

**DYNAMICS OF SUGARCANE PRODUCTION AMONG SMALL –SCALE  
GROWERS IN BUNGOMA COUNTY, KENYA**

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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
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THE SCHOOL OF HUMANITIES AND SOCIAL SCIENCES OF KENYATTA  
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## DECLARATION

This research thesis is my original work and has not been submitted for any award in any University.

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## **DEDICATION**

I dedicated this thesis to my beloved wife Mrs. Franciscah and my children Immaculate, Bramwel, Jacinta and Mercy Naliaka. I also dedicate it in memories of my late parents; Antonina and Maurice Khaemba who instilled in their children that education has no end.

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## **ABBREVIATION AND ACRONYMS**

BCIDP	Bungoma Integrated Development Plan
CD	Cobb- Douglas production function
CGOB	County Government Of Bungoma
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistics
FGD	Focus Group Discussion
GDP	Gross Domestic products
GoK	Government of Kenya
KII	Key Informant Interview
KSB	Kenya Sugar Board
MSC	Mumias Sugar Company
NACOSTI	National Commission for Science, Technology and Innovation
SPSS	Statistical Package of Social Sciences
SSA	Sub-Saharan Africa

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## ABSTRACTS

The sugar industry is an important agricultural sector in Kenya. In 1995, the industry had employed over 35,000 workers and supported over 2 million people in Western Kenya. Sugar production is a major contributor to the economy and has led to approximately 16% growth to the nation's Gross Domestic Product. The sub sector despite of having greater contribution to the country its output rate is declining and for now it is at 65 tonnes per hectare comparing with the approximated average national output of 100 tonnes per hectare. Due to the decline, many researchers have conducted studies concerning the sugar industry sector. Many researchers have focused much on factors determining productivity of sugarcane and leaving the gap on the socio economic factor causing the decline and the strategies to solve such crises. This study aims to investigate the dynamics of rate of sugarcane output among farmers growing on small scale in Bungoma County, Kenya. Specifically, the study sought to identify characteristics of small-scale sugarcane growers affecting sugarcane production in Bungoma County; determine socio-economic challenges facing sugarcane production in Bungoma County; and investigate the coping strategies adopted by small-scale sugarcane growers in the area of study. The study basing on the Production Theory, correlation design was the guiding parameter in the research process. The population targeted in the study comprised 5,838 small scale sugarcane farmers in Bumula Sub-County. Through multi-stage sampling procedures, divisions and villages were selected for interviewing the sugarcane farmers. Questionnaires were administered to 96 household heads out of 100 sampled. 10 members from each of the two focus groups were interviewed to give more insight on the study objectives. The questionnaire data yielded a reliability coefficient of approximately 0.9 after results representation using Cronbach Alpha's Measure of Internal consistency. Data recorded during the process was analyzed using two major tools the Microsoft excel and statistical package. Data summaries were in numerical form enabling the use of regressions to show relationship between independent and dependent study variables and sugarcane production. Using Pearson correlation the association between study variables and their significance was established. From data analysis coefficient of determination was at 0.675 indicating that there was 67.5% variance in sugarcane output relating to the study variables. The F value approximated as 161.406 indicates that regression model was fitting well. The model had no serious multicollinearity problems in model since the mean variance of inflation factor (VIF) was 2.349. The study revealed that education level, farm size, land ownership, farming experience, incentives, record keeping systems, extension education, cane by-products and non-contracted cane farming had significant positive effect on cane output. Input cost was found to be a major contributor of declining cane output since it had significant setback on sugarcane production. The study recommends that poor cane pricing, lack of extension education and inadequate financing in cane development in the sugar sector be addressed, to reverse the outcome and increase the potential of sugarcane production. Therefore a need arises to enhance income-generating activities like improving the micro- businesses environment and value addition to sugarcane by-products to increase cane production. There is a need to form collaborations between sugarcane firms, small-scale famers, as well as mentorship from stake-holders so that small-scale growers are well educated on the practice of sugarcane farming, and the challenges that go with it. This will result in enhanced sugarcane production in the area.

## **CHAPTER ONE: INTRODUCTION**

### **1.1 Background of the Study**

Production is a process that transforms factor inputs into outputs. The process is significant since it influences the living standard of agrarian population in terms of goods and services, employment and economy (Mishra, 2008). Mc Calla (2001) identified poverty and sustainability of resources as major setbacks in agricultural production in the 21st century. To lower poverty levels in the rural areas, there is a need to improve the agricultural output. The challenges facing agricultural systems in Africa including but are not limited to high input costs, inaccessibility to credit, insufficient infrastructure, and lack of off-farm income-generating activities (Cargill (2015). Research and developments, development of infrastructure, and transfer of extension knowledge to farmers are services required to increase agricultural output.

Despite the economic theory suggesting that there is reduction insignificance of agriculture as the economy grows, agriculture remains a vital component for societal change in Africa. Evidence has shown that agriculture is dynamic and can be affected by economic changes occurring such as price elasticity thus policies such as taxation on agriculture deters the development of the sector (Mundlack, 1985). Growth in economy should have a positive influence on the agriculture sector since it is the source for raw material to enhance industrialization. However, over-dependence on agriculture causes economic stagnation and poverty due to reliance on rain for agriculture which is subject to climatic change (Adimassu, 2016). The rural agrarian population must adopt new strategies to minimize their risks to achieve maximum production.

Historically sugarcane farming was done in tropical climate for Asian countries but due to evolution and agriculture advancements it is now grown in over 100 countries all over the world

(FAOSTAT, 2017). Globally sugarcane production has been on rise from 448 million tonnes per 9 million hectares of land to approximately 2.1 billion tonnes per 29 million tonnes from 1961-2016. Brazil leads in global sugarcane production (39% of world production in 2017). India accounts for 15.7% sugarcane production globally and hence is the second largest producer. Peru and Guatemala are leading in sugarcane productivity of over 121 tons of cane/ha (FAOSTAT, 2018).

The areal expansion in sugarcane has been brought about by population increase leading to higher demands for foodstuffs, animal feeds, and raw materials for industries. The driver for area expansion in sugarcane farming has been bio-ethanol which has been cited as a renewable bio-energy source. Sugarcane offers a better energy balance compared to other fuel sources and reduces greenhouse gas emissions (Lisboa *et al.*, (2011). The use of bioethanol has reduced price uncertainty associated with fossil fuels (Black *et al.*, 2012). Sugarcane production is income generating agricultural activity that transforms both social and rural sectors (Swinnen and Squicciarini, 2012).

Sugarcane production has various benefits as stated above but its expansion faces several dynamic issues related to sugarcane expansion on different ecosystems, social-economic and physical environments (El Chami *et al.*, 2020). For instance, high population growth rates have led to increase in competition for land use to grow food stuffs or sugarcane and these threatens food security. Land-use changes from forests to cane plantations increase greenhouse gas emissions. Bernard *et al.*, (2011) point out that, sugarcane expansion has hurt the biodiversity, which has resulted into a change in land-use in the Amazon basin, the leading sugarcane producer in the world. This has caused imbalances in the eco-system leading to some predators'

dominance. The social impacts of sugarcane expansion have been related to the health of the farmers and their wellness due to diseases transmitted through some predators (Silva *et al.*, 2010).

Africa accounts for 6% of the world's sugarcane production and it is produced in 28 countries. Out of the 28 countries, South Africa is the largest producer. It accounts for about 35% of the total continental production (FAO, 2016). Other countries that grow the crop include Mozambique, Cameroon, Egypt, Sudan, Ethiopia, Tanzania, and Uganda among others. However, sugarcane expansion has resulted in the depletion of water due to irrigation (Thornton *et al.*, 2009). For example in South Africa, scarcity of water problem and irrigating sugarcane has accounted to about 10% depletion of irrigation water causing deterioration in water balance (Chandiposha, 2013).

Despite the above problems, integrating small-scale farmers within the macro- agricultural value chains has gained momentum in the development agenda in recent years in Africa (Giuliano and Azambuja, 2019). Corporate agri-businesses have posed sugarcane farming as a good commodity to integrate small-scale farmers into a commercial agricultural chain. This is aimed at enhancing rural development and poverty reduction. This has been influenced by the new economic paradigm, in which agribusinesses and small-scale farmers have symbiotic benefits. The agribusiness companies standardized products while the small-scale farmers get access to the global market (Giuliano and Azambuja, 2019).

The sugar industry is a significant agricultural sector in Western Kenya. In 1995, it offered employment to more than 35000 people and has been an economic activity for more than 100,000 small-scale farmers supporting about 2 million people. By the year 2000, the people employed in the sugar sub-sector had reduced to 10,552. Sugarcane yields declined from approximately 70



tons/ha to 50 tons/ha over a period of 5 years from 2009-2014 whereas the global sugarcane production increased by 17.68% between the year 2004 to 2008 (GoK, 2008).

The status of sugarcane as a major income earner for the majority of the rural population is under threat due to various setbacks in the sugar sub-sector. FAO (2019) identifies the marketing problem as a critical challenge related to the factories inability to market local sugar in the face of dumped imports. Economic liberalization presents challenges to the Kenyan sugar industry. Multi-lateral trade treaties, especially Common Markets for Eastern and Southern Africa (COMESA), have facilitated the importation of sugar into Kenya at minimal tariffs from member states (FAOSTAT. 2018). This sugar is zero-rated by its source Government. This has negatively affected the marketability of local sugar, which has high production costs (Kenya National Assembly, 2019).

The Kenya National Assembly, (2015) points out that poor sugarcane farming practices lead to low yields and low sucrose content. The rising costs of farm inputs and field operations contribute to decreasing cane output. In addition, factory inefficiencies and factory capacity under-utilization lead to low income for cane farmers (Kenya National Assembly, 2015). The factory inefficiencies contribute to the high cost of locally produced sugar. These in turn negatively affect sugarcane farm operations and practices (the Republic of Kenya, 2020).

The farm-level productivity in Mumias Sugar Belt (MSB) has been on the decline for a couple of years. Sugarcane cane yield rate is approximately at 60 tonnes/ha as per the Kenya Sugar Authority data. The sugarcane production rate has decreased by approximately 30% (Dindi, 2013). The rising costs of farm inputs and field management, and lack of credit have contributed to declining cane output within the belt. Cane production is further hampered by transport costs

and poor infrastructure. The low sugarcane prices and delay in payment by the company for cane delivery are major challenges faced by small-scale sugarcane farmers. Many of these farmers had turned to other crops to sustain their livelihoods (Waswa and Netondo, 2014).

MSC has recorded losses running to billions in recent years. This has been caused by the inability of the factory to market local sugar due to the dumped imports (Agricultural Information Network, 2016). There have been poor farm management practices leading to low cane output and low sucrose content. In addition, factory inefficiencies and capacity under-utilization has led to reduced income for farmers (Dindi, 2013). These have resulted in the frequent stoppage of crushing sugarcane by the miller due to cane shortages. The government's financial interventions in 2015 and 2017 have not stabilized the miller's operations. The miller ground to halt in April 2018, necessitating Kenya Commercial Bank to place it under receivership for defaulting on loans amounting to KSH. 12.5 billion.

Ambetsa (2020) observes that nearly 60,000 farmers who supply sugarcane to MSC are struggling after their only source of livelihood is crumbling. A number of these desperate farmers in Kakamega, Siaya, Busia, and Bungoma counties have been reported to be uprooting the crop. They have switched to other economic activities, hoping for better livelihood (Kweyu, 2013). Their morale' to engage in cane farming is low, and thus many of them have declined participation in cane farming and abandoned the cultivation (Kweyu, 2013). This shows that sugarcane production is facing challenges. However, no known research has been done to examine the impacts of social-economic factors on sugarcane production in Bungoma County, and how small-scale farmers are coping up. This study will help to generate new knowledge on the socio-economic challenges facing sugarcane production in Bungoma County and adopted coping strategies used by small-scale sugarcane growers.

## **1.2 Statement of the Problem**

The sugar processing industries in Kenya just like other world industries have positive impacts of supporting over 2 million people in the sugarcane value chain. The Government of Kenya (2018) points out that the sugar sub-sector is a contributor to about 15% of the economy in terms of GDP. Despite the significance of the industry, the country's sugarcane production has been declining in recent years. The sugarcane yields in Kenya stand at 65 tonnes/ha which is much lower compared to the average potential yield per hectare. The declining cane yields and output, have led to frequent closures of many of the sugar factories in Kenya. The reduced cane output has had adverse effects on MSC operations. Sugarcane fed in MSC for sugar production drastically decreased in 2014 by half. In 2018, sugarcane production on average was approximately 60 tonnes/ha with the highest sugarcane production was at Nambale-Sub-county at 78 tonnes/ha. The lowest cane outputs of 40.38 tonnes/ha was recorded in Bumula Sub-County, making the Sub-County the worst in sugar cane output within Mumias Sugar Belt. From the existing literature, studies have established that factories inability to market local sugar in the face of dumped imports has led to a reduction in cane output and low sucrose content. Factory inefficiency and factory capacity under-utilization have led to low income for farmers. The factors have led to decline in agricultural sector without regarding both social and economic factors. The major aim of this research was to examine the dynamics of sugarcane yields among Small Scale sugarcane growers in Bungoma County, Kenya.

## **1.3 Objectives of the Study**

The study's aim was to establish the dynamics of sugarcane yields among farmers on small scale in Bungoma County, Kenya.

The study was to achieve the following objectives

- Identify characteristics of small-scale sugarcane growers affecting sugarcane production in Bungoma County
- Determine socio-economic challenges facing sugarcane production in Bungoma County.
- Investigate the coping strategies adopted by small-scale sugarcane growers in the study area.

#### **1.4 Research Questions**

The research questions under this study include;

- i. Does socio-economic factors of the affect sugarcane production in Bungoma County?
- ii. What are some of the potential socio-economic challenges facing small-scale sugarcane production in Bungoma County?
- iii. What strategies are farmers adopting to cope with social-economic challenges in Bungoma County?

#### **1.5 Significance and Justification**

The Strategy to Revitalize Agriculture (SRA) emphasizes the need to increase agricultural production to fight poverty. In accordance to vision 2030 agriculture is identified as a key aspect that is expected to deliver 10% to annual economic growth. Sugarcane is major contributor to economic growth of Kenya (GoK, 2007). Sugarcane production is important revenue to the residents in Bumula and it is one of the key-value chains being promoted in the County (CIDP, 2013). The study investigated the socio-economic challenges of sugarcane production and the coping strategies adopted by small-scale sugarcane farmers in the region.

