ROLE OF COST OF INFORMATION ADOPTION AND UTILIZATION IN THE RELATIONSHIP BETWEEN COST OF SUGAR CANE PRODUCTION AND COST OF FOOD PRODUCTION AMONG FARMERS IN NYANZA REGION, KENYA

BY

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DECLARATION

DECLARATION BY THE CANDIDATE:

I hereby declare that this thesis has not been presented for any degree award in any university or in any other institution of higher learning. The work herein is my original work and all sources of information have specifically been acknowledged by means of referencing.

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May God richly bless you

DEDICATION

This thesis is dedicated to the God Almighty, my dad and mum (May their soul rest in peace) and to my wife and sons.

ABSTRACT

In Kenya, agricultural sector absorbs 60% of the labour force, contributes 24% to GDP and sustains over 80% of the rural populations' livelihood. In Nyanza region, sugarcane production covers 55.9% of the total arable land yet the financial returns are insufficient to cater for household's food deficits. Shortfalls are abridged through food importation, government or donor support. Although Kenya has notable agricultural information dissemination channels, agricultural output in Nyanza region is still low. It is unclear whether this is attributed to high costs of adoption or utilization or whether information provided is irrelevant. Most methodologies used in making conclusions on competing needs among production factors between sugarcane and food production pitches on small geographical boundaries and documents only on technical efficiency. Since there is no congruence on the relationship between sugarcane on food production and the role of information adoption and utilization is also controversial, there is need for further investigation. The general objective was to investigate the role of cost of information adoption and utilization (IAU) on the relationship between cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya. Specific objectives were to; establish the extent of information adoption and utilization among sugarcane and food crop farmers; determine the relationship between cost of sugarcane production and cost of food production ; determine the cost efficiency level on cost of sugarcane production and cost of food production; assess the moderating and mediating effect of cost of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production cost; examine the coping strategies to food insecurity among sugarcane farmers in Nyanza region, Kenya. Cost minimization theory was adapted and modified while correlational research design was adopted. From 73,000 farmers, a multistage random sampling was used on 384 farmers generated through Cochran's formula. Response rate was 82.55%. Cronbach alpha $(\alpha = 0.757)$ tested for reliability; experts opinion tested for validity. Multinomial logit, Stochastic Frontier Analysis and Structural Equation Model (SEM) determined the causal effects. Descriptive statistics and coping strategy index (CSI) determined "the extent" and "coping strategies" respectively. From results, information adoption was at a greater extent, utilization was at a small extent; the relationship between Sugarcane production cost and food production costs was significant $(\alpha = 0.689; p = 0.002)$; cost efficiency level in the production of sugarcane and food crops is 74.96%; cost of adoption significantly moderated cost of land in sugarcane production $(\beta = -0.260; p = 0.004)$; cost of adoption and utilization moderated cost of capital and land in sugarcane production $(\alpha_1 = 5.45e-10; p = 0.000)$ and $(\alpha_2 = -5.51e-10; p = 0.020)$. Taking porridge and eating of left overs were the main coping strategies. Therefore, intensification of agricultural extensions services, stabilization of cost of land and capital are required. Mixed production is also recommended.

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OPERATIONAL DEFINITION OF TERMS

Cost Efficiency Level:	This is the point at which the factor inputs are able to create output at the minimal cost in order to maximize firm's profits.
Farmers:	This referred to sugarcane farmers although this study recognized the presence of mixed farming as part of coping strategy
Food production:	This referred to the level of food production. It was proxied by the total cost of food production and assessed in terms of availability of the main food crops by a particular household namely maize, beans, milk and vegetable production.
Information adoption:	This referred to the cost of acquisition of information gadgets such as Radios, mobile phones, television and computers.
Information utilization:	This referred to the cost of information exchange, management or processing and other relevant knowledge in the field of agriculture.
Mass media:	The use of newspapers, magazines, radio, television, and the Internet to communicate to the general public
Productivity:	This refers to output in relation to resources expanded. in this case, sugarcane output and well as output on food crops was matched to the changes in factor inputs such as capital, labour and land, ceteris paribus.
Role:	This refers to the part played by information adoption and utilization. It was measured by the extent to which information adoption and utilization either moderates or mediates on the relationship between sugarcane production and food production.
Sugarcane production:	This referred to the cost of processing and methods used to transform sugarcane seedlings into mature cane that then can be used to make sugar and other related by products.

ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
CRS	Constant Returns to Scale
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GoK	Government of Kenya
GPS	Global Positioning System
IAU	Information Adoption and Utilization
ICT	Information Communication and Technology
ILO	International Labour Organization
KARI	Kenya Agricultural Research Institute
KFSSG	Kenya Food production Steering Group
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
KSB	Kenya Sugar Board
KSI	Kenya Sugar Industry
MoA	Ministry of Agriculture
MRT	Marginal Rate of Transformation
NEPAD	New Partnership for African Development
NGO	Non-Governmental Organization
PPF	Production Possibility Frontier
SADC	South African Development Community
SEM	Structural Equation Modeling
SFA	Stochastic Frontier Analysis
SID	Society for International Development
SMS	Short Message Services
SONY	South Nyanza Sugar Company
TFP	Total Factor Productivity
UN	United Nations
VRS	Variance Returns to Scale

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The agricultural sector in Kenya, through service- related, distribution, manufacturing and other related sector connections, directly and indirectly contributed to 24% and 27% of GDP growth respectively. On government revenues, industrial raw materials plus the total export earnings, agricultural sector contributes to 45%, 75% and 50% respectively. It is also the greatest employer accounting for 60% of the labour force and for survival, more than 80% of the rural population relies on the agricultural sector and its related activities. Given these facts, the agricultural sector is held in high esteem to promote development nationally and the government always lays emphasis on tea, coffee, pyrethrum and sugarcane, being the major cash crops (Kenya Agricultural Research Institute, 2008). However, sugar cane production has seen the farm level efficiency (producing the maximum possible output at minimum cost) declining over the years. Despite Kenya having a remarkable agricultural information dissemination channels through mobile phone, radios, TV and computers, Nyanza still suffers from low agricultural output. It is not clear whether the concern is on the cost of adoption or utilization of these information channels to acquire agricultural information necessary to increase agricultural production.

Generally in developed countries, agriculture constitutes a very small share of employment and output, about 1% in the United States of America (USA) and United Kingdom (UK), although productivity is not disproportionately low (Todaro & Smith, 2012). In Canada, agriculture contributed $111.9 billion totaling to 6.7% of its gross domestic product (GDP) in 2016, as well as contributing to 12.5 % of the total Canadian employment (Commodity News Service, 2017). Besides, 45% of the 70% rural population depends on this sector for Pakistan's total labour demands. In a middle income country like South Africa, the agricultural sector only contributed to 2.3% of the total GDP and 5% of the labour force (Greyling, Vink, & Mabaya, 2015). In overall, the agricultural sector is critical in the provision of raw materials, minimization of poverty as well as provision of employment opportunities (Usman, 2016).

A sharp contrast however, exists in the developing countries with agricultural sector contributing substantially to the employment levels. In Nigeria, the agricultural sector contributed 70% of the total labour force, and also accounted for 40% of the total GDP (Odetola & Etumnu, 2013); In Ethiopia, the agricultural sector contributes 50% of the total GDP, 85% of the total work force as well as 90% of the total foreign exchange earnings (Welteji, 2018).

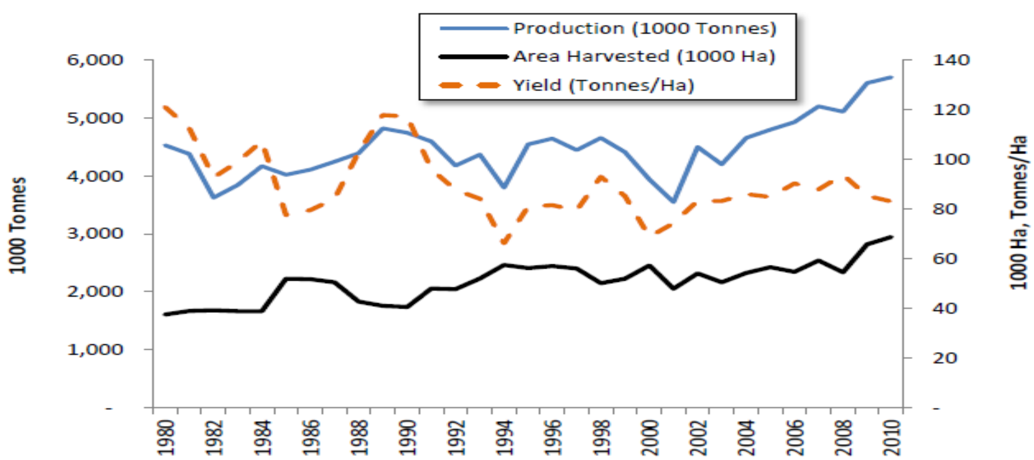
Kenya's total land mass is about 587,306 Km^2 and out of this, water covers 11,230 Km^2 . The remaining 576,076 Km^2 is covered by land and out of this, 16% is ideal for undertaking agricultural activities while the rest is either an arid or semi-arid land (ASAL). With an increasing human population size, land in the agricultural potential areas have been fragmented up to 0.5 – 10 ha. Besides this, the agricultural sector in Kenya has also faced a myriad of other challenges ranging from 60% of the population practicing agriculture and lives below the poverty line. The general economic performance also dropped thus impairing the sustainability of economic performance at 10% annually (Government of Kenya, 2007). Climatic changes and global warming has seen droughts occur every 2-3 years instead of 5-7 years as was previously the case. Human conflicts as well as floods have also not spared it either. Other challenges include the continued inadequate agro processing facilities, unproductive marketing channels, expensive credit facilities, high costs of inputs as well as poor infrastructure (Ministry of Agriculture, 2009). All these problems have assisted in escalating the food production concerns.

