	15000	25000	2	0	1
277	32500	11000	4000	5000	10000	3	0	0
278	40000	4000	4000	6000	10000	2	0	0
279	31500	12500	3500	6000	9500	3	1	0
280	39000	4500	3750	7500	9000	3	0	1
281	102000	13400	7000	12000	15000	1	0	1
282	19500	4000	2500	4000	10000	3	1	1
283	43500	4400	4000	8000	7500	3	0	1
284	32000	13333	3500	6500	8500	3	0	1
285	52500	12000	4100	10000	10000	2	1	1
286	85000	12286	4700	10857	13500	1	0	0
287	63000	12800	5200	10500	11000	3	0	1
288	114000	7400	6000	13500	15500	3	0	0
289	47000	11000	3400	9700	10000	3	1	1
290	70000	3429	6000	11000	12000	3	1	1
291	22500	5000	2500	4000	10000	3	0	1
292	20000	3667	3333	4000	11000	2	0	1
293	58000	11000	5000	10500	11000	3	0	1

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
294	45000	14250	4000	10000	12000	1	0	1
295	62000	4000	6000	11000	12500	3	0	1
296	81000	11000	4667	11500	13000	2	0	0
297	120000	7533	7000	13500	17000	3	1	1
298	52000	5000	4000	10000	10000	3	0	1
299	80000	3600	4500	12000	13000	3	0	1
300	90000	11000	3400	12000	14000	2	0	0
301	90000	7400	4400	12000	10300	2	0	0
302	60000	4000	4286	7429	6000	4	0	1
303	100000	3600	6000	10000	16000	3	0	1
304	52500	9333	4333	7500	18333	2	1	0
305	60000	4667	2889	8000	8000	1	0	1
306	30000	3600	4000	6000	4000	3	0	1
307	36000	4333	3800	6000	4500	3	0	1
308	50000	10750	3750	7500	20000	1	0	0
309	91667	11000	6000	10000	20000	3	0	1
310	39000	10000	3500	5000	17667	2	0	1
311	58333	14000	4000	6000	13200	3	0	1
312	80000	11250	5000	7500	18750	3	1	0
313	109500	9000	6000	11111	13111	3	1	1
314	20000	2867	2500	5000	10500	3	0	1
315	14000	3333	2500	3333	9500	2	0	1
316	27000	3375	3000	6000	8500	3	0	0
317	75000	13400	5000	11000	21200	3	1	1
318	100500	11500	6000	10000	21250	1	0	0
319	15000	5000	4000	7500	10000	3	0	1
320	85500	12000	5600	9600	19000	2	0	1
321	35000	3250	3500	8000	5000	3	1	1
322	30000	3500	4333	7333	4500	3	0	1
323	75000	13750	5000	12000	22500	2	0	1
324	60000	4667	6167	6500	8500	2	0	1
325	55000	4400	5200	5600	7000	1	0	1
326	69333	12000	6500	10000	23200	2	1	1
327	52500	4000	4000	10000	7250	1	0	0
328	76250	4000	5000	10000	10000	2	0	1
329	57000	4000	4700	7200	6000	3	0	1
330	50000	13000	4000	6800	20000	4	1	1

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
331	100000	11200	2800	8000	12200	3	0	0
332	90000	7000	6000	5000	9400	3	0	1
333	40000	9667	6667	8000	18000	3	0	1
334	54000	4250	3750	10000	6000	3	0	1
335	63000	4000	4800	6000	6500	2	0	1
336	72000	3500	4000	6667	7200	3	0	0
337	40000	4120	6400	6000	4500	3	1	1
338	100000	11200	6400	12000	24400	2	1	1
339	12500	3000	2333	5000	10000	2	0	1
340	40000	4000	5333	6333	4500	2	0	1
341	90000	4143	147	9000	18000	2	0	1
342	54000	4400	3400	12800	6000	1	0	1
343	62000	5500	7500	24000	6000	1	0	1
344	54750	4000	3400	8800	7000	2	0	1
345	10000	5000	6000	4500	6500	2	0	0
346	24000	2800	12000	10000	10000	2	0	1
347	165000	7800	5000	5000	19000	3	0	1
348	47667	3200	8000	12000	8500	1	1	1
349	40000	7500	2800	5400	10000	4	1	0
350	57667	9000	1000	1333	12000	3	1	1
351	102000	12200	3214	2143	15000	1	0	1
352	96000	12000	2500	3667	14000	1	0	1
353	114912	12000	3000	2600	15000	4	0	1
354	85333	9600	3000	4800	13600	2	0	1
355	128000	12000	1500	2400	16500	2	1	1
356	180000	18000	36000	4500	20000	2	1	1
357	108500	12000	3000	5400	17440	1	0	1
358	160000	16200	4400	7200	20000	1	0	1
359	120000	13500	3600	6120	16500	3	0	1
360	120000	13500	2040	16800	16500	3	0	1
361	120000	13500	7000	6250	16500	3	0	1
362	92000	10500	6200	8000	15000	2	1	1
363	12000	3500	6667	2000	6000	3	0	0
364	45000	4500	4250	6000	10000	2	0	1
365	80000	11500	5333	8000	13000	2	0	1
366	97500	11800	3400	10000	14000	2	1	1
367	165000	15000	3333	12500	20000	3	0	1

N	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
368	104333	9867	4267	10000	15000	2	0	0
369	42000	4000	3200	8000	6000	2	0	1
370	39333	6400	2800	6000	8500	1	0	0
371	52000	8500	2800	8000	10000	2	1	1
372	34333	4000	3400	6400	5200	2	0	1
373	62000	8500	1400	8000	11000	3	0	1
374	86000	10000	3000	9600	13500	2	0	0
375	90000	11500	2286	8571	14000	2	0	1

KEY

X_5: 1 = University level, 2 = Secondary level, 3 = Tertiary level and 4 = Primary level

X_6: 1 = Owner and 0 = Lessee

X_7: 1 = Male and 0 = Female