The findings will help improve the sugarcane production rates in Bungoma County and Kenya as a whole. Providing an understanding on socio-economic challenges facing sugarcane production helps overcome some setbacks faced and improve overall production rates. Increase in production rate of sugarcane improves the Gross Domestic Product of a country and enhancing sustainable sugarcane farming. The study identifies the socio-economic variables affecting sugarcane production rates and hence enabling the sugar factories and stakeholders in making policies to enhance sugarcane. The study contributes to the identification of areas requiring sugarcane sector support within Bungoma County to realize the Millennium Development Goals (MDGs). This will go a long way to poverty eradication and enable not only the county but the country as a whole to realize its dream of being food secure by the year 2030 (Agricultural Information Network, 2016).

The study would augment the body of knowledge available on sugarcane output especially in the area of coping strategies in the Bumula Sub-County of Kenya. The findings in this study are expected to form a baseline for other similar studies in Bungoma County. The study was beneficial to the researchers; it was an opportunity to gain insight on how socio-economic factors affect the small scale sugarcane farming in Kenya.

The study focused on sugarcane output in Bumula Sub-County in Bungoma, Kenya. The study was confined to sugarcane production since the year 2000. This is the time sugarcane farming started facing several challenges that led to farmers being disenfranchised. Bumula Sub-County was chosen because it recorded the highest decline in output in comparison to the other Sub-Counties within the Mumias Sugar Belt. According to MSC Records (2016), the average cane production rate in 2016 was 60 tons / hectare. The highest cane was in Nambale Sub-county at a rate of 78 tonnes/ha whereas the lowest production rate was at Bumula Sub-county at 40 tons/ha;

such adverse production rates prompts need for researching the case. The study was focused on socio-economic challenges facing sugarcane production (input cost, extension education, incentives, and access to markets and credit), farmers' characteristics (level of education, land size and ownership, and farming experience), and coping strategies (sugarcane by-products and off-farm income activities). Similarly 100 sugarcane farmers on small scale basis randomly sampled to determine the impacts of social and economic variables on cane output. Considering the total population of sugarcane farmers in the Bumula Sub-County, estimated at 5,838 a sample size of 100 farmers was drawn. Data were collected during December 2019.

## 1.6 Operational Definition of Terms and Concepts

Adoption:	Refers to a decision to use alternative sources of income
Challenges:	Refers to socio-economic factors that negatively affect sugarcane production
Contract farming:	Refers to an arrangement between sugarcane farmers and sugar firms for the supply of cane
Coping strategies:	Refers to ways of sustaining household livelihoods
Dynamics:	Refers to underlying forces in cane production
Green trash:	Refers to sugarcane green foliage after harvest
Household head:	Refers to a member of a family who is the chief decision maker and influencer
Non-contact cane farming:	Refers to private sugarcane cultivation with no contract to sugarcane farms.
Off-farm income:	Refers to household alternative sources of generating income outside farming
Productivity:	Refers to yield in tonnes of cane per hectare.
Social economic factors;	Refers to farmers' characteristics and variable inputs determining production
Sugarcane	Refers to a perennial tropical grass with stout tall jointed stems from which sugar is extracted
Sugarcane farmer	Refers to a farmer whose farming orientation is mainly sugarcane
Sugarcane by-products:	Uses of sugarcane stock other than selling to sugarcane firms
Small-scale farming	The cultivation of cane on a landholding which is five acres and below

## CHAPTER TWO: LITERATURE REVIEW

### 2.1 Introduction

The section entails a review and critiques on relevant research works on sugarcane production globally and nationally. Literature review incorporates both empirical and theoretical reviews of the conceptual framework. It also provides a review of the productions function that forms the bases of the study. The empirical review includes a discussion on farmers' characteristics, coping strategies and socio-economic challenges of sugarcane production. The chapter also highlights important concepts concerning the research works being reviewed.

### 2.2 Cobb-Douglas Production function

From the production theory of the farm, production concepts can be applied in the study where relationships between input and output variables are identified. Production functions help determine for given amount input what the expected output is. The function establishes a relationship between inputs and outputs identified (Jhingan, 2007). Sugarcane farmers attempt to maximize the output for the given input or minimize the input for a targeted output (Oluwatayo *et al.* (2008). The input-output factor relations enable farmers to know the amount of inputs for a given output target.

This study adopted production theory of the farm because it produces straight estimates of sugarcane output given the many input variables used in the study. The theory explicitly explains mathematical equations; it estimates the amount of output given certain amount of inputs.

The production function therefore estimates the input-output relationship. The function is stated as  $Q = f(L, K)$  and  $Q = AL\alpha K\beta$ .



.The function has been widely used in studies involving production analysis (Jamil *et al.* 2014 and Mandla and Maker, 2012). The function is simple to use and can be used in different empirical data set. The function has been criticized for lack of the knowledge of production technological processes of modern industrial production. It assumes that all factor inputs are divisible which the case is not always. Furthermore, its application may not be applicable in a macro environment as it considers only two-factors of production, which are capital and labour. This has been modified to include all the variables in the study. The production functions have been applied in studying sugarcane production in Pakistan (Jamil *et al.*, 2014). The production function had a well fit regression model.

Another study on sugarcane farming conducted by Adrian, 2013 incorporated the Cobbs production function. The study on smallholder sugarcane farming in Swaziland by Maker and Mandla (2012) also used the same production function. In both studies, the function produced a straight estimate of production elasticity using different inputs. The production function was easy to use and for various data sets it had an empirical fit. Furthermore, the cited references above indicate a wider application of the production model.

### **2.3 Empirical Review**

The review involves examining some of the literatures on sugarcane output globally, regionally, nationally and in Bungoma County, Kenya. The study reviewed literature mainly focusing on the social and economic challenges of sugarcane production (input cost, incentives and extension education, access to markets and credit), characteristics of the farmer affecting cane production (farmers' educational level, land ownership & size, and farming experience), and coping strategies used by cane farmers.

### **2.3.1 Farmers' Characteristics**

Ibrahim *et al* (2012) study on factors affecting groundnut production in Nigeria, observed that farmers with a long farming experience were less involved in groundnut farming. Similarly, Girei and Giroh (2012) had considered farmers' characteristics like farmer's experience and educational level, in their study on the factors affecting sugarcane production. Ibrahim *et al* (2012) used descriptive research design and benefits analysis in their study while Girei and Giroh (2012) used both descriptive and production function analysis. This study sought to investigate whether a farmer's farming experience influences sugarcane production in Bumula Sub-County. In addition, this study aimed to see if the conclusions in various studies on the farmers' farming experience is same as in Bungoma County, Kenya.

Research conducted on social-economic determinants of farm efficiency in Siaya County, Kenya was conducted in 2013 (Obiero, 2013). He observed that agricultural output does not depend on the farmers' education. However, his research was not particular on sugarcane farming. The research in this papers aims to establish whether the conclusion on the farmers' level of education is applicable sugarcane production in Bungoma County, Kenya.

Pokharel *et al.*, (2019) researched on productivity and profitability of sugarcane in the Eastern Plains of Nepal. The study adopted Cobb-Douglas production function analysis and random sampling methods. The findings suggested that most farmers were male dominant with small-landholdings, who had primary level education. The main cause for decline in sugarcane production was due to poor and delayed. Muli (2010) provides that a major concern facing the sugar industry and farmers of Kenya is the impact the level of productivity of sugarcane has on the level of profitability. Mule's study was aimed at focusing on challenges faced by the farmers'

characteristics such as lack of education and experience. The study wanted to establish the same conclusion on sugarcane farming in Bungoma County, Kenya.

The study by Kokeyo(2013) was carried out to establish whether the sugarcane farmers on contract were better off than those not on contracts financially. The findings suggested that both farmers on contract and those not on contracts were facing same financial challenges. He observed that sugarcane contracts are influenced by ownership of assets and farmers' education level. Farmers on contract participation were assessed using binary probit model. The major challenge facing sugarcane farming in Nigeria is land scarcity ( Girei et al., 2012) . Descriptive research design was used for the study.

According to Dlamini and Masuku, 2011 land ownership affected maize output in Switzerland. Tena *et al* (2016) carried out research to determine the constraints faced by cane growers in Ethiopia. The major setbacks facing sugarcane farming in Ethiopia is price fluctuation and land scarcity. This paper wanted to access whether sugarcane farming in Bungoma, Kenya is also affected by price fluctuation, land scarcity and land ownership.

The focus of most of the studies was on determinants of agricultural production, without regard to farmers' characteristics. Many of the research was conducted in various geographical area and on several types of crops therefore the conclusion drawn may not be true regarding the sugarcane farming in Bungoma County, Kenya.

### **2.3.2 Socio-economic Challenges of Sugarcane Production**

Clainos and Ledwin, 2011 identified some of the economic determinants on sugarcane farming in Zimbabwe include; lack of equipment, poor payment, and high transport costs. They used a descriptive design in their study and they did not consider the input cost and coping strategies.

The study cited limited extension services and poor post-field harvest methods as challenges facing sugarcane production in Zimbabwe. The study by Mandla and Maker (2012) identified farming experience, the distance between the farm and the mills, and yield per hectare and sucrose content as the determinants of sugarcane profitability. The study employed a multiple regression in data analysis. However, the study did not consider the cost of inputs, extension knowledge, and sugarcane by-products. This research wanted to assess if the same conclusion on input cost and extension education hold in the case of sugarcane output in Bungoma County, Kenya.

From Netondo and Waswa (2010), study on sugarcane production and diversification in Mumias Division, Western Kenya. The study concluded that declining cane acreage was caused by high cost of input, poor payment, spillage on transit, corruption at the weighbridge, and poor quality seed cane. This research wanted to find out if the same conclusion on input cost and poor and delayed payment is responsible for decline in sugarcane output in Bungoma County, Kenya.

Kweyu (2013) aimed to find factors causing farmers to move away from sugarcane farming in Mumias District, Kakamega County. The study identified high cost of input, lack of incentives, food insecurity, and poor payments as the main factors influencing farmers' withdrawal from cane farming. The study aimed to establish whether the same result on input cost, lack of incentive, and delayed payment is a contributing factor on sugarcane output in Bungoma County, Kenya.

The research conducted by Anangwe, 2014 on the socio-economic factors influencing fertilizer application on cane farms in Mumias, it was concluded that inadequacy in fertilizer use has negative impacts on sugarcane yielding rate. The study used descriptive research design. The

study did not look at other variable inputs and coping strategies. Tena, 2016 study on constraints facing small scale farmers found that price fluctuation, input costs and lack of pest resistant varieties are major setbacks faced by sugar cane farmers. The study used a participatory rural appraisal approach and structured sampling. This research wanted to establish if the same result on poor cane pricing, land scarcity and high input cost, hold on sugarcane production in Bungoma County, Kenya.

Owiti (2019) carried out a study on factors affecting cane output among small-scale farmers in the Nyando Sugar Belt. It was found that input costs, land ownership, and gender had a positive effect on cane output. This paper aims to investigate whether the same conclusion on input cost and land ownership have an impact on sugarcane production in Bungoma County, Kenya.

Ambetsa *et al.* (2020) study on the farm efficiency among small-scale sugarcane growers in Malava Sub-County and concluded that skilled labor, the size of the farm and seed canes are key factors influencing sugarcane farming efficiency. Further on the level of education, experience of farmers on sugarcane farming, affected sugarcane farming output. Some recommendations were put forth such as government ensuring all services required by sugarcane farmers are provided such the extension services. This study aimed to investigate whether the same findings on extension services and credit access were applicable in the case sugarcane output in Bungoma County, Kenya.

The above studies did not consider the extension knowledge, incentives, and coping strategies which were investigated by this study. Similarly, these studies were done in different locations and therefore, their findings, thus are limited and cannot be generalized to fit the case of sugarcane farming in Bungoma County, Kenya.

### 2.3.3 Coping Strategies

Coping strategies are strategies put in place in farming to prevent crop failures and loss in yields. They are mostly unplanned and short term made response to abrupt changes in farming of a particular crop (Adimassu. *et al*, 2016). According to Korir, (2011) coping strategies are methods adopted by households for survival in case of an abrupt failure. Individual households find new ways of raising incomes when faced with unanticipated livelihood failures. One way of raising income is through income diversification. According to Korir (2011), humans always adopt to diversification to ensure proper management of risks, iron out problems in labour markets, or handle seasonality in farming activities.

Ahmadzai, (2017) conducted a research on the implications of crop diversification on land efficiency. The study used a basic Stochastic Frontier Analysis model and it was not specific to sugarcane output rates. The results implied that diversification of crops improves farming efficiency. The study identified land, labour, and farm inputs as having a positive impact on farmers' revenues.

Hananu *et al.*, (2015) researched on the impact of the adoption of multiple sustainable agricultural practices among African rural households. The finding suggested that practicing intercropping, and animal manure in farming procedures increased household income. The study employed multinomial endogenous treatment effect to examine the effects of sustainable agricultural practices. The research generalized and therefore it is not effective for sugarcane production. This paper aims to determine whether cane by-products and non-contracted cane hold as coping strategies for sugarcane production in Bungoma County, Kenya.

According to Makate *et al.* (2017), the crop diversification agricultural system is ecologically sound, less costly, and an effective way of reducing uncertainties among small-scale farmers. It

provides a variety of food diets and increases the purchasing power of the household. The system expands the variety of crops to the market and increases the stability of produce, thus improving the household's income (Nguyen, 2017). However, the research was not specific to cane output. This research wanted to show whether the conclusion on by-products diversification can be applied on sugarcane production in Bungoma County, Kenya.