Nyanza region falls within Western Kenya and it is situated along latitudes 0°15'N and 1°45'S and longitudes 35°15'E and 34°E. Precisely so, the region is comprised of Kisumu, Homabay, Siaya, Kisii, Nyamira and Migori counties but focus was devoted to Kisumu, Homabay and Migori counties since they contain the main sugar belts namely Muhoroni, Chemelil, Ndhiwa and Sony (The Republic of Kenya, 2010).

Jaetzold *et al.,* (2009) established that the region possesses a humid climate and such conditions are sufficient in rainfall and good soil (Suchia, 2006). Rao, *et al.,* (2015) indicated that the region has the capability to produce maize, tobacco, coffee, tea and sugarcane, albeit in small scale, but the latter is the dominant crop occupying 55.9% of the total estimated rain fed arable land. Sugarcane sector alone adds to almost 15% of the Kenya's agricultural GDP (Thuo 2011) and provides livelihood to almost six million individuals, annually brings in almost Ksh. 12 billion, and provides almost 500,000 jobs. Although this is the case, its total output is approximately

450,000 metric tonnes against a total demand of close to 610,000 tonnes. This deficit is filled through importation (Kenya Sugar Industry, 2009).

Examining the annual growth trend in sugarcane production from 1980 to 2010 and from 2016 to 2017, the former indicated that there had been an increase in production attributed to acreage of land planted as opposed to the yield per acre mainly from 1991 up to 2010 (Kenya Sugar Industry, 2009). Given by Kenya Sugar Board (2010) report, output per hectare declined in the years 2000s and 1990s as matched to the outputs recorded in the 1980s. This decline was due to poor land management and agricultural practices, delayed sugarcane harvesting and the usage of low quality sugarcane varieties.



Source: (Food and Agriculture Organization, 2012)
Figure 1.1 Sugar Cane Outputs in 1980-2010

In 2016 to 2017, KNBS (2018) alluded that total sugarcane production in Kenya degenerated from 639.7 thousand tonnes to 376 thousand tonnes, a 41.2% decline. This prompted an importation of 989.6 thousand tonnes. The reason for this was the conversion of some areas to crops such as maize and soya beans but being as it may, maize production also fell from 3,402 thousand tonnes 3,186 thousand tonnes in the respective years resulting into soaring of food prices in 2017 as compared to 2016.

Comparatively, the output and market contribution for each sugar industries in Kenya by 2010 was at 73.8% and the country's import dependency ratio was as 26.2%, (Monitoring African Food and Agricultural Policies project [MAFAP], 2013). a summary is given below.

Table 1.1 Output and the Market Contribution by 2010

Position	Producer	Output (tonnes)	Market share (%)
1	Mumias	24,7970	45.25
2	West kenya	70,692	12.9
3	Nzoia	69,705	12.72
4	Sony	63,623	11.61
5	Soin	1,863	0.34
8	Kibos	38,524	7.03
9	Muhoroni	26,523	4.84
10	Chemelil	29,099	5.31
Total	Total	547,999	100

Source: KIPPRA (2010)

This data showed a concentrated structure, where, Mumias Sugar Company alone accounted for 45.25%, while the rest hold small market shares indicating the absence of dominance in the entire national market for sugar (KIPPRA, 2010). However, factories in Nyanza region counties alone namely Sony, Sukari, Kibos, Muhoroni and Chemelil, accounts for 36.85% of the total sugarcane market share and at the moment, two factories are closed.

Sugar cane production/yield can be measured in various ways namely through the energy requirement, cane yield (tonnage per acre), cost of production, gross or net returns and cost benefit ratio (Tena *et.al,* 2016). In this study, the cost of production of sugarcane was isolated and formed the basis upon which sugarcane production was measured in order to preserve the units of measurement between production of sugarcane and other variables that this study examined.

Although sugarcane contributes to increased levels of employments and to agricultural GDP, the production as well as the financial returns started to decline from 1980s (Mati & Thomas, 2019) and Nyanza region still suffers from food production deficiency (Malinga, 2009). From the county integrated development plans for the three counties, every county government prioritizes to address food insecurity within their jurisdiction (County Government of Homabay, 2017; County Government of Kisumu, 2018; County Government of Migori, 2018) The direct correlation between sugarcane and food insecurity is, however, still controversial. Ramashala

(2012) established that sugarcane growing has a potential increases the households income thereby increasing their ability to afford food but Anguyo (2014) ascertained that its presence does not lead to food adequacy because rich out-growers enjoy the tenancy leaving the households with little patches for growing cane. According to Terry & Rhyder (2007), poor cane out- growers in Swaziland faced food deficiencies upon adapting sugarcane farming. In Mumias, Kenya, shifting to sugarcane farming could gear up food insecurity among the small-scale producers (Tyler, 2008).

According to KFSSG (2008), food production is "a situation in which all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meets their dietary needs and food preferences for an active and healthy life". According to Verburg *et al.*, (2013), this security is determined by food utilization, availability, stability and access. Therefore, its physical availability is a necessary although not a sufficient condition since affordability, quantity adequacy and nutritional contents are also important. For this reason, food production is due to the purchasing power and income, not merely just a supply issue hence its link to poverty. Therefore, it must contain food availability, accessibility, stability and utilization/nutrition (Ministry of Agriculture, 2009). Although this study recognizes that there are other important crops and agricultural activities which provide income, enjoyment and nutritional benefit to the farmers, focus on grains (maize & beans), vegetable and milk was key forms of food production and the cost of food production was proxied by the cost of food production.

The motivation to include food production in this study stemmed from, Mohajan (2004) findings that Kenya, compared to other eastern African countries, is the largest importer of other agricultural products and food since maize production, a staple food crop, is lower than the national demand. The country integrated development plans for the counties of Homabay, Kisumu and Migori, have commonly indicated food insecurity as a major draw back and a factor that they have propritized to address (County Government of Homabay, 2017; County Government of Kisumu, 2018; County Government of Migori, 2018). From the big four agenda that the Government of Kenya is currently pursuing, the govenmemnt is committed to ensuring that Kenya attains 100% food and nutrition security. The remaining three agendas are to increasing manufacturing to 20% of the GDP; achieve 100% universal health care and 1million homes by 2022. Prices of food are currently 45% of the total income and this is to be scalled down to 25% of the total income by 2022 (The National Treasury and Planning, 2020).

In Nyanza region, most household plant maize, sorghum and benas yet food insecurity is still a common problem since 85% of the households realize food insecurity for at least 3 months each year. Reasons contributing to this are natural disasters, limited access to or knowledge of credit use, lack of adequate income, presence of non-local markets to increase their agricultural outputs and high rates of HIV/AIDS (CARE, 2010). Moreover, in 2015 alone, donors have pumped 12 billion shillings in order to address food insecurity within these areas (Thuita, 2016). In kisumu region, 53.6% of the households are food insecure (Urban Futures, 2018).

In relation to sugarcane production and food production, Masayi & Netondo, (2012) reported that with sugarcane monoculture in the areas that they are being practiced in Kenya, food crop production has dropped hence food insecurity and malnutrition among children because sugarcane earnings have dwindled partly due to low farm productivity from 100 tonnes for maximum profitability to 65 tonnes per hectare. Besides, cane maturity period of 18 to 24 months have also aggravated food insecurity situation hence the need for small holder farmers to spread their income sources as well as increase their household food production. Lihasi, Onyango, & Ochola (2016) observed that the small scale sugarcane farmers in Mumias had low capability livelihoods and high levels of food insecurity. As such, this study considered both the food crop farmers as well as the sugarcane farmers, given the complementarity of these two products. This complementarity emerges on the common usage of factor inputs in the production process, for example, when fertilizers are applied to sugarcane, the some residual nutrients may be necessary to the production of food crops if the farmer is practicing rotational farming.