Several studies have shown that the agricultural practices that conserve organic matter in the soils lead to increased agricultural production. For instance, Magarey *et al.* (2010) found that small-scale sugarcane farmers in Australia adopted crop diversification by breaking monoculture practices with legumes. Legumes fix nitrogen and reduce the need for more fertilizer use. Makate *et al.*, (2017) observed that legumes are environmentally friendly, increases food to the household, and are sold to raise additional household income. The paper aims to establish whether the conclusions on intercropping legumes and sugarcane would show the same implication in Bungoma County, Kenya

Agro-forestry has enabled many communities in Ethiopia to improve their income and compensate for the loss in sugarcane (Kassie, 2017). According to Kassie (2017), 'agro-forestry products buffer up farmers' income during the loss of crop yields. Ogbonna's (2015) study in Nigeria, found that small-scale sugarcane farmers rear livestock as another income generating activity. Livestock keeping is reliable and acts as wealth store since it can be liquidated very easily. However, the studies did not include strategies used by small-scale sugarcane farmers. This study goes further to investigate sugarcane by-products diversification as the coping strategies to overcome challenges regarding decline in sugarcane production

Farming has failed to provide sufficient household income in many developing countries because of declining agricultural production, shrinking farm income, and widespread poverty (Babatunde & Qaim, 2016). Micro-business has become the preferred coping strategy to compete for income risks from crop failure including sugarcane. Rural households engage in micro-businesses to supplement their household income during the off-farming season periods (Babatunde & Qaim, 2016). However, the study only addressed off-farm activities, while the present study addresses both off-farm and on-farm coping strategies that caution farmers during sugarcane yield loss.

Adimassu and Kassler, (2016) carried out a study on factors deterring farmers in Ethiopia from adopting to coping strategies in face of yield reduction due to climatic conditions. The findings shows that inadequate labour and lack knowledge, and information on coping strategies, and insufficient capital are the major factors deterring farmers from adapting the coping strategies. The study recommended that access to information and knowledge and strengthening social capital are key factor that help farmers adapt the coping strategies in sugarcane farming. The research was generalized for farming therefore this paper sought to know whether failure to access information and knowledge deters adopting coping strategies in sugar farming in Bungoma County, Kenya.

According to Agyeman , (2014) reasons for income diversification in the Western Region of Ghana indicated that 65% of the households indulge in other economic activities. The data was collected using a household level survey and analyzed by the Tobit regression model. The study results identified the level of education, income, extension services, household assets, and road network factors influenced income diversification. The study recommended government-private sector support to increase capacity building among the households to raise their living standards.



Adopting the coping strategy depends on farmers' social characteristics like gender, age, and education level (Kragt *et al.*, 2013). Uddin, (2014) studied how social characteristics affects adopting the coping strategies in Bangladesh, the finding showed the aged and those not educated could not easily adopt to new methods of farming. Besides that, Ike and Ezeafulukwe, (2015) made an observation that the farm size and family income influence farmers choice to adopt the coping strategies..

The above studies did not consider diversification of sugarcane by-products used by small-scale cane growers which this study investigated. Many of the studies reviewed focused on income diversification and technical efficiency at the farm level. All findings are specific to geographical areas on the particular crop and the conclusions may not be effective to sugarcane farming in Bungoma County, Kenya.

## **2.4 Theoretical and Conceptual Frameworks**

### **2.4.1 Theoretical Framework**

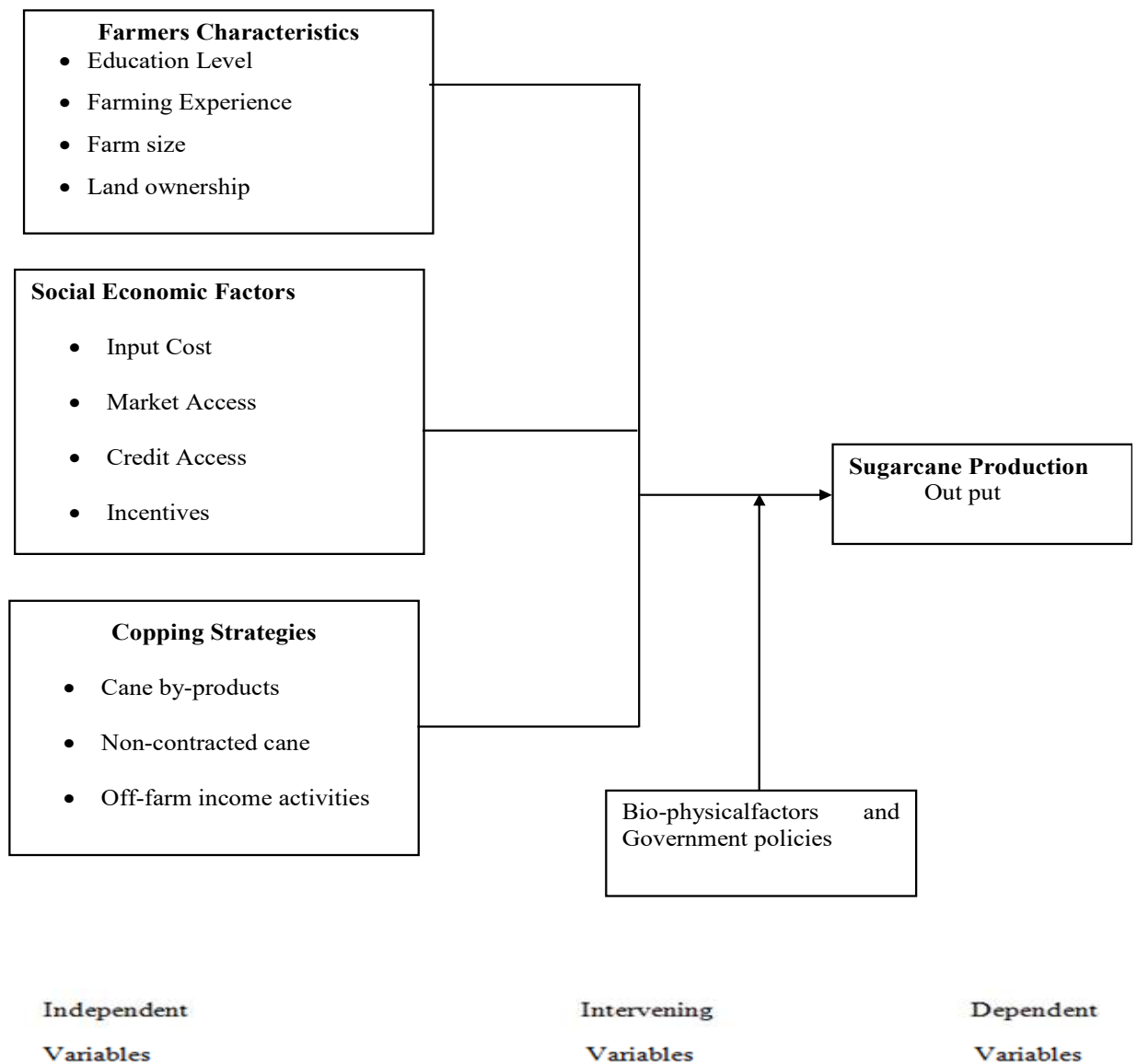
Production theory involves transforming of inputs to outputs. The theory helps understand why firms make decisions on how much input is required to achieve a given output. The theory encompasses production function analysis. It tries to establish the expected output for given set of inputs. The objective of any firm in production theory is to maximize profits and achieve maximum output at a minimal input cost.

The research is based on the Cobb-Douglas production function which shows input-output relationship. The production function helps the researcher to understand the cane factor input on cane production/output. The production function was chosen for this study since it was flexible,

had a good empirical fit, and easily accommodated all the study variables that were regressed against sugarcane output (Clainos and Ledwin, 2011)

#### **2.4.2 Conceptual Framework**

In this study, the sugarcane production process is a function of several factors which are classified as; farmers' characteristics, socio-economic challenges, and coping strategies. These factors determined the mix used to produce sugarcane. The farmers' characteristics influence how, what, when, and for whom to produce, and as such, it influences the sugarcane production process taking into account the socio-economic challenges (such as input cost, extension knowledge, and incentives) and adopted coping strategies. On the other hand, biophysical factors and government policy aspects (intervening variables) play a major role in determining the available resources for sugarcane production. Government policy such as taxation will influence the input cost for agricultural productivity. It also included the biophysical factors that are climatic factors such as rainfall and other environmental concerns that are exogenous to the farmers' farming operations at the farm level. All these factors influence sugarcane production, which in turn will result in reduced farm output levels, household incomes, and livelihoods. The conceptual framework is presented in Figure 2.



**Figure 2.1: Conceptual Framework**

**Figure 2.1: Conceptual Framework**

## 2.5 Gap in Knowledge

Most of the studies reviewed focused on economic determinants of agricultural production without regard to farmers' characteristics. They focused more on variable inputs and technical efficiency at the farm level. In addition, they did not consider farmers' adopted coping strategies

especially sugarcane by-products that are core to this study. The studies reviewed are for different geographical area farming on a particular crop and hence the studies are not specific to the study area. Many of the studies adopted the descriptive survey design with the use of descriptive statistical tools. The current study employed inferential statistical tools to test the relevant premises from which information on relationships between the study variables could be inferred for appropriate conclusions made basing on the findings of the study. Furthermore, this study addressed the weaknesses in research methodology in some of those studies reviewed.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.1 Introduction**

The section entails methodologies used in the study. The chapter describes the study locale', the research design, target population, sample size, and sampling procedures used. In addition, the chapter highlights the research instruments and the procedures of data analysis. The validity, reliability, and ethical considerations are also given.

### **3.2 Description of the Study Locale'**

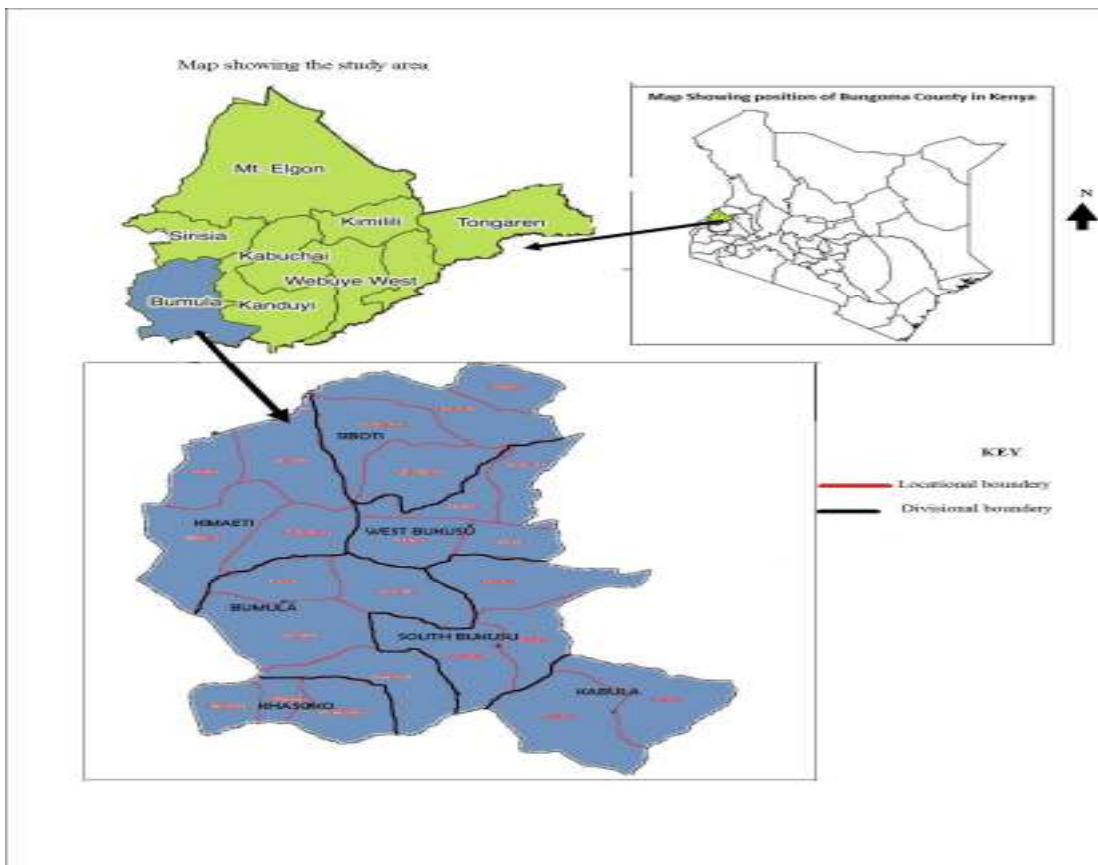
The study was conducted in Bumula Sub-County in Bungoma County, Kenya; the location had declining sugarcane production compared to other Sub-Counties. The location had the average sugarcane production of 40 tons per hectare compared with the approximated average production of the region which is 60 tons/ha. Namable Sub County had the highest sugarcane production of 78 tons/ha in the region (Mumias Sugar Company records, 2016).

Bumula Sub-County lies between latitude 0° 30.2' North and longitude 34°30' east. Bumula Sub-County is bordered with Sirisia and Kanduyi Sub Counties, Kakamega and Busia Counties. The Sub-County covers a total land area of 347.8 Km<sup>2</sup> (Figure 3.1). It has 7 administrative divisions namely; Siboti, Kimaeti, West Bukusu, South Bukusu, Bumula, Khasoko, and Kabula (Bungoma County Intergraded Development Plan, 2013). The geographical map of for the location to be studied is shown in fig 3.1

The land slopes from altitude 1800 to 1200 m above sea level (Mkomwa, 2011). It has hills such as Siboti, Malakisi, and Nakuti. The Sub-County is drained by five rivers; River Sio forms the boundary to the West and North West with Bungoma Central and Matungu Sub-Counties respectively. The other four rivers draining the central areas are Mayanja, Matiba, Khayo, and Nasianda. It has dark acrisols and ferrosols soil types. These soils are suitable for a range of crops. However, they have lost nutrients like Nitrogen and Phosphorous due to sugarcane mono-

cropping practices (Mkomwa, 2011). The Sub- County enjoys a well-distributed annual rainfall with two rain seasons (March/ May- long rains and August/ October- short rains). The area has a temperature range of 21 °C to 25°C all year round (Mkomwa, 2011). Most farming activities take place during the long rains.

The Sub-County has a density of 657 persons per Km<sup>2</sup>. It is densely populated Sub-County in the country (BCG, 2016). It has the highest percentage of residents with no formal education (23%); compared to other Sub-Counties within Bungoma County. 54.9% of the residents live below the poverty line, compared to 52.8% of the County's average (BCG, 2016). Most of the residents are small-scale sugarcane farmers contracted by Mumias Sugar Company.