Although this may be the case, there is still some policy confusion since policy makers still encourage an aspect of different cash crops and are encouraging diversification by intercropping sugarcane with other food crops to end the perennial dependence upon sugarcane alone. This indicates that sugarcane is still a highly regarded crop among farmers and policy makers within Nyanza region counties (Ochieng & Raballa, 2018).

Although there is an incredibly high levels of information channels KNBS (2011), farmers are still experiencing low productivity and grapples with limitations in management, technology as well as economic concerns, yet with information adoption and utilization, Mati & Thomas (2019) acknowledged that countries across the globe that possesses the same agro ecological condition as Nyanza region such as India and Bangladesh, and have adopted and utilized information, have seen remarkable improvements in their levels of income and yield by 15.2% and 15% respectively (Raj *et.al*., 2011) and (UNCTAD, 2012).

This study investigated the role of the cost of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production to find out whether it amplifies the linkage or provides a process through which cost of sugarcane production and cost of food production are related. Besides, studies on role of cost of information adoption and utilization in agricultural practices are minimal (Kwadwo & Mekonnen, 2012). Although Mwombe *et al.,* (2013) studied the effect of information among banana farmers; this study investigated the effect on information among sugarcane and food crop farming.

Upon realization that the system of organizing the factors of production depends on the level of information at the behest of the farmer, in order to determine what to produce, how to produce and whom to produce to (Riley 2011), there was the need to investigate the role of cost of information adoption and utilization had on the relationship between costs of sugarcane production and cost of food production among farmers in Kisumu, Homabay and Migori counties in Nyanza region, Kenya. The role (part played by) of cost of information adoption and utilization, therefore, came into the cost of sugarcane production (from preparation of land through to the product's delivery to the destined market) as well as the cost of food production through knowledge provision generated by or from the information gadgets owned by the farmers and their ability to quest for agricultural information.

Cost of information adoption and utilization as used in this study, refers to a combination of both the cost of acquisition of software and hardware as well as the cost of information management, exchange and processing through the use of television, internet, radios, geographical information services, computers and cellphones (O'Farrell, 2015). Their use in agriculture refers to taking full advantage of modern information technology advancements in mobile phones, geographic information systems (GIS), remote sensing, cloud computing, global positioning system, the wireless communication technology and the internet in order to improve agriculture (Food and Agriculture Organization, 2016). As such, this study investigated the cost of acquisition and the cost of usage of these information gadgets to acquire information regarding the best farming practices that may improve agricultural production.

Interest developed towards the study of cost of information adoption and utilization was based on the assumption that there should be perfect information/ full knowledge of all the relevant information for the concept of utility theory to hold. Satisfaction is often achieved when the marginal utilities are equal to the marginal rate of commodity substitution and this is only possible when marginal cost in the production process equals to the marginal revenue received from the sales per unit (Staff, 2016). Some of the benefits of information adoption and utilization includes the promotion of technologies in agriculture; provision of platform and opportunities for knowledge exchange, experiences and strategies among farmers; besides creating and promoting agro-meteorological databases and applications for expert groups, livestock and crop modeling as well as support systems for crop performance, Daoliang (2017) and lack of it is a limitation to smallholder development, (Springer, 2001). Such critical information can be used in land preparation to determine the soil fertility, in capital to know the current/ modern capital efficient technologies, on labour to understand the emerging labour saving technologies besides providing critical information on marketing of agricultural products.

Even though there has been information revolution, providing volumes of institutional, technological and market information to small farmers, such information are yet to reach the majority of poor producers in low-income countries (Springer, 2001). Because of this concern, this study evaluated how intense information has been adopted and utilized among farmers within Nyanza region counties and what role the costs of adoption and utilization plays on the interaction between the cost of sugarcane production and cost of food production either as a moderating factor or as an intervening factor. Precisely so, the cost of adoption and utilization was examined in terms of the cost of voice calls, sms and data either on mobile phones, radios, computers and televisions. Because the areas are predominantly sugarcane growing areas and sugarcane, being an industrial crop, is complementary to food crops; Wiggins, Henley, & Keats (2015), this study investigated all the sugarcane and food crop farmers irrespective of their affiliation to a particular crop type.

This study was pegged on the cost minimization theory which states that the cost of a product is a combination of the cost of the physical output as well as the cost of the factor input that went into its production (Ebele & Nneamaka, 2018). Specifically, this study assessed how the costs of inputs varied between food production and sugarcane production on the assumption that cost was minimized through factor substitution and that the possibility of such substitution also depended upon the relative price level of the various factors. Based on the rationality of the household behavior, the general assumption was that there is a combination of both food production and sugarcane production that can be done simultaneously to make a farmer/society better off and beyond a certain point, any increase in the cost of sugarcane production led to a total shift towards food production and vice versa. Given this assumption, this study explored the role of information adoption and utilization to shift such points because in the ordinary sense of the production possibility frontier, technology is always held constant while other factors of production are varied. In this study, the factors of production that were considered were labour, capital and land.

This study used Coping Strategy Index, Multinomial Logistics Regression and Stochastic Frontier analysis (SFA) method and supposed that farmers always tended to maximize their profits, production as well as tend to minimize their cost and in doing so, not all of them succeed given the same inputs and technology and because of this, the methodology was useful for it was able to take care of deviations that may be as a result of the farmers' inefficiencies and therefore prescribe measures to address such inefficiencies.

1.2 Statement of the Problem

Kisumu, Migori and Homabay counties in Nyanza region possess humid temperature which is useful for the growth of cash crops such as sugarcane, cotton and coffee; food crops such as sorghum, millet, maize, vegetables and beans; rearing of domestic animals such as cows, sheep and goats. Given this, 55.9% of Nyanza's total arable agricultural lands are under sugarcane production yet farmers from this region still suffer from food shortage. This is because the financial returns from sugarcane production are insufficient to cater for the deficits in food production. As such, farmers rely on government and donor food support and importation of food crops and animal products (milk and meat) from the neighbouring counties such as Kericho and Nandi. Besides, all the County Integrated Development Plans have prioritized to address food insecurity within the region. Despite Kenya having a remarkable agricultural information dissemination channels through mobile phone, radios, TV and computers, Nyanza still suffers from low agricultural output. It is not clear whether the problem is on the cost of adpotions and utilization or whether the problem is the content of the information that are being provided. However, countries, across the world, with the same ecological conditions but have adopted and utilized information immensely for example India and Bangladesh, have realized net output and incomes rising by 15% and 15.2% and the fertilizer costs reduced by 25% resulting into paucity of information on the extent of information adoption and utilization and the effect of its cost on sugarcane production costs and food production along the sugar belts in Nyanza region, Kenya. Although studies in India, Brazil and Australia have acknowledged that there has been competing needs on the factors of production between sugarcane and food production, especially on capital, insufficient literature exists on the subject matter in Nyanza region. Technical efficiency level in sugarcane production and food production has been preferred, by most studies, at the expense of cost efficiency level yet costs are critical component in revenue and profit determination. Besides, most studies have been on financial and food compromises, as coping strategies, at the expense of non-financial compromises. Since there is no congruence on the relationship between sugarcane on food production and the role of information adoption and utilization is also controversial, there is need for further investigation. Hence, this study investigated the role of cost of information adoption and utilization on the relationship between the cost of sugarcane production and food production among farmers in Nyanza region.

1.3 Objectives of the Study

The broad objective is to determine role of cost of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya.

1.3.1 Specific Objectives

The specific objectives are to;

1. Establish the extent of adoption and utilization of information among sugar cane and food crop farmers in Nyanza region, Kenya ;
2. Determine the relationship between cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya;
3. Determine the cost efficiency level between the cost of sugar cane production and cost of food production among farmers in Nyanza region, Kenya;
4. Assess the moderating and mediating effect of cost of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya;
5. Examine the coping strategies to food insecurity among farmers in Nyanza region, Kenya.

1.4 Research Questions and Hypothesis

Given that the objectives were both qualitative as well as quantitative; this study formulated the research questions and hypothesis as follows;

1. What is the extent of information adoption and utilization among sugarcane farmers and food crop farmers in Nyanza region, Kenya?
2. H_{01}: There is no relationship between the cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya.
3. H_{02}: There is no cost efficiency level between cost of sugar cane production and cost of food production among farmers in Nyanza region, Kenya.
4. H_{03}: There is neither a moderating nor a mediating effect of cost of information adoption and utilization on the relationship between costs of sugarcane production and cost of food production among farmers in Nyanza region, Kenya.
5. What are the coping strategies towards food insecurity among farmers in Nyanza region, Kenya?

1.5 Significance of the Study

As a matter of policy, Government of Kenya's big "four" agenda itemized food production as one of the main agendas. The intention of the government is to have 100% food and nutrition commitment. To achieve this, reduction of food costs as well as increasing the ICT capacity to farmers is necessary. Because the cost of food production is positive though inelastic to changes in the cost of sugarcane production, it implies that as the cost of sugarcane production changes, the cost of food production also changes but by less than the proportionate change in the cost of sugarcane production. This study, therefore, advises that for food to be made available, by reducing its cost of production, the cost of sugarcane production must be reduced. However, to the sugarcane industry, the results of this study showed that cost of land is the major determinant of the farmer's choice towards sugarcane and if this cost is not addressed, then sugarcane farming will not be taken up. Consequently, unless the cost of labour and capital are not addressed, food production is still untenable.

This study advices that the solutions to the challenges bedeviling farmers, lies on the extent of information available to them. Since most of the information is passed through radios, telephones, TVs and computers, the government should ensure the existence of proper channels to disseminate such agricultural information. Once received, farmers are also advised to make use of such information to advance their agricultural output. In order to reduce their cost inefficiencies, those interested in sugarcane production must watch on the costs related to land and land preparation while those interested in food crop production must watch on related to labour and capital.

This study is useful to the field of academia in that in as much as most studies have examined the qualitative nature of the moderating role of information generally, the quantitative cost elements of information adoption and utilization has been less studied. As such, the incorporation of the quantitative cost elements of adoption and utilization would greatly enhance this study's contribution to the field of academia. Besides, there is also no known study that has incorporated a structural equation modeling to observe the mediating connection between the costs of sugarcane production constructs and those of cost of food production constructs.

1.6 Scope of the Study

This study was undertaken within the four sugar belts in Nyanza region, Kenya. These sugar belts were Muhoroni and Chemelil in Kisumu County; Ndhiwa in Homabay County and Sony in Migori County. The targeted farmers were between 25 years and above with a minimum of 5 years' farming experience. This study focused on technical, operational or market driven information available to the farmers and which could be necessary to increase their agricultural productivity. The study variables were sugarcane and food crop farmers; the cost of information adoption and utilization; the cost of sugarcane production as well as the cost of food production. Mechanisms towards coping strategies to food production were also investigated. With regard to time, the primary data used in this study was carried out from January 2019 to March 2020; secondary data were only used as reference points.

1.7 Conceptual Framework

According to Magher (2017), conceptual frameworks are pictorial in nature and are meant to allow the reader to understand a particular study flow. Because this study involved developing a causal relationship, Swaen, (2015) opined that conceptual framework is critical for such kinds of studies. The self-conceptualized framework is outlined below.

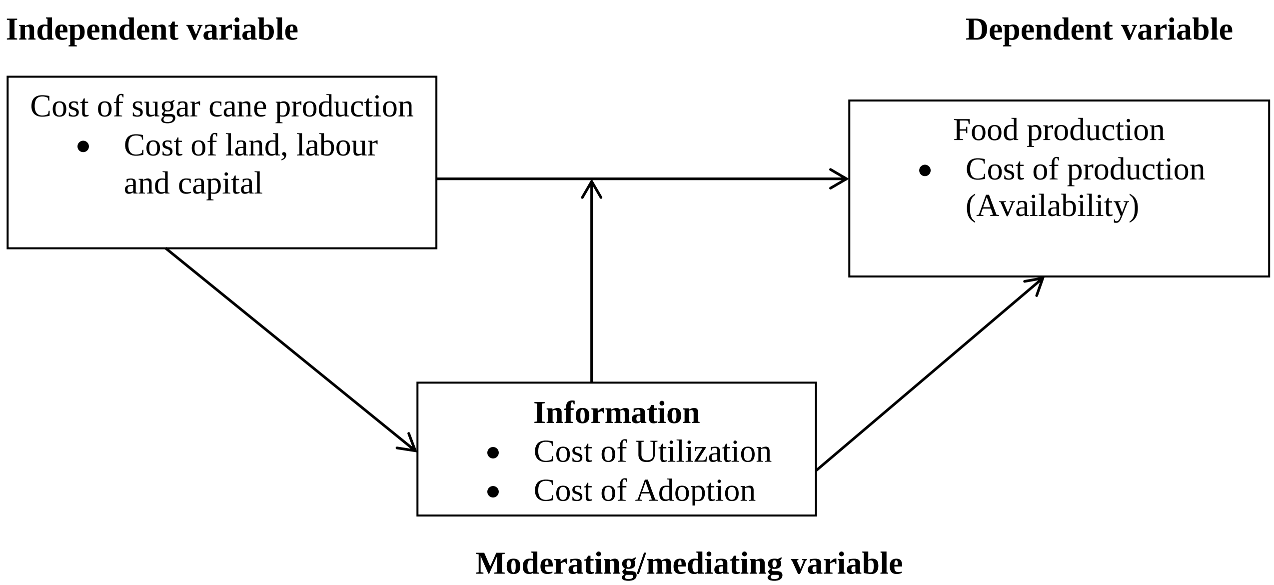


Figure 1.2: Self Conceptualized Framework

From Figure 1.2 above, the assumption is that cost of sugar cane production directly affects cost of food production (a proxy for food production). Hence, there is a competing need for the factors of production namely capital, labour and land.

With the arrows moving from cost of information (in this case as a mediator) through cost of sugar cane production and then to cost of food production, the assumption was that proper information adoption and utilization on sugarcane may influence food production. Likewise, the direct link from cost of information can also improve food production. With direct relationship between cost of sugar cane production and cost of food production, cost of information adoption and utilization interjecting from beneath, the assumption was on its ability to moderate the relationship based on the premise that it could answer the three fundamental questions of how, why and to whom in the production process. In this study, cost of information adoption and utilization came into cost of sugarcane production and cost of food crop production through the cost of knowledge provision generated by the information gadgets under ownership of the farmers. Hence, conclusions are drawn depending on the reaction of costs of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production.

Given that cost of information adoption and utilization acted as a confounder, thus affecting the results that would otherwise not have been the case had there been a link between the cost of sugarcane output and cost of food production, this study dealt with such factors statistically after the data collected was analyzed through multinomial logistics regression that accorded odds to control for the multiple confounders.

To isolate the relationship of interest between the multiple confounders, this study adopted a linear regression analysis as well as the analysis of covariance to examine the relationship between multiple covariates and established their numeric outcome.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide an understanding of the theory that this study was anchored on. It also contains some relevant empirical literature reviews that have been studied, in the past, on the specific objectives that this study investigated. Finally, it contains a summary of the literature gaps that were witnessed in the previous studies, which this study addressed.

2.2 Theoretical Literature

This study is anchored on the cost minimization theory. For a firm to maximize its profits, it must minimize/lower its cost to produce a specific output or maximize their productivity. The choice of these costs depend on their operating environment. However, regardless of the the level of output to be produced, input bundles that minimizes the cost of production must be chosen. Therefore, it is a necessary condition for profit maximization (Osborne 1997).

According to Dwivedi (2009), business decisions are generally based on the monetary value of both the inputs and outputs. It is this monetary value that is referred to as the cost of production. The understanding of this cost of production enables the firms to minimize their costs of operations, identify the possible weak points in production management and also generate the optimal production level.

In this study, the households were considered as business entities/firms and therefore, their farm outputs were considered to be market outputs, although some of these outputs could be consumed domestically. Investigations were based on the relationship between the cost of production of sugarcane and the cost of food production (proxied by cost of food production) and how the cost of information (both adoption and utilization) may mediate or moderate this relationship. Production function, in this case, meant the cost of physical output from a production process to the cost of physical inputs/factors of production. These costs included the cost of land, labour and capital. Given that the households are firms and may have the profit maximization objective, revenues is exogenously determined hence what they have control over are the cost minimization aspects.

A cost function expresses a functional relationship between total cost and factors that determine it. The factors that determine total cost of production (TC) of a firm are the output (Q), the prices of the input factors such as labour (L), capital (K), land (D), entrepreneurship (E) and the level of technology (T). A production function such as this help firms to determine how much output they are likely to produce given the price of a good, and what combination of inputs they should use to produce given the prices of factor inputs.

This general function can be expressed as;

$$TC = f(L, D, K, E, T) \quad \text{………………………………………………………..(2.1)}$$

Where;

TC is total cost;

L is cost of labour;

D is cost of land;

K is cost of capital;

E is cost of entrepreneurship;

T is the state of technology.