**Figure 3.1: A Map of Study Location of cane growing in Bungoma County, Kenya**

Source: Bungoma County Intergraded Development Plan, 2013

### 3.3 Research Design

Correlation design was used for this study since it provides an opportunity to get in depth data and information from the respondent. The research design also enables derive the relationship between study variables. The data obtained is in quantitative form and hence enables flexibility in analyzing.(Kothari, 2010).

### 3.4 Target Population

The target population for the study included 5,858 registered sugarcane farmers spread across the Bumula Sub-County (MSC Report, 2020). The target population was the small-

scale sugarcane growers in Bumula Sub- County with sugarcane plots of 5 acres and below. This population was ideal because the land size was one of the socio-economic factors to be analyzed in the study. Therefore, the targeted respondents were to fall under the following criteria below:

- i. They must have practiced sugarcane farming in the area for the last five years.
- ii. Farmers with sugarcane farms of five acres and below.
- iii. Extension officers and chiefs were to be selected as key informants for the study.

### 3.5 Sample Size and Sampling Techniques

Applying Slovens' formula, the sample size is obtained (Yara *et al.*, 2012)

$$N = \frac{N_0}{1 + \frac{N_0 \cdot e^2}{k^2}} \dots\dots\dots (1)$$

$$N = \frac{9833}{1 + \frac{9833 \cdot 0.05^2}{4^2}} : 98.31 \text{ (approximately 100 respondents).}$$

Where N= is the sample frame,

n is the sample size and  $\alpha$  is the margin of error,

$\alpha$ : precision level is

Several sampling procedures were used in the selection of the area of study and the required respondents. The purposive sampling procedure involves the hand-picking of subjects based on certain specific characteristics. This sampling procedure was used to pick the 8 key respondents and 8 small-scale farmers. The key respondents were the 4 extension officers and 4 area chiefs (an area chief and extension officer from each of the administrative divisions). These were people who had worked for more than five years and therefore had knowledge in sugarcane matters.

The study employed a stratified random sampling technique that utilized the 7 existing administrative divisions (Figure 3.2) which were major sugarcane growing areas in the Sub-



County (MSC Report, 2013). These were Kabula, Khasoko, Bumula, and South Bukusu divisions, from which the villages in the strata were selected, one from each of the selected divisions. These villages were Talitia, Mungore, Lumboka, and Mateka respectively.

The study area had uneven pollution distribution hence proportional sampling was used. This was used to ensure that a sufficient number was selected from each division since they were not equal in size (McMillan, 1999). From the huge database population on sugarcane farmers' records at MSC Offices at Nasienda and by Binet Square method a sample of 100 farmers were selected (Funa *et al.*, 2021).

**Table 3.1: Sample Size**

Number of Farmers in each Division	No. of farmers	Sample size
Kabula	1436	24
Khasoko	996	17
South Bukusu	1836	30
Total	5,338	100

Source; Field Data

Source; Field Data

Every village following a minor road leading to the rural residence was considered to be a random way of selecting the sample. For that matter, every second homestead, to either the left or the right of that very road was chosen for the interview. As a result, 100 household heads were interviewed from the four villages.

### **3.6 Piloting Study**

Conducting pilot study ensured that the questions were precise and would give relevant information. Pilot study helped the research to ensure the reliability of primary data obtained from the study. The pre-tested questionnaire and interview items yielded a value of 0.877. This value is within the acceptable Cronbach's alpha range of 0.70 to 0.95 according to Mohsen and Dennick (2011). It was conducted in West Bukusu in October 2019. These

farmers had similar characteristics to those of the entire study site. This division was not included in the actual study (Orodho, 2004).

### **3.7 Data Collection Tools**

Data collection was by survey questionnaire, focus group discussion guide (FGD), interview schedule, and field observation checklist. They are discussed as follows:

#### **3.7.1 Questionnaire**

Both forms of structured and unstructured questionnaires were used for data collection (Appendix I). Questionnaires were used to enable the researcher to get clear and precise data from the respondents. The questions were specific to research objectives. The targeted study sample were the 100 household heads and in their absence, the spouse or a family member who was above 18 years. The questionnaire was read to the respondent by the researcher or his assistants. The responses given were filled in the questionnaire and used as data.

#### **3.7.2 Interview Schedule**

To complement the information gathered by the questionnaires, an interview guide was conducted on vital respondents (Appendix II). These vital respondents were four extension officers, four area chiefs, and ten farmers making a total of 18. The respondents selected had vast experience in dealing with sugarcane matters in the region and therefore they were right candidates for the study. The respondents' views were videotaped and recorded down in a notebook at the same time. This information was transcribed and used as data.

#### **3.7.3 FGD Interview Guide**

It involved two group discussions held at different times in the course of the study. Each group comprised 10 participants. The participants had more than 5 years of farming experience and were obtained from the list supplied from the MSC Office at Nasianda. The

discussion lasted for an hour and was guided by an interview guide (Appendix III). During the discussion, the members discussed sugarcane farming challenges that were generally shared and how farmers were coping up. The conversation and interviews were recorded on videotapes using a mobile. This was done so as not to interrupt the respondents during the discussions. In addition, important observations were also noted down in the notebook during the interview. This information was later coded, transcribed, and used as data.

#### **3.7.4 Observation Check List**

Direct field observations were carried out with the help of the observation checklist (Appendix IV). This method allowed recording what was seen directly through photographs. The field observation identified the following; reduced sugarcane farms, uprooted stumps, sugarcane by-products which included jaggery and green trash, jaggery boiler and cane crushing machines, and non-contracted cane farms. The method was used to validate the data gathered through the questionnaires, focus group discussions, and interview schedule.

#### **3.7.5 Secondary Data Gathering**

Sources of secondary data included farmers' records, Mumias Sugar Company agricultural data, Kenya Sugar Board surveys, journals and internet publications and other published materials from Ultra-Modern Library at Kenyatta University.

### **3.8 Validity and Reliability of Research Instruments**

#### **3.8.1 Validity of the Research Instruments**

According to Polit & Beck (2010) validity is an ability of an instrument to obtain required data. According to Mugenda and Mugenda (2003), the three kinds of validity are construct, content and criterion. The study considered both the construct and content validities of the tools. This related to the clarity of items and their relevance in measuring the study

objectives by submitting the research instruments to the supervisors for examination. This was in line with Polit and Beck's (2010) advice that a research instrument should be examined by a panel of experts before it's used in research.

### 3.8.2 Reliability of the Instruments

Instrument used in the study should be able to produce consistent results when subjected to same study environment. Repeatability test was done for 12 respondents; 1 extension Officer, 1 area chief and the interviews for 10 farmers after duration of one week. The instruments were given to the same group after one week. Reliability was assessed by checking the consistency of the responses between the instruments. The Internal consistency of questionnaire and interview items was established through the computation of the Cronbach Alpha coefficient, which yielded a value of 0.877 which falls within Cronbach Alpha range of 0.7-0.95( Mohsen and Dennick, 2011). The reliability coefficients for the variables investigated are presented in table 3.2 below.

**Table 3.2: Summary of Reliability Test Results**

Farmers' characteristics	No. of items	Cronbachalpha	Status
Challengeson sugarcane farming	9	0.789	Accepted
Adopted coping strategies	27	0.857	Accepted
Reliability statistics		0.877	Accepted

### 3.9. Data Analysis and Presentation

The study involved statistical tools in the analysis. The descriptive statistics all quantitative data used to summarize socio-economic challenges of sugarcane production and coping strategies adopted. Correlation and regression analysis were used in inferential analysis. Quantitative analysis was done using Cobb-Douglas production function and correlation analysis. The production function applied in determining how socio-economic challenges

affect sugarcane output. This model has wide acceptability in agriculture economics-related data (Adil *et al.*, 2014). This production functions well because it satisfies both economic and statistical criteria (Erkoc, 2014).

Cobb-Douglas production expression is given as;

$$Y_i = \alpha_0 X_{1i}^{\alpha_1} X_{2i}^{\alpha_2} X_{3i}^{\alpha_3} X_{4i}^{\alpha_4} X_{5i}^{\alpha_5} X_{6i}^{\alpha_6} X_{7i}^{\alpha_7} e^{u_i} \dots \dots \dots (2)$$

$Y_i$  = Sugarcane production

$X_{1i}$  = Input cost.

$X_{2i}$  = farm size

$X_{3i}$  = land ownership

$X_{4i}$  = Farming experience

$X_{5i}$  = Education level

$X_{6i}$  = Extension Education/ knowledge

$X_{7i}$  = Incentives

$X_{8i}$  = Credit access

$X_{9i}$  = market access

$X_{10i}$  = Record keeping

$X_{11i}$  = sugarcane by-products

$X_{12i}$  = non contracted cane

After modification the equation becomes

$$\ln Y_i = \alpha_0 + \alpha_1 \ln X_{1i} + \alpha_2 \ln X_{2i} + \alpha_3 \ln X_{3i} + \alpha_4 \ln X_{4i} + \alpha_5 \ln X_{5i} + \alpha_6 \ln X_{6i} + \alpha_7 \ln X_{7i} + \mu_i \quad | \text{(Odondo } et al., 2013).$$

Presentation of data involved use of graphs, tables and charts. Results were in form of least square model whereas analysis, summarization and interpretation was done using the SPSS Vers. 25 packages and the model were tested by multicollinearity, normality and out correlation model.

### 3.10. Operationalization variables of the study

The section comprises the variables of the study, how they are measured and their expected behavior.

**Table 3.3: Table of operational variables**

Dependent Variable	Description	Measurement	Sign
Production	Total sugarcane output	Output per acre in tonnes	None
Independent Variable			
Farm input cost	Total variable input cost	Total input cost in Ksh.	-
Farm size	Sugarcane acreage owned by farmer	Total hectares	+
Land ownership	Farmers having title deed	Dummy ( 1 if yes, 0 if no)	+
Farming experience	number of years farmer has been in sugarcane farming activity	Number of years	+
Credit access	Access to credit facilities for cane financing	Dummy ( 1 if yes, 0 if no)	+
Incentives	Access to farm incentives	Dummy (1 if yes, 0 if no)	+
Extension education	Technical services offered to farmers sugarcane	Dummy (1 if yes, 0 if no)	+
Accessibility of the market	Good pricing	Dummy (1 if yes, 0 if no)	+
Sugarcane by-products	Adoption	Dummy (1 if yes, 0 if no)	+
Non-contracted cane	Adoption	Dummy (1 if yes, 0 if no)	+

### 3.11 Ethical Considerations

Research proposal was approved by School of Social Sciences, Kenyatta University. The research permit was acquired from the National Commission for Science and Technology

(NACOST). Confidentiality of the respondents was assured, and survey questionnaires were anonymous. Participation is at free will.

## CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSIONS

### 4.1 Introduction

The section entails results presented per the objectives stated. Both inferential and descriptive statistics was used in data analysis. The descriptive analysis included the social and economic characteristics of the household heads and the adopted coping strategies used. The econometric results of the effect of social and economic challenges of sugarcane production are also presented in this chapter.

### 4.2 Response rate

The study targeted 100 sugarcane farmers chosen randomly drawn from the four divisions of the Bumula Sub-County. Data were collected from 96 respondents from the 100 sampled which is appropriate since it is above 80% according to Mugenda, 2004.

### 4.3 Descriptive analysis

#### 4.3.1 Characteristics of study respondents.

The four major characteristics relevant to the study include the area of land and how it's owned, the past farming experience and farmer's level of education. The data was presented using quantitative statistical tools

**Table 4.1: Farmers' Characteristics**

VARIABLE	CATEGORY	FREQUENCY	PERCENTAGE
<b>Level of education</b>	No formal education	7	7.29
	Primary	53	55.28
	Secondary	25	26.04
	Tertiary	11	11.45
<b>Land ownership</b>	Have title deed	37	38.54
	Free hold	42	43.75



	Leased	17	17.7
<b>Land size</b>	1-2 acres	49	51.04
	2.1-3 acres	26	27.08
	3.1-4 acres	15	15.63
	4.1-5 acres	7	7.29

Source: Field Data, December 2019

To further information on the social and economic factors affecting sugarcane production factors such as past farming experience, the amount of land owned and level of education were considered. The table above shows educational level variables and it reveal that the most of the respondent had their education level to primary education at 55.2 whereas 26.04 % of the respondents educated to secondary school level, 11.45 % were for tertiary education level and 7.29% had no schooling. Nonetheless, the majority of the respondents had basic education, thus could participate in the research study. The educational level determines one's ability to seek and apply knowledge. Given that most of sugarcane farmers had formal education indicates that many farmers had the capacity to increase sugarcane production since they could be easily trained on-farm management and the adoption of new agricultural skills. Despite the high level of education, sugarcane output was declining in the area. According to Kahinde 2005, education plays an important role in farming productivity.

The result in Table 4.1 implies that 7.29% of the respondents were farming on 4 - 5 acres. The majority of the farmers (51.04%) had sugarcane farms below 2 acres, where sugarcane farms between 2 -3 acres were 27.08% and 15.89% had sugarcane farms between 3 -4 acres. The majority of the small-scale sugarcane growers had subdivided their land into small portions for most cereal crops.

One farmer explained thus:

*I reduced my cane acreage from 5 to 2. This is because I gave three acres to my sons who are married. They have decided to cultivate food crops to feed their families. As a result, the output reduced from 15stacks to 4 stacks (Farmer # 7, December 2019).*

The high population density in the area had led to land fragmentation making cane production uneconomically viable in the area. Besides, the findings from FGD revealed that land tenure systems had encouraged land fragmentation thus hindering the effective participation in sugarcane farming which favours large portions of land. This hurt sugarcane production in the area. These results confirm Tena *et al.*, (2016) findings that shortage of land was a major challenge facing small-scale farmers in Ethiopia.