With households functioning as firms, this is to say that they are producing output for the market; the general cost minimization problem (Bounthavong, 2019) is given as;

$$\begin{aligned} &MinC = w_1 x_1 + w_2 x_2 \\ &st. f(x_1, x_2) = Y \end{aligned} \quad \text{……………………………………………………………….(2.2)}$$

Where;

w_1, w_2 are the costs of input x_1 & x_2

From equation (2.2), $f(x_1, x_2)$ is the production function and it denotes the optimal level of output to be gotten from x_1 units of the 1st input and x_2 units of the 2nd input.

In this study, the general total cost function was adopted and modified to encompass the cost of labour (L) cost of land (D) and the cost of capital (K) while the production function adopted and modified the general Cobb Douglas function such that;

$$Min.TC_i(L_i, K_i, D_i) = \alpha_1 L_i + \alpha_2 K_i + \alpha_3 D_i \quad \text{…………………………………………………(2.3)}$$

$$st.Q_i = AL_i^{\beta_1} K_i^{\beta_2} D_i^{\beta_3}$$

Where;

TC is the total cost of all goods produced

$\alpha_1, \alpha_2, \alpha_3$ are the prices of labour, capital and land respectively.

L_i is the labour input from an individual farmer

K_i is the capital input from an individual farmer

D_i is the land acreage from an individual farmer

i are the cross sectional subscripts

A = Total factor productivity

β_1 = Elasticity of labour

β_2 = Elasticity of capital

β_3 = Elasticity of land

The solutions to this cost minimization problem are conditional in that they depend on the level of output. In this study, consideration was given to the cost of sugarcane production and to the cost of food production and on mixed production. Given this, equation (2.3) was modified to reflect the total cost of sugarcane production, the total cost of food production and the total cost of mixed production. The modified functional relationship was specified in equations 2.4; 2.5; and 2.6 ;

$$\ln TC_{iS} = \alpha_1 \ln L_{iS} + \alpha_2 \ln K_{iS} + \alpha_3 \ln D_{iS} \quad \text{..........(2.4)}$$

$$\ln TC_{iF} = \alpha_1 \ln L_{iF} + \alpha_2 \ln K_{iF} + \alpha_3 \ln D_{iF} \quad \text{..........(2.5)}$$

$$\ln TC_{iSF} = \alpha_1 \ln L_{iSF} + \alpha_2 \ln K_{iSF} + \alpha_3 \ln D_{iSF} \quad \text{..........(2.6)}$$

Where;

$\alpha_1, \alpha_2, \alpha_3$ are the individual elasticities of labour, capital and land respectively.

$\ln L_i$ is the labour input from an individual farmer

$\ln K_i$ is the capital input from an individual farmer

$\ln D_i$ is the land acreage from an individual farmer

$\ln TC_{iS}, \ln TC_{iF}, \ln TC_{iSF}$ are the total cost of sugarcane production, total cost of food production and combined total cost of sugarcane production and total cost of food production from an individual farmer

From economic intuition, a firm's profit maximization objective entails either cost minimization at a given level of output or output maximization given the factor inputs through different combinations of resource use (Ebele & Nneamaka, 2018). Given that this theory assumes that firms produce a single homogeneous good; as the effect of one factor input is analyzed, the other factors are held constant, in the short run; the state of technology is assumed to be fixed and that the variable factor is continuously increased at the most minimal total cost. Given this fact, this study presupposed that there was the possibility of this kind of factor substitution and that the possibility of such substitution also depended upon the relative price level of the various factors. The one that is relatively cheaper was substituted for the one that was relatively more expensive. As such, profits can only be maximized if costs are minimized through the principle of least cost combination.

The principle of least cost combination suggests that a given output level can only be achieved using different combinations of at least two variable inputs. For this to be realized, the inverse price ratio of the factor inputs must be equal to their marginal rate of substitution.

2.3 Empirical Literature Review

2.3.1 Information Adoption and Utilization

Information communication and technology (ICT) development has had significant relevance on individuals and families due to its incorporation into the family's life and in work. This is because of their acquisition and ownership (adoption) and their subsequent use (utilization). According to Adeoye & Adeoye (2010), "adoption" denotes the stage in an organization where a family or an individual selects a technology for use. From the definition by Bridges to Technology Corp (2005), technology adoption begins with the user becoming cognizant of the technology, and ends when the user embraces the technology and completely uses it. Anybody who embraces technology is probable to find innovative uses for it, replace it should it break and cannot envisage life without it.

According to Varzaly & Elashmawi (1984) technology utilization denotes the expertise in using technological resources to attain instructional objectives and has great effect on the survival of the firm, especially where such technological variations are faster and dramatic and firms experience mass business failures due to their inability to maintain a competitive edge in technology utilization.

In the process of adoption, there has to be the creation of awareness and although the transfer of new information and technologies are supported by the production and distribution of printed materials; electronic media, radio and television plays a major role communicating the latest information in support of development (Nnadi *et al.,* 2012).

According to Springer (2001), what limits technology adoption and development by a small scale farmer is the absence of education, training and information. However, improvements on human capital lead into an improved and strengthened market systems production. Wongsim, Sonthiprasat & Surinta (2018), established that even though there has been an information revolution, such are yet to reach the majority of poor small scale producers in low-income countries. Because of this concern, this study evaluated how intense the information has been carried out among the sugar farmers within the Nyanza region and what role it plays on the interaction between sugarcane farming and food crop production.

In assessing the level of technology adoptability in sugarcane burning smoke plume mitigation in Louisiana, South Carolina, Flecher (2013), examined the possession and computer and/or internet use and assumed that the possibility of adoption of the sugarcane burn planner technology is higher for those who own and can access more internet-accessible devices. In conclusion, this researcher ascertained that the uptake and the usage of this technology was higher and this was due to the fact that it simplified the process, was faster, gave the appropriate information to the farmers, besides providing advice and incorporating the farmers' intuition.

In a study to analyze mass media utilization by farmers in Ikwere, Nigeria, Ani *et al.,* (2015) adopted a multi stage sampling technique, from a sample of 180 farmers. Their study established that television and radio were the most available while e-mail, internet and computer were the least used within the study area. The low usage of computer and internet may have been as a result of complexity in their use as well as the relatively high costs (Muto &Yamano,2009). Ani, *et.al.,* (2015) recommended that there was need to increase devices with high speed information dissemination. Although their study was done in Nigeria, their main objective was replicated in

Kenya and specifically in Nyanza region to see the level of adoption and utilization of information among the farmers since no such study has been documented among farmers in Nyanza region.

In evaluating educational level and technological adoption and use, Riddell & Song (2012) used Ordinary Least Square (OLS) and IV estimations to obtain the results among Canadian employees from 1999 to 2005. From their study, education was not significant in affecting computer-controlled or assisted technology use. This suggested that the level of education does not affect computer-controlled or computer-assisted technology use. In this study, focus was on the farmers and an open approach to information technology use was investigated as opposed to the closed environment in the working place.

According to GSMA (2019) report, the number of women in possession of mobile phones is significant in LDCs since 2014 and that the number of such ownership had risen to 80 per cent of women across these markets. In Kenya, Jumia (2019) reported that the level of mobile phones penetration is at 93%. With reference to radio penetration, Kenya National Bureau of Statistics [KNBS](2011) reported that the population had almost 80% access to a radio terminal. When it comes to TV and computer adoption, KNBS (2011) report indicated that access/adoption stood at 29.2% and 4.3% on TV and computers respectively. According to Li, Glass, & Records (2008) concluded that males use more technology than the females.

According to KNBS (2010), families with members who are over three years and possessed a radio were 33.1%, 18.2 % owned computers, 15.0 % had Television set and 7.4 % were connected to the internet. They established that use of radios were common among the less educated households while use of television was common among families with an educated head. Computer usage was common among households headed by the elites.

In evaluating information use by small scale banana farmers in Gatanga District, Kenya, Mwombe *et.al.,* (2013), used multistage purposive sampling method to choose 116 respondents. Their findings revealed that the most accessible information gadgets used in production and/or marketing of bananas were the radio, mobile phones and television. The least accessible information gadgets were computers, video cassettes and internet services. However, they established that the greatest impediment towards adoption and usage of information gadgets/ tools were the low education levels and the proximity to internet services. Besides, the farmers lacked money to buy the information gadgets and internet services. In concluding, they opined that further research on technology-specific attributes should be undertaken to meet the farmers' needs. Although their study evaluated the information utilization in Gatanga district and specifically dwelt on the banana farmers, this study expanded the scope and Apart from examine a specific crop farmer; it evaluated information adoption and utilization by all farmers within a larger sugarcane growing areas of Nyanza region.

2.3.2 Cost of Sugar Cane Production and Cost of Food Production

Sugarcane, species of herb belonging to the grass family with *Saccharum officinarum*, being its botanical name, belongs to the family of *Gramineae*. Many world economies use it as inputs in the production of alcohol, yeast, sugar and other derivatives. It grows to a height of 10-20 feet with a single plant bearing many thick, solid and aerial stems, coming in different colors ranging from white, yellow, black, dark green, purple, red or violet. The stems are jointed and the inter nodes are smaller at the base and increase in length, until it terminates in inflorescence (Ramashala, 2012).

In sugarcane production, Mendoza *et al.,* (2014) established that sugarcane production must be increased to serve the needs of the sugar mills. Such an improvement also leads to the betterment of the farmers' lifestyle. As such, the value chain analysis of sugarcane in Philippines, affirmed that good land preparation, sugarcane variety, proper scheduling of planting and fertilizer application, are critical in ensuring yields.

Bernardo *et al.*, (2019) analysed the various factors that were responsible for sugarcane productivity in Brazil. They applied bibliographical, documentary and shift-share quantitative method to decompose sugarcane production into the area effect and the productivity effect. From their findings, it was evident that production of sugarcane was mainly due to the increase in land acreage but not on productivity (Wiggins, Henley, & Keats, 2015).

Rout *et al.,* (2017) did a comparative study on costs and returns of sugarcane production in India. From their study, they ascertained that sugarcane production costs included the cost of land, the cost of bullock, machine charges, pesticides,seeds, fertilizers, transport charges and working capital. According to them, if land is increased, then the returns on sugarcane per acre also increase. From the results, they posted that bullock labour, and fertilizers on marginal, small and medium farms and human labour, fertilizer on large farms were significant in positively influencing the returns on sugarcane.

Islam *et al.,* (2016) investigated the economics of sugarcane farming in Bangladesh. They used primary information from 60 farmers and estimated profitability using gross return, gross marging as well as the cost benefit analysis. Using a Cobb- Douglas function, they established that human labor, urea and irrigation were positive and significant in determining the returns on sugarcane. However, organic fertilizer was established to significantly affect sugarcane returns negatively.

Hussain & Khattak (2011) investigated the socio economic variables responsible for the cost of sugarcane production in Pakistan. They used structured questionaires from a randomised sample of 50 farmers and gauged their perceptions on the effect of proper water management, weeding, application of chemical fertilizers, labour, land rent, seeds, irrigation and tractor use. The results indicated that land, labour, and tractor use were statistically significant costs in sugarcane production.

Nazir, Jariko, & Junejo (2013) also investigated the factors that affected sugarcane production in Pakistan. Their study was conducted among 387 sugarcane farmers between 2007-2008. Using a Cobb Douglas fuction, the results revealed that the costs of DAP, urea, land preparation, farm yard manure, weeding, seed application and irrigation costs, were the critical factors influencing sugarcane growers' returns. However, they also pointed out that sub optimal sugarcane production was also as a result of high input prices, lack of capital, low output prices and late payments. Besides, technical constraints for example land preparation, deficient scientific knowledge, seeds, insecticides, pesticides, natural calamities and insufficient irrigation, also contributed to the dismal sugarcane output.

There was a decline in sugarcane production among small scale sugar growers in South Africa. Because of this, Zulu, Sibanda, & Tlali (2019) investigated the factors that affected sugarcane production. They administered a structured questionaire to 100 small scale farmers and used a Cobb-Douglas function to find out the relationship. From the results, late harvesting, late fertilizer application and late chemical application were cited as the primary challenges that affected sugarcane production. However, labour and chemical application costs were positive and statistically significant in determining sugarcane production. Although Zulu, Sibanda, & Tlali (2019) study focused on technical efficiency, this study investigated the relationships of input costs of sugarcane from the direction of cost efficiency.

In order to attract private investment and generate employment, Olukunle (2016) investigated the profitability and competitiveness of sugarcane enterprises in Nigeria. Using both primary and secondary data, the author collected information on farm size, size of operations, equipment costs for storage, production and processing, revenues, fixed assets, labour (hired and family), prices for input and output, interest and wage rates and also used accounting method of measuring the competitive edge of the different firms by considering the production costs and the gross margins. From the analysis using frequencies and percentages, costs of fertilizer were dominating the overall cost of sugarcane. This was followed by the cost of hired labour, cost of renting equipment and the interest rates paid on accounts.

Dlamini & Masuku (2013) investigated the determinants of sugarcane profitability in Swaziland. They used secondary data sourced from 15 small scale sugarcane farmers associations from 2005 to 2011. These associations were sampled purposively based on the farmers' experience and multiple linear regression equation used to determine these determinants. In terms of profitability, analysis of costs and returns was used. From the results, it was determined that the farm sizes, labour and fertilizer costs as well as sucrose prices were significant determinants of profitability.

O'Kane (2011) reviewed the challenges facing the globe in terms of food sufficiency are numerous, amidst the growing population. These challenges include the declining arable land given land degradation, soil deterioration in terms of acidity and salinity, diversion of water from other potential areas, declining water quality and changes in biodiversity due to the extensive land clearing and climate changes as a result of modern industrialised agriculture.

While investigating the socio economic factors that affected agricultural development, Abah & Petja (2015) administered questionaires to 300 farmers who came from 15 farmers' cooperative societies in Benue, South Africa. They used descriptive statistics to generalize their results. From their findings, they concluded that lack of access to farm inputs, land and credit as well as farm sizes, worked together to threaten the future agricultural development in Benue basin. Ahmed *et al.*, (2015) ascertained that food production is negatively connected to the cost of transport and the road networks.

Di- Marcantonio *et al.*, (2014) assessed the impact of policy, governance and access to food production especially on domestic food availability. constructed on the secondary data from 1968 -2008, the study was conducted in 41 African countries. some of the indicators studied were agricultural inputs, urbanization and agricultural exports. From the OLS estimation, the results indicated that agricultural inputs such as land, irrigation and labour, were significant in influencing food productivity.

Food production and poverty are rife in Ethiopia and these situations are made worse by the ravaging droughts and inadequate public policy. Because of these, Alem-meta Assefa Agidew & Singh (2018) evaluated the determinants of food insecurity in the rural households. Using a multi stage sampling of 215 households, the authors used descriptive statistics and a simplified equation of a Household Food Balance (HFB) model that considers measuring the average daily food availability per person. The results indicated that the family size, labour force, relief support, agro ecological zone, farming experience as well as household head ages, are significant determinants of the rural food insecurity.

With regard to food production contribution given sugarcane farming, Mwavu, *et al.*, (2018) investigated the contribution of sugarcane cultivation has on household food production in Uganda. Focus was devoted to land use. They used an exploratory research design to interview 208 respondents. Data was analysed descriptively and the relationships determined by using chi square statistics. From their analysis, they pointed out that because of the commercial gains, majority of the farmers are not interested in sustaining their food production and therefore, suffer from lack of adequate and nutritious food. They concluded that the generation of income need not necessarily lead to increased food production since even those who practiced sugarcane farming were food insecure.   As a suggestion for further studies, they recommended for the analysis between the livelihoods components of smallholder farmers, natural resource governance and commercial sugarcane cultivation to stimulate future sustainability. Because of this, this study investigated the element of sustainability from the dimension of cost efficiency in the production of sugarcane and food crops. This study also used correlation as well as a multinomial regression model to establish a more robust relationship Apart from the use descriptive statistics.

Wiggins, Henley, & Keats (2015) investigated whether industrial crops and food production are competitive or complementary. This was because there was fear that cash crop production in Africa would displace food production. Concern was that small scale farmers would be exposed to market risks due to the dominance of the large firms. These indistrial crops were believed to have an effect on food production as witnessed from the perspective of food availability, access, utilization, stability and reliability. From their results, with increased cash crop production, food production from the perspective of availability had been sustained. Otherwise on access, households that practise cash crop farming may still suffer from low incomes because of lack of labour, land and capital to produce more. On stability, their report established that variations in the prices of industrial crops may cause instability on prices. this leads to labour switching to other areas.

Sulle & Smalley (2015) investigated sugarcane outgrowing on the livelihoods of the residents and stakeholders in Tanzania. They conducted interviews to 83 stakeholders. The report established that sugarcane growing stimulated business growth around some specific towns where it was being practised. Besides, returns from sugarcane have enabled the farmers to fund other crops, build houses and educate children. However, it was noted that the consequencesof expanding sugarcane plantation led to land scarcity and the costs of purchase of land also become expensive and continued expansion leads to the replacement of food crops.