Results on land ownership in Table 4.1 reveal many respondents, 43.75 % owned freehold land (family land), and 38.54 % of the respondents had owned land with title deeds and 17.7 % had leased land. This shows that most of the farmers own their land. However, majority of the land owned was inheritance from their parents. The parcels had been given to them as freehold but they did not have individual title deeds. The lack of title deeds was a barrier to accessing financial credits to develop their farms. The elders were still holding on land and not willing to surrender as it was a sign of power and prestige in the community and one farmer explained thus:

*My father gave me a portion of land about three acres. I have been cultivating sugarcane and food crops for over 15 years. I am 54 years old and my father is aged but has refused to allocate us title deed and surrender ownership. I cannot develop this land fully because I do not know where I shall eventually be given (Farmer # 18, December 2019).*

These results further confirm the study made by Kassie, *et al.* 2009, which found that those farmers with large farms were likely to pay close attention to cash crops as opposed to small

farms that will focus more on food crops to feed their families. Similarly, Dlamini and Masuku (2011) concluded that land ownership influenced maize production in Swaziland.

The study aimed to establish the sugarcane farming experience of the farmers (Table 4.2).

**Table 4.2: Farmers' Farming Experience**

<b>Variable</b>	<b>Observation</b>	<b>mean</b>	<b>Std dev.</b>	<b>Min</b>	<b>max</b>
Years of faming experience	96	20.5	9.86	1	41

Source: Field Data, December 2019

From Table 4.2, results indicated that averagely farmers had 21 years' experience in sugarcane farming showing that most of data collected will be reliable on sugarcane farming. Years of experience amongst the respondents were on a range of 1 year - 41 years. One farmer explained thus:

*I have been cultivating sugarcane since 1983. At that time the company used to pay us well. I used to cultivate 8 acres but nowadays I only have 2 acres. I used to get 7 stacks and more from one acre but nowadays I only harvest 2 stacks in one acre (Farmer # 6, Khasoko, FGD, December 2019).*

Even though farmers were experienced in sugarcane farming, yields had continued to decline. These findings contrast with those of Muli (2010) who argued that farming experience contributed to high sugarcane production. The findings from FGD revealed that the low yields in the area were due to lack of farm inputs, poor and delayed payment. These factors have led to poor cane husbandry practices at the farm level. This study confirms Owiti (2019) that, the long stay in the sugarcane production by farmers does not necessarily mean good returns but lack of alternative crops.

### 4.3.2 Challenges of Sugarcane Production

The study established the socio-economic challenges of sugarcane production that were categorized under extension education, incentives, marketing, and input cost.

#### 4.3.2.1 Extension Education

The findings on extension education are as presented in table 4.3.

**Table 4.3: Extension Education services**

Variable	Category	Percentage
Extension education	EO regular visits	9
	EO advice suited to situation	13
	Workshops & seminars	7
	Able to implement EO advice	9
	No extension services	58
	no formal records	71
	manual records	16
	external records	5
	computerized records	0
	Missing	4

Source: Field Data December, 2019.

Information was sought on Extension Education and services provided by the extension officers (EOs); EO regular visits, EO advice suited to situation, workshops & seminars, able to implement EO advice, and no extension services offered. The findings in table 4.3 indicate that a majority, 60 % of the farmers interviewed had no access to extension services, 9 % of them were able to implement the advice given by Extension Officers or received regular visits by EO while 7.2% of them attended workshops and seminars. The respondents interviewed noted that their contact with extension officers was very minimal. Below is an excerpt of the sentiment of one of the farmers:

*We used to have extension officers but that was a long time ago. It was at the time the company used to provide farm inputs and incentives. They regularly visited us, organized field demonstrations and seminars. But all these are no longer there. I can't remember when I was last visited by extension officers (Farmer # 17, December 2019).*

Extension education through seminars, workshops and field demonstrations promote effective technology exchange and transfer to both extension workers and farmers. Extension knowledge facilitates the diffusion of cane farming skills among small-scale farmers. On-farm trials and demonstrations were noted to create avenues to showcase the effectiveness of the latest cane farming skills to farmers. These activities act as useful tools to show and convince the farmers to enhance participation in sugarcane farming. These results imply that there has been no adequate transfer of extension knowledge to the farmers in the study area. Further analysis of data revealed that Mumias Sugar Company stopped offering extension services like demonstration farms, seminars and workshops in 2010. These had negatively affected sugarcane production in the area.

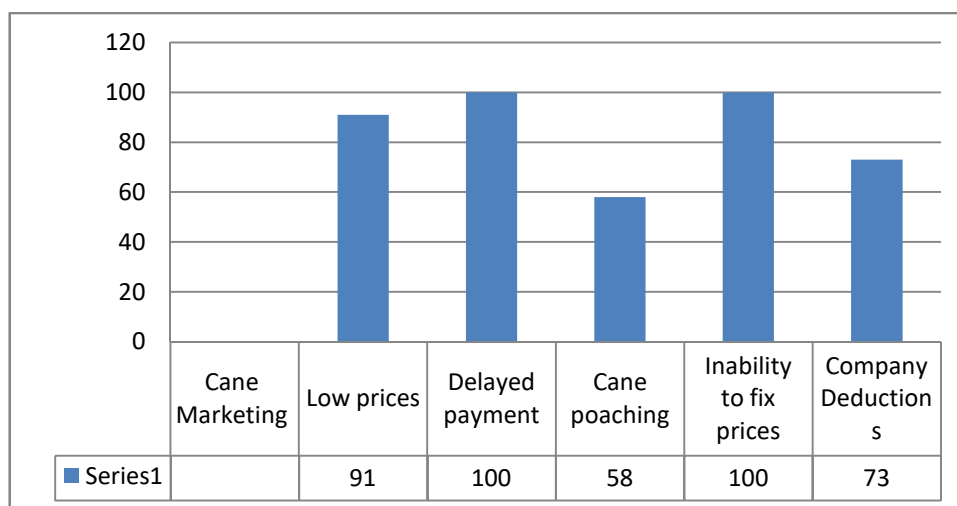
The inadequacy in the transfer of extension knowledge to farmers was further revealed through farmers' record-keeping systems. As shown in Figure 4.1, the results on farmers' record-keeping systems indicated that a high percentage of respondent lacked formal records (75%), 16 % of the respondents had manual records and 5% of the respondent had external records. The computerized records had no responses while 4% did not answer the question. This shows that, there has been no adequate transfer of extension knowledge to the farmers in the study area. One farmer explained as in the following excerpts:

*.....Why should I keep the records? What for? I have been cultivating cane for 15 years. I know the fertilizers I use. How many bags do I require for my farm, why should I record that down when I know?... ((Farmer # 84, December 2019).*

The lack of recording systems had affected the farmers' sugarcane field management practices as they had no records to refer to in terms of the cost of inputs, fertilizer usage and the yields obtained. It was further noted that the farmers were not even aware of the sugarcane varieties they planted and the fertilizers suitable for those varieties. Farmers were also not aware whether they were making a profit or losses in cultivating sugarcane. These findings are similar to those of Adimassu and Kassler, (2016) who observed that access to information and farming records affects farmers' agricultural productivity. This finding is further confirmed by (Ambetsa, 2020) who observed that contact with extension agencies has a positive relationship with the knowledge level to bring about desirable changes among the farmers.

#### 4.3.2.2 Sugarcane Marketing

There was a need to ascertain the knowledge of marketing of sugarcane by the farmers (Figure 4.1).



**Figure 4.1: Sugarcane Marketing Challenges**

Source: Field Data December, 2019

The results revealed that 91% of respondents noted that they were affected by low sugarcane prices. They lamented that the low cane prices made them get losses which affected their

field operations. They also claimed that the low cane income had made them indebted to the company. Inability by the government to set sugarcane prices was reported by all of the interviewed farmers. They noted that they were not allowed to negotiate for the prices. The poor pricing of cane had discouraged many farmers from cultivating the crop. Similarly, the study by Kweyu (2013) revealed that the low prices were a disincentive to the small-scale sugarcane growers in Mumias District.

Delayed payment by MSC was another constraint in sugarcane marketing which was reported by all the respondents. Farmers noted that their payment was delayed for over a year. They needed the money to be paid early so that they could pay for labour, buy farm inputs, and other field operations. Below is an excerpt from one of the farmers:

*I supplied my sugarcane to Mumias 2 years ago, and I have not been paid up to now. I am unable to maintain my sugarcane. The field is in tire need of fertilizer but has no money to buy. I have not even weeded my cane farm (farmer # 6, FGD Bumula, December 2019).*

This shows that most of the farmers acknowledge the importance of market access and good prices. The poor marketing of sugarcane has made farmers develop a negative attitude towards sugarcane farming. It has demoralized farmers making them abandon sugarcane cultivation. Similarly, Oyugi (2016) had indicated that delayed payment had demoralized sugarcane farmers in Nyando Sugar Belt.

Additionally, about 73% of the interviewed farmers complained about many charges deducted by MSC from sugarcane income like transport and harvesting costs. These deductions made them indebted to the company. The farmers qualified the causes of their indebtedness to the company in different ways. For instance, the excerpt below communicates the sentiments of one of the farmers:

*I supplied my cane to the factory but continued to be indebted. I had to pay the debt from the subsequent cane deliveries* (Farmer # 5, Kabula FGD, and December 2019).

This indebtedness to the company had ripple effects on the farmers across the study area. They resorted to selling their cane to the middlemen at very low prices; others uprooted the cane and abandoned cane farming. Most farmers associated the indebtedness with their tough livelihoods.

A majority (58%) of the farmers reported having sold their sugarcane to the middlemen at very low prices. They cited the delayed payment and their indebtedness to MSC as the reasons as to why they sold to middlemen rather than to the company. It was noted that they avoided selling their cane to the company to avoid the debt recovery by the company. Even though the factories arrange for transportation, the cost is met by the farmer eating much of their income. This concurs with Mitullah *et al.*, (2017), who concluded that the farmers do not have control over the mode of transport and cost of their products.

#### **4.3.2.3 Access to Incentives**

There was need to assess access to incentives as a factor affecting sugarcane production as shown in Table 4.4.

**Table 4.4: Access to Incentives**

<b>Access to Incentives</b>		
<b>Yes</b>	No	Missing
<b>3</b>	89	8

Source: Field Data, December 2019

The results show that 89 % of the respondents cannot access farm incentives while only 3 % of the respondents received incentives while 8% did not respond to the question. The farmers claimed that they used to get good yields when the company was supplying farm inputs and incentives. High yields guaranteed their high income. Further analysis of data



revealed that the few had received incentives from One Acre Fund, an NGO operating in the area to maize production. These farmers had diverted the inputs to boost their cane farms.

The lack of incentives had negatively affected sugarcane production in the study area.

Key informants confirmed that there had been a decline in sugarcane output. He attributed the declining production to various issues as follows:

*.....Tonnage has moved down due to a lack of fertilizer due to the ups and downs the company is going through. ....farmers have reduced cane and turned to maize farming which is not giving them what they need....* (Farmer # 5, December 2019)

There is a need for incentives to support sugarcane field operations to lower cost of farm inputs. These findings confirm the study by Kweyu (2013) that input cost and lack of incentives is the major reasons why farmers withdrew from sugarcane farming in Mumias District. This was also supported by Waswa and Netondo (2013) that there has been a decrease in the number of sugarcane growers in Western Kenya.

#### **4.3.2.4 Input Cost**

The results on input cost revealed that 82.3% of the respondents could not afford high farm input costs while only 17.7% could afford to purchase farm inputs. High input costs have highly influenced the reduction of sugarcane production in the area. Below is an excerpt of the sentiments of one of the farmers:

*Mumias used to pay us well and we were managing our farms from the income. We could buy fertilizers and apply twice. This gave us good returns. I used to get 8 stalks in an acre but these days I can hardly get 3 stalks in the same piece of land. But with the collapse of the company, we are unable to get money to buy the inputs. I have reduced from 2 acres to one but am considering leaving cane farming altogether. It's just expensive for nothing.* (Farmer # 15, December 2019).

The high cost of farm inputs was making farmers pull out of cane farming. This had led to a drastic decline in sugarcane production in the area. These findings are similar to Netondo and Waswa (2010) and Kweyu (2013) who observed that the decrease in sugarcane output rate was caused by high cost of inputs, poor and delayed payment, and lack of incentives. This finding matched those of Anangwe (2014) made an observation that inadequate use of fertilizer influences sugarcane production.

The respondents were asked to indicate the sources of financing sugarcane farming. The results are as indicated in table 4.5.

**Table 4.5: Sources of Financing Cane Farming**

Variable	Percentage
Government subsidies	7
MSC incentives	0
Financial credits	11
Self help groups	10
Self financing	30
Unable to finance cane	36
Others	7

Source; Field Data, December 2019

On sugarcane financing, 31% of the respondents had self-financing, 36% had no source of financing sugarcane and so had abandoned it, 12% were financed through credit, and 10% of the respondents got their financial assistance from self-help groups while 7% got government subsidies and other sources. This is consistent with our observation that many of the sugarcane farms were poorly maintained and or some farms had been abandoned. Some farms could be seen with uprooted stamps due to a lack of finance. This study confirms Ambetsa *et al.* (2020) findings which showed that credit access contributes to farm technical efficiency.

The farmers suggested that the company and government agencies increase and intensify the provision of support services including extension education, efficient transport, and technical training to sugarcane farmers. Farmers were to be encouraged and supported to use modern farming methods which are environmental- friendly.

### 4.3.2 Coping strategies

There was a need to establish the strategies used by small-scale sugarcane growers in coping with a decline in sugarcane production. The coping strategies to the declining sugarcane production included Cane by-products, non-contracted cane farming, and petty trade. Sugarcane growers were asked to indicate the benefits they obtained from sugarcane other than selling it to the sugarcane firms.

#### 4.3.2.1 Cane By-Products

There was a need to ascertain the farmers' responses on the benefits they obtained from sugarcane farming apart from selling to the millers. The cane by-products included the cane stalk and green trash. The results are as indicated in Table 4.6.