Intarapoom, Srisompun, & Sinsiri (2019) used quantitative methodological approach to investigate the impact of sugarcane farmland on food production. This investigation was done among 357 households in Thailand. Primary data was used and the data collection instruments contained the dimensions of food production, namely food access, availability, stability and affordability. The study progressed by getting the quotient between the sugarcane planting area and the rice plantation area in the following manner; 100:0, 75:25, 50:50, and 25:75 respectively. From the report, results ascertained that households producing sugarcane, considering sugarcane to rice land ratio of 100:0; had low food production level than the rest of the groups while households with sugarcane to rice land ratio of 25:75; had the greatest food production level.

Gunatilake & Abeygunawardena (2011) considered food production as a contender in studying sugarcane bioethanol economic feasibility in India. They used secondary data that spanned 25 years. They ascertained that cost of bioethanol (generated from sugarcane) outdid the social gains, even after disregarding the opportunity cost of sugar production. They also ascertained that the production of sugarcane to make bioethanol also compromised food production and therefore recommended non- production of bioethanol using sugarcane juice since it was neither socially desirable nor economically feasible in India. In their study, three different regions with different climatic conditions were studied and this led to the existence of variances in production cost. In this study, the regions were chosen because they fall within the same geographical zoning and hence have the same climatic condition which then may result into the same cost of production. Being a cash crop, sugarcane production utilizes inputs like seeds, chemicals and fertilizers that mostly are purchased from the market. However, most if not all, of their output are taken to the market for sale. Because of their sturdier ties to foreign markets than food crops, they are prone to changes in exchange rates. Because of this, they may experience higher input prices for imported inputs and at the same time gain from the crop exports.

On the subject matter of continuous cropping of sugarcane, Mardamootoo *et al.,* (2010) studied the impact the usage of phosphorus fertilizer on agronomic phosphorus status of sugarcane soils in Mauritius. The results showed that such practices led to amplified soil acidity, depleted nutrients as well as condensed biomass and soil microbial activity if likened to other natural vegetation or agricultural land uses. This was due to over application of the fertilizer.

Complicating this state further, sugarcane production takes 18 to 24 months to mature. This period is too long and farmers can make more money by planting or intercropping other crops. However, not all crops can be intercropped with sugar cane except sweet sorghum, sugar beets or beans because of nitrogen fixation element in sugarcane farming (Geetha, Sivaraman, & Dhanapal, 2015).

As noted by Wafula *et al.,* (2010), the higher cost of sugarcane inputs leaves the farmer with less income than expected to fulfill other needs, among them, the purchase of food. Conversely, output price falls on cash crops can be quite sudden, and they may be due to harvest failures or even changes in regime. When these happen, the farmers become devastated since they are incapable of buying food or even taking their children to school (Cogneau & Jedwab, 2012).

While conducting a study in Mumias division, Kenya, Masayi & Netondo (2012) used purposive sampling to obtain the respondents among farmers and key informants aged 50 years and above and had resided in the area for 30 years. They concluded that commercial sugarcane farming reduced the vegetable varieties in the study area. Although there was a declining trend on the acreage of land, the descriptive statistics used could not address wholly the "the effect question" that their study purposed. The best response to such an issue was to draw a relationship and see the causal effect, which this study applied through the use of the regression.

According Khaleed (2000), agricultural land-use has created a green revolution that has seen food production in Asia increasing without a commensurate increase in food production. While investigating the income prospective of different crops on the livelihood of farmers in Nzoia and Mumias, Waswa, Mcharo, & Netondo (2009) established that there was competition for land use among different crops but which favored sugarcane and maize in exclusion of other native food crops such as sweet potatoes, tomatoes, cassava and onions and the result for this is the persistent food insecurity in these regions.

According to Pretty, Thompson, & Hinchcliffe (2000), there has been a spirited effort towards intensifying agriculture in a sustainable way in order to offer noteworthy chances of improving food production, external resources dependency reduction as well as lessening environmental degradation. However, production of food may not mean food production if access to food and people's rights cannot be improved. In the case of cereals, sustainable agriculture may not be possible because farmers follow the cobweb model and diversify into planting new crops in order to improve their yields thus curtailing land area under cereals. After converting to sustainable agriculture, farmers become so excited by the rise in productivity resulting into a glut in the following year. This glut results in price reduction which then results into loss making by the farmers. Farmers then react to this loss by reducing the acreage under cereals and moves into planting other crops. A scenario was witnessed in Taita Taveta, Kenya, where food production and nutritional status among the people improved following the introduction of traditional foods such as bananas, arrow roots, sweet potatoes, sugarcane and livestock zero grazing as well as fruit trees introduced by an NGO.

After Brazil, India is second in the production of sugarcane in terms of quantity and in acreage of land with the sugarcane cultivation occupying 4.94 Million Hectares. However, in a study conducted to establish cultivation costs and use of inputs in Telangana, Rao (2014), established that sugarcane crop, as compared to other crops; requires huge costs of production at various stages of production. These costs include labour, irrigation, fertilizers and pesticides, transport among others. This conclusion was arrived at after using statistical tools of percentages, averages and the simple correlation. Although this was the result, the element of cost was considered in absolute terms and no reference was considered per unit. As a result, this study incorporated the elements of cost per unit output.

In Kigali, it is strenuous to work in a sugar cane plantation and still be able to support a family since the wage rates are low. This situation has resulted in disaffection to the level where all year-round, labourers lament about deteriorating position and their inability to vary their food requirements since the emergence of sugarcane agriculture (Lankhorst & Veldman, 2011).

While conducting an ethnographic study in northern region of Fiji, Carswell (2003) examined the importance of family labor in sugarcane production and the linkage between paid and unpaid labour among small scale sugarcane farms. In the study, it was concluded that labour in this region was undertaken in a gang since majority could not pay laborers to work for them because of poverty. In as much as men were being paid for offering the services, women were hardly paid. As a result, income from the husbands could not sustain the needs of the family hence many families engaged in other economic activities to supplement their meager incomes. For the sake of reliability, ethnographic studies are usually unreliable and hence the need have a more robust approach that is more reliable. This study employed inferential statistics with observable data to make it become more reliable.

Nyanza and western regions in Kenya have astronomical poverty levels as well as the lowest human development indices (HDI) despite sugarcane farming being done within these regions. Society for International Development[SID] (2004) affirmed the narrative that commercial sugarcane farming is important in affecting the living standards of smallholder farmers. In relation to this finding, Waswa, Mcharo, & Netondo (2009) also performed a social survey among 88 farmers in Nzoia and Mumias on the land use patterns. They established that 56% of the total land was under sugarcane cultivation yet the farmers still risked famine and hunger due to the prolonged sugarcane cycle. This study included labour and capital as input in the agricultural production besides land use pattern that Waswa, Mcharo, & Netondo (2009) examined.

2.3.3 Cost Efficiency between Sugarcane Production and Food production

Cost efficiency refers to output production at least possible cost or the ability to produce the same output with minimal cost for a given input. One of the factors that determine the level of competitiveness of an enterprise whether big or small is the level of efficiency. This level of efficiency can be classified into three namely cost, technical as well as allocative efficiencies. These efficiencies lower per unit cost of production hence enables enterprises to supply their commodities at a reasonably lower cost (Karagiannis, Katranidis, & Tzouvelekas, 2008).

The motivation to study the element of costs, in this study, was prompted by a report by Omondi (2014) which ascertained that sugar firms, in Kenya, incur 78% in production cost even before processing begins, and out of this total, 52% goes towards procuring sugarcane and the rest of the 26% goes towards meeting other overhead costs such as transport, storage as well as bribes to political leaders as protection fee no matter how inefficient such sugarcane industries are (Ndii, 2015). In Kenya, sugarcane industries cannot meet national demand or even effectively compete in the international market because of cost inefficiencies in the region (Monroy, Mulinge, & Witwe, 2012).

According to Fatima & Yasmin (2016), expansion of efficiency in developing countries is vital for the general economic development. By using secondary data and adopting meta- analysis to estimate the efficiency and productivity levels of farms in Pakistan, Fatima & Yasmin (2016) used the technical score as the dependent variable to achieve their objectives. From the results, farms in Pakistan produced at 73% efficiency level. However, in this study, efficiency was assessed from the cost perspective and primary data was used in order to give a comparative view on which crops, sugarcane or food crops, the farmers experience levels of (in) efficiency.