**Table 4.6: Sugarcane By-Products**

<b>Variable</b>	<b>category</b>	<b>Frequency</b>	<b>Percentage</b>
Cane juice	Soft drinks	17	17.7
	Jaggery	24	25.0
Cane stalk	Seed cane	16	16.6
	Chewing locally	6	6.30
	Sold to middlemen	53	71.4
Green trash	Animal feeds	76	79.2
	Green manure	17	17.7
	Burnt trash	3	3.10
Bargasse	wood fuel	24	25.0
	Charcoal	2	2.02

Source: Field Data, December 2019

On green trash, the findings show that most of the respondents 79.2% ,used green trash as animal feeds, 17.7% used it as green mature while 3.1% of respondents burnt the trash on their farms. It was noted that some farmers fed the green trash to the animals directly while others made hey and fed it to the livestock during the dry season. It was also observed that some farmers sold hey to get income (Plate 4.1). The farmers qualified the benefits from the green trash in different ways. For instance, the excerpts below communicate the sentiments of the farmers:

*After selling sugarcane to Lorries (meaning middlemen who come with Lorries to buy cane from them), I was able to sell the green trash and raise fees for my two children in secondary schools (Farmer # 30, December 2019).*

*After harvesting my sugarcane and before I could be paid, I got money from selling the trash to my neighbours for animal feeds. I was also paid for transporting the trash to their homes using my motorcycle. (Farmer # 73, December 2019).*



**Plate 4.1: Green Trash on Market for Sale**

Source: Mateka Market Field Data, December 2019

When sugarcane stalk was examined, 71.5% of those interviewed said they sold the cane to middlemen, 16.6% said they sold the cane stalk as seed cane while 6.3% did sell the cane stalk to the local markets for chewing. It was observed that, although most farmers preferred

to sell the cane stalk to the middlemen, it did not earn much money as when they were delivering to the company.

When the cane juice was examined, 25% of the respondents said that they extracted the juice for making jaggery while 17.7% of the respondents said that they made soft drinks to make beverages. It was observed that the jaggery was sold as animal feeds and in the making of the local brews. The sugarcane juice was sold or consumed as soft drinks and one farmer explained this:

*We extract sugarcane juice and use it to make tea for the family since buying sugar is very expensive. We also sell part of the juice to the neighbours and get some income (Farmer # 5 FGD, Kabula, December 2019).*

Plate 4.2 shows the facility for boiling sugarcane juice to make jaggery at a farm in Kabula Division



**Plate 4.2: Boiler for Making Jaggery**

Source: FarminKabulaDivision, FieldData 2019

The field observation revealed that some farmers had a stock of jaggery which had not been sold for some months because of lack of market (Plate 4.3).



**Plate 4.3: Jaggery cooling down in containers**

(Source; Farmer#5, December, 2019).

In collaborating results from the FGDs, members said they would wish to increase the making of the cane juice; mix with other fruits, bottle, and sell on a large scale but lack the capital to do so. The field observation indicated that few farmers had bought machines for crushing the sugarcane to obtain juice as shown in Plate 4.4 below.



**Plate 4.4: Cane Crushing Machine**

Source: Farmer #5, December, 2019.

When bagasse was examined, 25% of respondents said they used it as wood fuel while 2.0% of the respondents said that they made charcoal from it. Bagasse, is the residue of cane stalk after extraction of juice, is used as wood fuel in the making of the jaggery, saving on

the money farmers would have used to buy firewood. Field observation revealed that two farmers had value addition on bargasse by adding some additives in making charcoal. They had machines for making bagasse charcoal and packaging for commercial selling. The data from the FGD revealed that many farmers wished to make jaggery and use bargasse in making charcoal but lacked the capital. They resorted to selling the cane stalk to a few farmers with crushing machines or to the middlemen. Similarly, Brjan (2013) argued that finance is a key constraint in starting a business venture or livelihood activities.

Farmers also noted that they did not prefer selling the cane stalks to the local markets because it was not sold at once and did not earn much profit as it involved harvesting and transportation costs which reduced the profit margin. They noted that they preferred to sell to the middlemen instead.



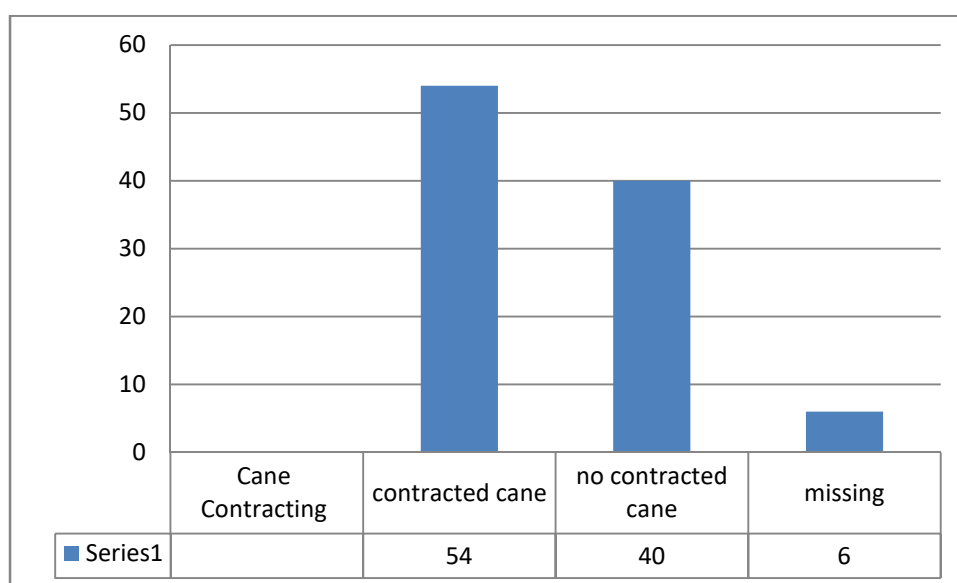
**Plate 4.5: Cane Stalk on Market for Sale**

Source: Mateka Market, Field Data, December 2019

These findings imply that sugarcane has a variety of products that are of much economic value to the farmers; nothing is wasted. The majority of those interviewed lamented that they wished to engage in other income-generating activities but they lacked finance. Further analysis of data revealed that farmers lacked capital for value addition to produce quality products that can capture large markets. The farmers argued that they were capable of

producing animal feeds like a chicken marsh, soft drinks and beverages, sweets, and packaged charcoal if they were given the necessary support in terms of skills, finance, and marketing.

When sugarcane-contracting was examined (Figure 4.2) most of the respondents were on contract, 54% with Mumias Sugar Company, 40% of the respondents said they cultivated non-contracted (private) cane while 6% did not answer the question.



**Figure 1.2; Non- Contracted Cane**  
Source: Field Data, December, 2019.

Those respondents who preferred to cultivate private (non-contract) cane did so to avoid company deductions. Non-contracted cane gave them the freedom to sell to any willing buyers without restrictions. However, it was observed that this had created opportunities for other sugar firms to infiltrate the area and poach the company contracted cane. Nonetheless, most farmers asserted that growing and selling sugarcane privately has very low returns. One farmer narrated as follows:

*I sold out my cane to lorries, however, a cane that could earn ksh.40,000/= with MSC fetched Ksh.15,000/= ... (Farmer # 28, December 2019).*



### 4.3.2.2 Off-farm Income Activities

Farmers were asked if they participated in other economic activities as a way to cushion them against sugarcane production decline. The farmers identified petty trade and the sale of firewood as a way of raising income. The study results are as shown in figure 4.3.



**Figure 4.3: Off-Farm Income Activities**

Source: Field Data December, 2019.

On off-farm income-generating activities, 28 % and 24% of the farmers were involved other engagements and petty trade respectively, 8% of the farmers were engaged in selling firewood while the majority 40% of the respondents were not engaging in other economic activities. The farmers said that they wished to engage in some micro-businesses but they lacked the capital to start. This implies that the area has a low business environment. The majority of the population has low purchasing power. This further means that, high number of the respondent relies on returns from their farms which could not meet the needs of their livelihoods.

Farmers affirmed the low business environment in the area in the focus group discussions. They illuminated the low business environment on the financial constraints on their

livelihoods as having been caused by reduced cane output in the area. The key informant explained the challenges farmers faced as follows:

*Low income from cane farming is making farmers pull out. The standard of living has gone down. Farmers have been using sugarcane to educate their children. There has been an increased school dropout rate* (Key informant, Extension officer 2, December 2019).

Further analysis of field data indicated that those who sold firewood had uprooted cane in favour of planting eucalyptus trees. It was observed that eucalyptus tree farming was becoming very popular in the area as a number of cane farms had been uprooted in favour of them. However, farmers lamented that eucalyptus tree farming requires large parcels of land and take a long period to get income from the venture.

The findings further revealed that the incomes from the coping strategies used by the farmers were inadequate. These strategies could not substitute sugarcane farming in the study area. Farmers noted that income from contracted sugarcane with MSC was far better than what they got from the adopted coping strategies or earned from private cane.

### **4.3.3 Cane output**

#### **4.3.3. 1 Perception of the Respondents on Cane Output**

Respondents rate sugarcane production whether increasing or declining and state their readiness to expand sugarcane production in the questionnaire. The study results are shown in figure 4.7. Most respondents, 95% indicated that since the year 2000, there has been a reduction in cane output while only 5% response showed that there was an increase in sugarcane production

#### **Table 4.7: Readiness to sugarcane farming expansion**

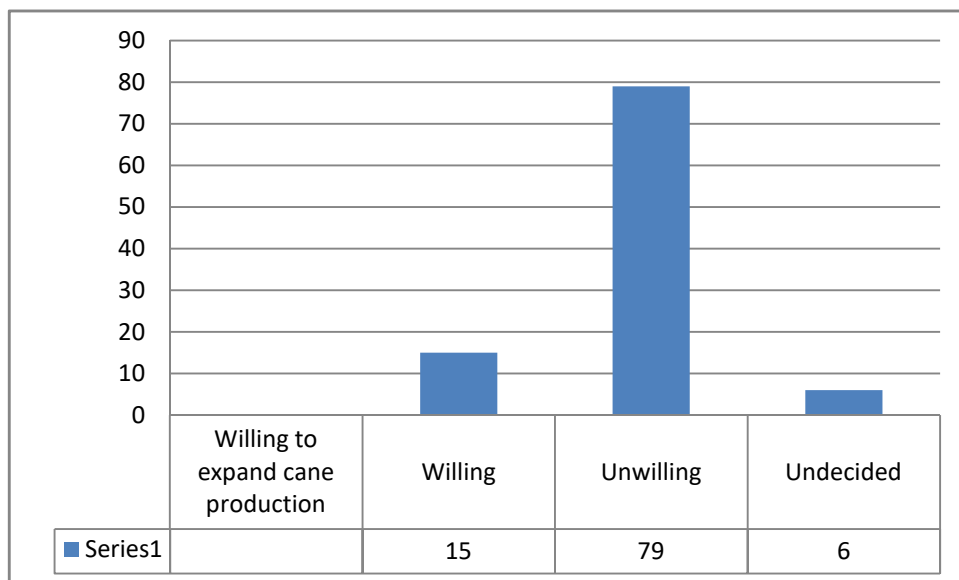
Readiness for sugarcane farming expansion ( percentages)		
Ready	Unready	Undecided
15	79	6

Source; Field Data, December, 2019

The respondents stated that the low sugarcane production were due to harsh biophysical conditions, depleted fertility; high input costs and poor and delayed payments that lowered morale for sugarcane farming.

95% percent of the responded who recorded decline in sugarcane production since 2000, 79% of the population were not ready to expand sugarcane farming due to low sugarcane output, delayed and poor payments, poor field and factory management, and high costs of inputs. However 15 % of the respondents indicated readiness to indulge in expansion of sugarcane production due to the high earnings they receive. The remaining 6% were not sure

and indicated that it will depend on the sugarcane price trajectory. Revisit the figure below.



**expand cane production**  
Source; Field Data, December, 2019

**Figure 4.4:**  
**Willingness to**

### 4.3.3.2 Cane Output since the Year 2000

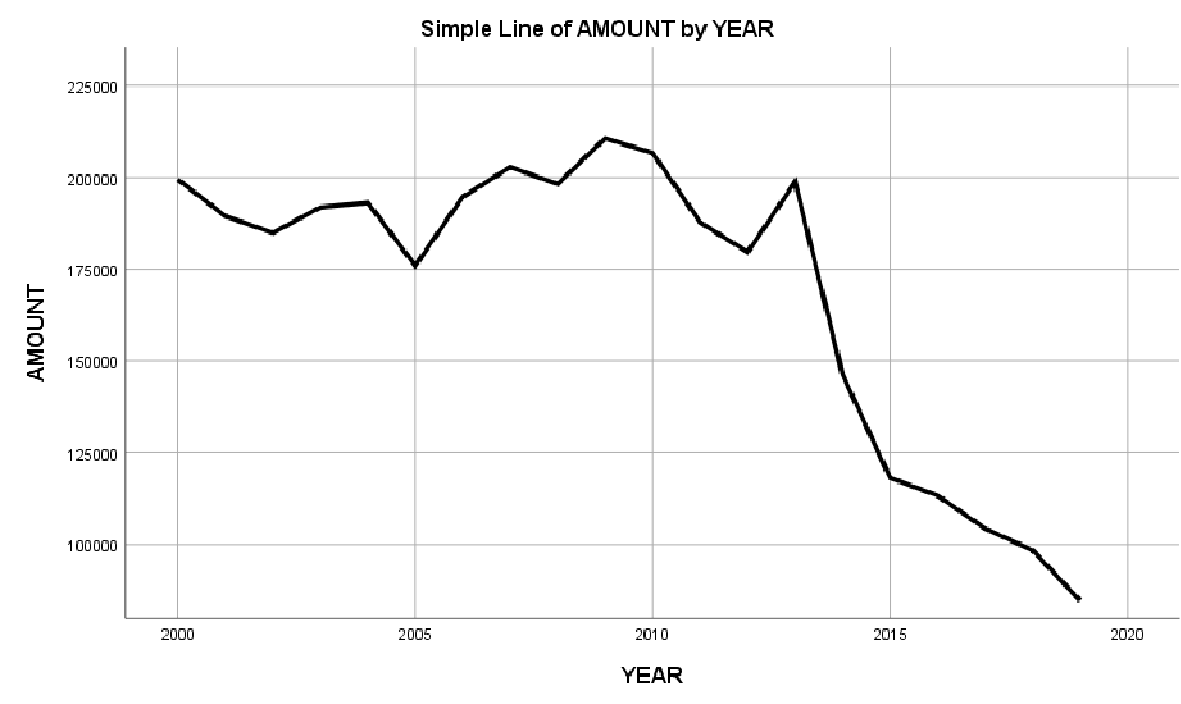
The study analyzed the data obtained from MSC Records (2020) on sugarcane output since the year 2000 (Table 4. 8).

**Table 8.8: Cane Output since 2000**

<b>Year</b>	<b>Output (tons)</b>
2000	1829054
2001	2034536
2002	1996534
2003	1918483
2004	1931181
2005	2043579
2006	1947003
2007	2027922
2008	1981768
2009	1834677
2010	2066148
2011	1526319
2012	1579190
2013	1556738
2014	1462796
2015	1181333
2016	1067382
2017	1026773
2018	978932
2019	817647

Source; Field Data, December, 2019

The study results indicated a general declining trend since the year 2000 from 1,829,054 tons to 817,647 tons in 2019. This is shown in figure 4.5.



**Figure 4.5: Cane Output since the Year 2000**

Source: Mumias Sugar Company Records, December 2019

There were fluctuations over the years but with a notable increase in 2013 with an output of 180,744 tons from 157,919 tons obtained in the previous year. Since 2013, there has been a downward trend in cane output in the study area to 817,647 M tons in 2019 (MSC Records 2020). This was confirmed by the data obtained from the FGD reports in the study area (Figure 3.1). Further analysis of data revealed that from the time MSC withdrew the provision of farm inputs, incentives, and extension services to farmers, cane output and field productivity had been fluctuating with a downward trend. This is captured in the following excerpt:

*I reduced my cane acreage from 10 to 2. This is because the company has collapsed. Output has also declined from 7 stalks I used to get to just below 3 stalks per acre. I don't get any assistance from the company. (Farmer # 9, Kabula FGD, and December 2019).*

Key respondents who had worked with MSC for over 10 years confirmed that there had been a reduction in cane output. They attributed the drop in cane output to various issues:

*.....sometimes Mumias stopped supplying farmers with fertilizer. This has made yields go down drastically... (Farmer # 4, Kabula FGD, and December 2019).*

*I have worked in this area since 2014; ...poachers take away a lot of cane but give farmers what is not required. Tonnage has moved down due to a lack of fertilizer and delayed payment. Farmers have reduced the cane and turned to maize farming which is not giving them enough income compared to what Mumias was giving (A key informant, Extension officer, field data, December 2019).*

These findings are supported by Kweyu (2013), who found that most cane farmers in Mumias District pulled away from growing sugarcane because of the increased cost of input, food security and delayed payments for the cane supplied to the factory. This was further confirmed by Waswa and Netondo (2013) that there had been a decline in the number of farmers growing sugarcane in Western Kenya.

#### **4.4 Assumption of Regression Model**

Normality, multicollinearity, and out-correlation assumptions were used to test the fitness of the Cobb-Douglas production function. These are specified as below.

##### **4.4.1 Normality of Data**

Measures how a model fits the data obtained from a study. Studies having large samples have normal distribution irrespective of the variations in data (Kothari, 2004). Testing was done on the data to check its normality (Table 4.9). The data was normally distributed since both the standard deviation of kurtosis and skewness was in a range of +2 to -2

**Table 4.9: Normality Test**

Std. Error of Mean	Kurtosis	Std. Error of Kurtosis	Skewness	Std. Error of Skewness	Std. Deviation
.155	-1.496	.833	.409	.427	.847

Source: field data, December 2019

#### 4.4.2 Multicollinearity Test

Multicollinearity problem is a phenomenon when independent variables can be described by two other variables in the study. The multicollinearity errors may lead to wrong calculation of regression coefficients hence conclusion drawn might be wrong. When determining existences of multicollinearity problem in the model VIF values (1/VIF) values are used and when they are greater than one, multicollinearity problem exists (Pan and Jackson, 2008)). VIF values for the study ranged between 1.12 and 3.74 as shown in Table 4.10 having an average 2.349 meaning that multicollinearity problem exists in the model but is not serious. The values of the mean of the factors (1/VIF) were found to be between 0.237 and 0.764. The maximum VIF value of 4 and 1/VIF value of not more than one are highly recommended (c.f., Pan and Jackson, 2008).

**Table 4.10: Mult-collinearity Test**

Std. Error of Mean	Kurtosis	Std. Error of Kurtosis	Skewness	Std. Error of Skewness	Std. Deviation	Harmonic Mean
.155	1.496	.833	.409	.427	.847	2.95

#### 4.4.3 Autocorrelation Test

A test when the residuals are independent of each other. The study used Durbin-Watson to test autocorrelation. The test result is presented in Table 4.11 as follows.

**Table 4.11: Auto -correlation Test**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change statistics				
					R Square Change	F Change	df2	Sig. F Change	Durbin-Watson
1	.681 <sup>a</sup>	.046	.675	.991	.681	161.750	93	.000	1.865

The study data had Durbin Watson at 1.865 therefore the data requires auto correction.

#### **4.5 Inferential statistics**

##### **4.5.1 Correlation Analysis**

The study used correlation test to show independent variables influence sugarcane production (figure 4.12)



**Table 4.12: Correlation Matrix**

Correlations														
		Sugarca ne output	Education	Farm size	Landowne rship	Farming Experience	Input_cost	Incentives	Record keeping systems	Market Access	Credit Access	Extension Education	Cane by- products	Non- contracted cane
Sugarcane Output	Pearson Correlation	1												
	Sig. (2-tailed)													
	N	100												
Education	Pearson Correlation	.011	1											
	Sig. (2-tailed)	.017												
	N	96	96											
Farm size	Pearson Correlation	.326	.346**	1										
	Sig. (2-tailed)	.049	.000											
	N	96	96	96										
Landowne rship	Pearson Correlation	.161	-.031	-.128	1									
	Sig. (2-tailed)	.031	.456	.203										
	N	96	96	96	96									
Farming Experience	Pearson Correlation	-.053**	-.044	.047	-.031	1								
	Sig. (2-tailed)	.083	.662	.645	.757									
	N	96	96	96	96	96								
Input Cost	Pearson Correlation	-.387**	-.121	-.185	.050	.231*	1							
	Sig. (2-tailed)	.000	.229	.066	.622	.021								
	N	96	96	96	96	96	96							
Incentives	Pearson Correlation	.259	-.032	-.079	.077	.055	.031	1						
	Sig. (2-tailed)	.005	.351	.434	.444	.385	.761							
	N	96	96	96	96	96	96	96						
Record	Pearson Correlation	.160	-.017	-.007	.081	-.070	.017	.203*	1					



The bivariate association between Cane output and independent variables; level of education, farm size, land ownership, farming experience, input cost, incentive, record-keeping systems, market access, credit access, extension education, cane by-products, and non-contracted cane variables are as shown in Table 4.12.

The bivariate association between sugarcane production and educational level of the farmer is -0.011 and p-value 0.017. Therefore, a 1.1% decline in sugarcane production is attributed by educational level of the farmers. From the analysis there is poor negative association between educational level of a sugarcane grower and sugarcane production. The result concurs with Obiero 2013, on the impacts of socio-economic factors on farming productivity in Siaya District, Kenya. Education level was insignificant to productivity since farming involves on job training. However, the findings contrast with Kahinde, (2005) study, who suggests that education level of farmers has great impact on productivity in Nigeria.

The bivariate association between sugarcane production and farm size is 0.326 and p-value 0.049, indicating that there is 32.6% increase, sugarcane output in relation to farm size. Suggesting a high positive relationship between farm size and cane output. These findings confirm the study by Tena *et al.*, (2016) which had found that shortage of land was a major challenge facing small-scale farmers in Ethiopia.

The bivariate association between production of sugarcane and farming experience is -0.053 and p-value 0.083 indicating a 5.3% reduction in cane output is associated with farmers' farming experience, showing a very weak significant negative association between farmers' farming experience and cane output. These results confirm the findings of the study by Muli (2010) who argued that farming experience contributes to high sugarcane production.

The bivariate relationship between sugarcane production and mode of land possession is 0.161 and p-value 0.031 indicating a 16.1% increase in sugarcane production is related with

mode of land possession. Therefore there is a lower positive relationship between land ownership and sugarcane production. This confirms the study by Dlamini and Masuku (2011) who observed that land ownership influences production rate of crops.

The bivariate relationship between sugarcane production and input cost is -0.387 and p-value 0.000. Thus, a 38.7 % reduction in sugarcane production is related with input cost, showing a higher positive linkage between the cost of input and sugarcane production. It is similar to the findings of Netondo and Waswa (2010), Kweyu (2013), and Wanangwe (2014) who observed that the declining rate in sugarcane production was influenced by high cost of inputs and lack of incentives.

The bivariate relationship between sugarcane production and extension education is 0.258 and p-value 0.063. Thus, a 25.8 % increase in sugarcane production is influenced with extension knowledge indicating a lower insignificant positive relationship between the extension knowledge and sugarcane production output. These findings are confirmed by Adimassu and Kassler, (2016), who observed that contact with extension agencies, information access, and farming records have a positive relationship with the knowledge level to bring about desirable changes among the farmers.

The bivariate relationship between sugarcane and incentives is 0.259 and p-value 0.005. Thus, a 25.9% increase sugarcane production is positively related with incentives. This indicates a higher positive relationship between incentives and sugarcane production.

The bivariate relationship between sugarcane production and market access is 0.441 and p-value 0.057 indicating, a 44.1% increase in sugarcane production is linked with market access. Hence existence of a higher positive linkage between markets access in terms of pricing and cane output. Similarly, the study by Kweyu (2013) revealed that the low prices were a disincentive to the small-scale sugarcane growers in Mumias District.

The bivariate relationship between sugarcane production and credit access is 0.215 and p-value 0.085 implying 21.5% increase sugarcane production output is affected by credit access, implying a lower positive relationship between credit access and sugarcane production. These findings confirm the study by Kweyu (2013) that lack of incentives influenced the farmers to abandon sugarcane production in Mumias District.

The bivariate association between independent variables; cane by-products and non-contracted cane were 0.541, land 0.548 respectively an indication of multicollinearity problem.

#### 4.5.2 Cobb-Douglas Production Function

The study applied the Cobb-Douglas production function to determine the effect of the socio-economic challenges on sugarcane production. The results are shown in Table 4.13 below.

**Table 4.13: Modal Summary of Cobb-Douglas Function**

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.681 <sup>a</sup>	.118	.675	.980	.681	161.604	11	88	.000
a. <b>Predictors:</b> (Constant), education, farm size, land ownership, farming experience, input cost, incentives, record keeping systems, market access, credit access, extension education, cane by-products , non contracted cane. <b>Dependent :</b> Cane output									

The study results in Table 4.13 indicate that the production function is statistically significant. From the model summary proportion of variance in the cane output with independent variables is 67.5 % ( $R^2$  -Coefficient of determination). This implies that all the

12 variables studied accounted for 67.5% variability in sugarcane output at a 95% confidence interval. However, 68.1% (R) variations in the cane output could be explained by the variations in the independent variables. R-value is used to show the strength and direction of the relationship between the variables. In this case, the R-value of .681 indicates a very strong positive relationship between variables (Nabiswa, 2018).

The model F- a value of 161.604 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. This result suggests the existence of other factors that explain the remaining 32.5% of the variation in the sugarcane output.

#### 4.5.3 Assessing Fit of Cobb-Douglas production Function

Variance analysis helped to investigate whether Cob-Douglas production function will be effective on the data collected. The results were shown in Table 4.14

**Table 4.14: ANOVA Model**

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.263	11	1.024	161.406	.000 <sup>b</sup>
	Residual	84.527	88	.961		
	Total	95.790	99			

Table 4.14 shows a summary of F-test results. There is zero variance on sugarcane production (F=161.604, p=0.000a). The F-test is highly significant. Therefore the Cobb-Douglas Production Function (CD) is of great importance in this study. This shows that the CD function was fit for the data and hence all the socio-economic variables used in the study affect sugarcane output. ANOVA model predicted sugarcane output significantly (p=0.000).

This shows that the Cob-Douglas function statistically predicted sugarcane production output in the study area.

#### **4.5.4 Regression Analysis**

T-test of statistical significance of each regression coefficient was conducted to determine the beta weight, which shows the strength and direction of each of the socio-economic variables used in the study (Table: 4.15).

**Table 4.15: Cobb-Douglas Production Function**

Regression Coefficient								
Effect	Unstandardized Coefficient						Co linearity	
	Standardized Coefficient						Statistics	
	B	Std Error	Beta	t	df	Sig.	VIF	1/VIF
Intercept	-1.406	.113	.406 <sup>a</sup>	.000	0	.000		
Education	.187	.314	.392	11.986	3	.007	3.74	0.345
Farm size	.217	.787	.650	8.244	6	.022	3.69	0.567
Landownership	.283	.758	.622	14.216	6	.027	3.13	0.678
Farming experie.	.175	.778	.641	6.235	6	.397	2.81	0.342
Input cost	-.473	.661	-.524	4.118	6	.000	2.76	0.761
Incentives	.292	.570	.649	7.242	3	.065	2.56	0.237
Record keeping	.117	.546	.981	15.574	12	.021	2.29	0.470
Market Access	.381	.348	.426	6.020	3	.011	2.23	0.613
Credit Access	.373	.391	.040	9.634	9	.381	2.23	0.557
Extension educat	.279	.358	.437	4.030	3	.258	2.19	0.691
Cane -products	.267	.140	.234	3.542	2	.009	1.15	0.379
Private cane	.147	.183	.224	2.345	2	.059	1.12	0.764
							2.349	

Applying the regression formula:  $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$ .

The established model for the study was;



$Y$  (cane output) = -1.406 (constant) + 0.187 (level of education) + -0.217 (farm size + 0.283(land ownership) + 0.175(farming experience) + -0.473(input cost) +0.292 (incentives) +0.381 (market access) +0.117 (record keeping) +0.279 (extension education) + 0.373(credit access + .267(cane by-products + .147(non-contracted cane).

The regression equation established that taking all factors into account (socio-economic factors) constant at zero sugarcane output was -1.406. This means that keeping all factors constant at zero reduction in sugarcane output was 1.406. From the regression equation, input cost was the most important variable to sugarcane production contributing to a 47.3% decline in sugarcane production. The other major significant contributors were access to Market and credit contributing 38.1 % and 37.3% respectively. Farm size, land ownership, extension education, and coping strategies each contributed over 20% to sugarcane production. The least contributors were level of education 18.7% and non contracted cane 14.7%. However, any inadequacies in these variables negatively affect sugarcane production. The constant value of -1.406 implies that with no serious interventions in the major significant contributors, sugarcane production is declining in the study location.

These results confirm findings by Kweyu (2013) and Waswa and Netondo (2014) who opined that challenges such as lack of inputs, incentives and extension education harm sugarcane production in the Lake Victoria Basin.

## **CHAPTER FIVE: SUMMARY, CONCLUSION, AND RECOMMENDATIONS**

### **5.1 Introduction**

This section discusses the implications of the research carried out, conclusions, and recommendations for further study

### **5.2 Summary**

The sugarcane sub-sector is an important economic activity that improves economic status of a region and raising the standard of living in sugarcane growing zones. Socio-economic challenges harm sugarcane production resulting in declining output and reduced income. The socio-economic challenges of sugarcane production are very important for making policies and for the management of farming. The results on the first objective revealed that farmer's characteristics namely; education level, farming experience, land size, and ownership affect sugarcane production. There is a need to form collaborations between sugarcane firms, small-scale farmers, as well as mentorship from stakeholders so that small-scale growers are well educated on the practice of sugarcane farming and the challenges that go with it. This will result in enhanced sugarcane production.

The second objective was to investigate the coping strategies adopted by small-scale sugarcane growers. The study established several cane by-products that were beneficial to farmers which include soft drinks, jaggery, seed cane, animal feeds, and green mature. The cane-by products were sold without value addition earning little income. The farmers were also engaged in off-farm income like petty trade and the sale of firewood to caution themselves against reduced cane output. Some farmers cultivated non-contracted sugarcane to avoid company deductions. Non-contracted cane gave the farmers the freedom to sell to any willing buyers. However, they earned less than when they supplied the cane to the

company. A few farmers were involved in the Petty trade and sale of firewood as a way of raising income. The area had a low business environment with the majority of the population relying on farm income. The population had low purchasing power. The study found shows a great relationship between cane output and the adopted coping strategies.

The third objective used correlation to test how sugarcane production is affected by the socio-economic variables used in the study. The study indicates a strong negative relationship between sugarcane production and the cost of input while land ownership had a weak significant negative association. There was a low positive association between cane output and level of education, extension education, and farm size and credit access.

The study applied production function to investigate the effect of the socio-economic challenges on sugarcane output. Cobb-Douglas multiple regression results show that production function was significant for this study with a Coefficient of determination of 67.5%. The Pearson Correlation Coefficient was 0.681%, indicating a very strong positive linkage between sugarcane production and the independent socio-economic variables used in the study.

### **5.3 Conclusion**

There has been a declining trend in cane output since the year 2000. The reduction in cane output is caused by the inadequacy in the farmers' characteristics specifically; farming experience, level of education, land fragmentation, and land ownership which significantly influenced the sugarcane output. The adopted coping strategies that farmers engaged in to caution themselves against declining cane output, could not measure up to the economic power they had while sugarcane farming was flourishing. The adopted coping strategies especially cane by-products needed value addition to earning a good income. The study

established that the farmers lacked the support services like market and credit access, incentives and extension education which adversely affected sugarcane output in the study area.

#### **5.4 Recommendations**

The study therefore recommends:

- Poor cane pricing, lack of extension education and inadequate financing in cane development in the sugar sector be addressed, to reverse the outcome and increase the potential of sugarcane production.
- There is a need for the County Government to improve the micro-businesses environment and encourage value addition to sugarcane products to reverse the outcome and result in an increased sugarcane output.
- There is a need to form collaborations between sugarcane firms, small-scale farmers, as well as mentorship from stakeholders so that small-scale growers are well educated on sugarcane agriculture and the challenges that go with it. This will result in enhanced farmers' participation in sugarcane production.
- Kenyan government should create more awareness on modern sugarcane agricultural practices through extension services to small scale farmers to ensure increase in sugarcane production.

#### **5.5 Suggestions for Further Research**

The objectives of the study were achieved and the study can be used to conduct research on other study areas.

- This study limited demographic data of farmers to farming experience, educational level of the farmers, how the land is owned and its size. Future studies could incorporate more demographic data on the age, occupation and gender of the farmers

- The study shows that Farmers should invest more in farm input costs to reverse the outcome and increase the cane production rate. The future studies should investigate on how to optimize the inputs to increase sugarcane production rates..
- The study incorporated correlation research design which has both strengths and weaknesses. Other research design should be adopted to ensure accurate results.

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## APPENDICES

### APPENDIX 1: CONCENT FORM

SUB-COUNTY \_\_\_\_\_ DIVISION -----  
VILLAGE \_\_\_\_\_

DATE OF VISIT \_\_ \_\_/\_\_ \_\_/2016

#### RESEARCH ASSISTANTS

NO	NAME	GENDER	TELEPHONE	SIGNATURE
1.				
2.				

RESEARCHER \_\_\_\_\_ SIGN \_\_\_\_\_ DATE \_\_\_\_\_

#### Introduction

I am Protas Fwamba Khaemba, a postgraduate student of Kenyatta University and my colleague is \_\_\_\_\_ a research assistant. We are conducting a research on the dynamics of sugarcane production among small-scale growers in Bungoma County. As a student researcher I will be grateful to hear your inputs as they will help us document success stories, challenges and progress on sugarcane farming in Bungoma County.

The process will involve note taking and the conversation will be recorded as the interview proceed, participation is for free up. The confidentiality of that participate is ensured since the name and other personal credentials are kept anonymous be kept anonymous, that is, your name or other identification will not be reported along with your answers to the questions. The participants are free to leave or not answer the question they do not want do. The interview duration is 30 mins.

Interview session will be interactive and the respondent can ask a question

Do you agree to participate in the study?

YES  Signature of Interviewee: \_\_\_\_\_ (Certifying that informed consent has been given by respondent)

No

TIME: START OF INTERVIEW \_\_\_\_\_ Respondent's code-----

## APPENDIX 1I: SURVEY QUESTIONNAIRE

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CONFIDENTIALITY: The questionnaires are administered to acquire data for academic use. The aim of the survey is investigating impacts social economic factors affect the sugarcane production in Bungoma County, Kenya. Raw data collected are subject to confidentiality and a solution to academic dilemma

Name \_\_\_\_\_ (Optional)

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### PART 1: QUESTIONNAIRE ON RESPONDENT DEMOGRAPHIC DATA

1. State your educational level?

- a) No formal education [ ]
- b) Primary [ ]
- c) Secondary [ ]
- d) Tertiary [ ]
- e) Other (specify).....

2. For what period have you indulged in sugarcane farming industry?

- a) Below one year [ ]
- b) 1-10 years [ ]
- c) 11-20 years [ ]
- d) Over years [ ]

3. State ownership of sugarcane land

- a) Owned [ ]
- b) Rented/Leased [ ]
- c) Borrowed [ ]
- d) Other, specify.....

4. Do you have a title deed for your sugarcane farm? a) Yes [ ] No [ ]
5. Have you used your land as collateral to secure a loan? Yes [ ] No [ ]
6. What area of your land is under sugarcane production?
- a) Less than 2 acre [ ]
- b) 2 – 3 acres [ ]
- c) 3 – 4 acres [ ]
- d) More than 5 acres [ ]

**PART II: COPING STRATEGIES ADOPTED BY FARMERS**

- 7 Other than selling your cane to the company, do you get any benefits from other sugarcane products? Yes [ ] No [ ]
8. If yes, what other benefits do you get from sugarcane products...?
9. Do you have value addition to your sugarcane products before selling?  
Yes [ ] No [ ]
10. If yes, what are the benefits of value addition...?
11. Do you engage in non-contracted cane farming? Yes [ ] No [ ]
12. If yes, why do you engage in this type of cane farming...?
13. What other on-farm income activities do you engage in...?
14. Do you engage in any off-farm income-generating activities? Yes [ ] No [ ]
15. If yes, which one?.....
16. If you compare the incomes from contract cane and other income-generating activities, which one pays better?.....

**PART 3: CHALLENGES TO SUGARCANE PRODUCTION**

17. Do you face any financial challenges in sugarcane farming? Yes [ ] No [ ]
18. If yes, how do you finance your sugarcane farming?
- a) Secure credit loans from financial institutions [ ]

- b) Government subsidies
- c) Incentives from NGOs
- d) Provision of input/ credit from MSC
- e) Other,specify.....

19. Have you received extension services from anybody or an agency?

Yes  No

20. If yes what aspects of extension services listed below are you familiar with?

- a) Could name extension officer
- b) Could cite the last visit
- c) EO advice suited to the situation
- d) EO visits field
- e) Able to implement the advice
- f) EO provides affordable services

21 Which of these methods of extension services have you received that best help to improve sugarcane farming?

Employees visiting sugar farms

Meetings on extension services

Visiting model farmers

Training, seminars and workshops

Non

22. What the type of record keeping is used in sugarcane farming?

No formal record system

Manual records

External consultation

Computerized records

23. How easily do you find markets for your sugarcane? Yes [ ] No [ ]

13. Indicate challenges you face in marketing sugarcane

a) Low selling prices [ ]

b) Not able to negotiate market price [ ]

c) Delayed payment/harvest [ ]

d) Company deductions [ ]

**PART 4: OUTPUT OF SUGARCANE PRODUCTION**

Provide the information below to the best of your knowledge

Year	Stalks per acre	Output in tons	An increase/ decrease

THANK YOU



## **APPENDIX III: FOCUS GROUP DISCUSSION GUIDE**

### **Preamble**

I will ask you questions and you will give your answers. I will tape-record the discussion as well as write down your responses. The interview should take about 30 minutes. Kindly if you are available respond to the questions below

In-depth discussion on

A) Challenges of small-scale sugarcane growers

Sugarcane financing→

Extension education to farmers→

Sugarcane marketing→

Incentives→

Cane output

B) Strategies used by sugarcane growers to cope with declining cane production.

D) Uses of cane products and challenges

THANK YOU

## **APPENDIX IV: INTERVIEW GUIDE TO MSC MANAGEMENT**

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### **Introduction**

I will ask you questions and you will give your answers. I will tape-record the conversation as well as writing down your responses. The meeting will last about one and a half-hour. If you have any questions, you can ask at any stage of the interview

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1. What challenges face small-scale sugarcane growers in the area o study?
2. In your view what are the coping strategies used by the small-scale sugarcane growers in cautioning against declining sugarcane cultivation?
3. Recommendations if any to revitalize the sugarcane sector?

THANK YOU

## APPENDIX V: OBSERVATION GUIDE

OBSERVATION BY.....DATE.....

ITEM(S)	PRESENT	ABSENT	EVIDENCE
Sugarcane decline <input type="checkbox"/> Acreage <input type="checkbox"/> Field with uprooted cane stamp			
Farm support services <input type="checkbox"/> Training/advisory centres/workshops <input type="checkbox"/> Financial credit facilities			
Coping strategies <input type="checkbox"/> Crop farming( named crops) <input type="checkbox"/> Animal rearing( named animals) <input type="checkbox"/> Farming methods (intergraded)			

## APPENDIX VI: BUDGETARY ESTIMATES

Item(s)	Cost per item	Amount
Concept draft	25 @ 200 /=	5,000/=
Proposal	25@ 500 /=	7,500/=
Stationery	Pens & pencil 10 @ 20/=	200/=
	Materials	5,000/=
Lab top	@ 37,000/=	42,000/=
Camera (hire)	1 @ 2,000/=	2,000/=
Transport	3 @ 5,000/=	15,000/=
Research assistants	2 @ 9,000/=	18,000/=
Interview guide printing	120 @ 50/=	6,000/=
Thesis draft, printing & binding	3 @ 3000/=	9,000/=
Final Thesis printing & binding	3@ 3000/=	9,000/=
Air time		5,000/=
Contingencies		10,000
Total		137,700/=

## APPENDIX VII: RESEARCH WORKPLAN

ACTIVITY	2016						2017					
	J	F-M	A-M	J-J	A-S	N-D	J-F	M-A	M	J	J	
Activities												
Literature review												
Concept development and presentation												
Research proposal writing and presentation												
Research proposal collection and submission												
Research permit processing and pilot study												
Qualitative data collection												
Data processing and analysis												
Manuscript writing (first draft)												
Manuscript writing (final draft)												
Submitting final copies and submission												
Evaluation												



## APPENDIX VIII: NACOSTI AUTHORIZATION LETTER



### NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone +254-20-2213471,  
2240349,3310971,2219420  
Fax +254-20-318249,318249  
Email: [og@nacosti.go.ke](mailto:og@nacosti.go.ke)  
Website: [www.nacosti.go.ke](http://www.nacosti.go.ke)  
when replying please quote

9<sup>th</sup> Floor, Utalii House  
Uthuru Highway  
P.O. Box 30623-00100  
NAIROBI-KENYA

Ref. No.

Date:

**NACOSTI/P/16/69537/14373**

**28<sup>th</sup> October, 2016**

Protas Fwamba Khaemba  
Kenyatta University  
P.O. Box 43844-00100  
**NAIROBI.**

#### **RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on "*An analysis of the dynamics of sugarcane farming in Bungoma County-Kenya.*" I am pleased to inform you that you have been authorized to undertake research in **Bungoma County** for the period ending **28<sup>th</sup> October, 2017.**

You are advised to report to the **County Commissioner and the County Director of Education, Bungoma County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

  
**BONIFACE WANYAMA**  
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner  
Bungoma County.

The County Director of Education  
Bungoma County.

APPENDIX IX: RESEARCH PERMIT

**THIS IS TO CERTIFY THAT:  
MR. PROTAS FWAMBA KHAEMBA  
of KENYATTA UNIVERSITY, 2665-50200  
BUNGOMA, has been permitted to  
conduct research in Bungoma County**

**Permit No : NACOSTI/P/16/69537/14373  
Date Of Issue : 28th October, 2016  
Fee Received :Ksh 1000**

**on the topic: AN ANALYSIS OF THE  
DYNAMICS OF SUGARCANE FARMING IN  
BUNGOMA COUNTY-KENYA**

**for the period ending:  
28th October, 2017**



**Applicant's  
Signature**

**Director General  
National Commission for Science,  
Technology & Innovation**

**CONDITIONS**

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officer will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one (1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice



REPUBLIC OF KENYA



National Commission for Science,  
Technology and Innovation

RESEACH CLEARANCE  
PERMIT

Serial No.A

11504

CONDITIONS: see back page