Narayan (2004) conducted sugarcane production analysis in Fiji from 1970 to 2000 and used a time series data to explain the possible short and long run causes of sugarcane production. The author adopted the Cobb-Douglas function and examined land, labour and fertilizer cost as the factor inputs. From the results, all these factors affected output positively and significantly except labour. Although Narayan (2004) approached the study using time series data, this study explored the use of primary data and focused on stochastic frontier approach that takes into account the incidental error terms as well as the random error terms. Cobb –Douglas functions only focuses on the random error terms. Similarly, Narayan (2004) used the cost of fertilizers alone as a proxy for capital but this study expanded the meaning of capital in include all other inputs like weeding, pesticides, transportation and also the cost of repair.

While analyzing sugarcane production resource use efficiency in Kaduna state, Nigeria, Sulaiman *et al.,* (2015) used a multistage sampling technique to randomly select 330 respondents. The results showed that cutting farm size, labour, fertilizer, and agrochemical were positive but inelastic in affecting efficiency. However, the level of technical efficiency was found to be 89%. From this result, they concluded that the resource inputs used in the analysis were not used efficiently. Apart from the technical efficiency that Sulaiman *et al.,* (2015) investigated, this study examined the cost efficiency.

In analyzing sugarcane production efficiency among households in South Nyanza sugar company (Sony), Nyanjong' & Lagat (2012) selected 205 active sugarcane farmers through a multi stage sampling method. They applied a dual parametric stochastic decomposition technique to disaggregate the components of economic efficiency. From their results, they established that there were economic (cost) inefficiencies in sugarcane production was 37.5% among farmers in Sony out grower zone. Therefore, they recommended that in order to appreciate an increase in economic efficiency, cost savings of up to 40.95% was important. This study departed from Nyanjong' & Lagat (2012) study in that this study widened the scope and incorporated all the sugar growing areas in Nyanza, Sony out growers also included.

2.3.4 Information Adoption, Utilization and Crop Production

The essence of examining the role of information adoption and utilization on the cost of sugarcane production and food production was to consider its influence on the cost efficiencies in the production of these outputs. The effect was analyzed from the perspective of being a moderator as well as mediator variable.

With regard to the theory of production, a shift in the production possibility frontier is as a result of changes in the level of technology which is majorly influenced by the level of perfect information at the behest of the producer, in this case the farmer. Given this requirement, such information can only be availed to the farmers through the information gadgets such as radios, televisions, mobile phones as well as computers. Unless farmers adopt and make use of these gadgets, they may not be able to possess such knowledge and or information. Besides, in utility theory, satisfaction is often achieved when the marginal utilities are equivalent to the marginal rate of commodity substitution. This is always premised on the assumption of perfect information/ full knowledge of all the relevant information.

Incorporating information adoption and utilization in this study was premised on the suggestion of (Alastair, 2014). According to this author, the only way to address global challenge on food production is to adopt the digital/green revolution to meet the ambitious food productivity targets. Alastair (2014) established that changes in the climatic conditions, diminishing agricultural supply, increases in population, diminishing land and water supply coupled with changes in trade policies among the trading partners, are some of the major reasons why nations need to rethink about their food production requirements.

In context, this study defined information adoption and utilization as a mixture of both soft and hardware and how they interact to permit the interchange, processing and control of knowledge and information through the use of radios, computers, televisions, cell phones etc. (O'Farrell, 2015). In order to improve agricultural endeavors, there should be an improvement in the use of computers, remote sensing, internet, cloud computing, GIS and GPS (Food and Agriculture Organization, 2016).

In China, Daoliang (2017) ascertained that provision of information serves to encourage the use of agricultural technology processing; provision of openings and platform for knowledge swapping among farmers. Besides, they also help in creating and promoting professional groups for agro-meteorological database development, livestock and crop modeling.

While referencing Dike (2007), Gwang (2011) established that advances and globalization in technology in the 21st century helps in increasing the speeding and the exactness at which information is transferred, accessed, produced or even used in production. Besides, the author noticed that the use of information also elevates the position, the influence, the wealth and power of any given nation.

With changes in information technology in the agricultural sector, there may be improvements in the overall output either in sugar production as well as food crop production. According to Mileff (2015), computers alongside other telecommunication gadgets can be used in agriculture to store, retrieve, transmit or manipulate data in order to increase the level of efficiency in production. The author ascertained that if they are used well, then farmers can make better decisions, plan better, realize agricultural breakthroughs and also improve community participation. Milovanović (2014) ascertained that because the agricultural sector faces a myriad of challenges ranging from price fluctuations, deregulation of the agricultural market as well as volatility in the export market, they require a lot of information use to address these concerns.

Ali, Jabeen, & Nikhitha (2016) conducted a study on the impact of ICTs on agricultural productivity in Kapiri Mposhi district of Central Province, Zambia. They used multiple stage random sampling technique among 117 farmers and adopted OLS method of estimation to generate results. In their study, the results revealed that ICT usage was positive yet insignificant in affecting agricultural productivity. However, in this study, SFA and SEM were applied to generate more robust results as opposed to OLS method of estimation.

With respect to agricultural production, Dobermann & Nelson (2015) acknowledged that although population is increasing and food production is also increasing, agriculture still faces challenges and risks. Because of this, they suggested that cheap information and sustainable agricultural product must be initiated to increase agro ecological activities. Muriithi, Bett & Ogalleh (2009) also noted agricultural productivity still faces problems in terms of agricultural information access, efficiency and affordability among the small holder farmers. For these challenges to be overcome, innovative solutions that integrate ICT into agriculture must be exploited by incorporating such information in social media, internet, remote sensing, weather data, mobile phones and videos, Dobermann & Nelson (2015).

Although Chisita (2010) described some challenges that farmers go through to get information through the use of ICT in Harare, Zimbabwe; Jack & Tobias (2017) established that information alone is not a cure but a means of helping farmers to make informed decisions on agricultural inputs and selection of the best practices. Besides, such information accords farmers a bargaining power when interacting with buyers consequently transforming agricultural productivity.

Kwadwo & Mekonnen (2012) studied the role of evolving ICT use in agriculture in African. Their study was prompted by the lessons learnt in Asia. The main interest of their study was to examine how information access impacted upon the farmers' livelihood, agricultural productivity and the general agricultural practice. They explained that the use of ICT had the potential of changing an environment through socio economic transformation especially in Africa. In their study, they concluded that very little has been done in terms of the impact of ICT in agriculture.

Muto & Yamano (2009) examined the effect of mobile phones acquisition on farmers' sale in Uganda from 2003 to 2005. They adopted a panel data approach and from their study, they established that mobile phone coverage increased the sale of bananas in areas away from the study area. Nevertheless, the same effect was not realized with regard to the sale of maize. Therefore, they concluded that market involvement increased through mobile phones coverage to remote based farmers but only on the perishable agricultural commodities. In the same country, a study on the effects of information access efficiency on smallholder farmers led Abdul-Salam & Phimister, (2015) to observe that information access is significant in increasing agricultural productivity. In drawing their analysis and subsequent conclusions, Abdul-Salam & Phimister (2015) used a panel data to estimate the Stochastic Frontier Models. However, this study used cross sectional data and specifically adopted the path analysis to estimate the direct and indirect effects of the variables.

Raj *et al.*, (2011) investigated the use of mobile phone sms, voice call or web pages on the livelihoods of farmers in Nagapattinam district, Tamil Nadu state, India. They did this through customizing crop cultivation and nutrients management among the farmers. Their results showed that ICT use substantially reduced farmers' costs and also improved their farming practices. Compared to the control group, there was a 15.2% rise in income among the intervention group besides reduction of costs in terms of seeds, nutrient management, nursery preparation and weeding. Their study focused at the pre-harvest stage whereas both pre and post-harvest stages was the focus of this study.

By examining food production situation by 2030 and the part played by technology, science and innovation among developing counties, UN (2017) quoted UNCTAD (2012) report that assessed how information and communication technologies improved soil quality in Bangladesh. In this project, information service on fertilizer was launched in a mobile phone in the native language. The result demonstrated a 25% reduction in fertilizer costs as well as a 15% increase in yields. They recommended for the development of a digital skills on technologies that can boost food production.

In Kenya too, Apart from the traditional radio and television programmes that were used to disseminate information to farmers, other initiatives such as "Seeds4needs" was launched in 2009. This is an electronic farming method which was piloted in 2011 and used text messages to give advice to farmers on different hardy crop varieties, fertilizer use as well as crop management. The other available e-platform is the M-farm which has provided smallholder farmers with market pricing information through an SMS or mobile phone application. Since these initiatives began, only 5000 farmers have registered and the results have shown that farmers using then have realized a double rise in returns (Alastair, 2014). However, the report noted that the adoption and utilization of such a technology can be low if no funds or resources are devoted to their implementation. The inclusion of information adoption and utilization that this study preferred was as a result of such e-platforms to gauge the platforms' level of use among the farmers in Nyanza region.

According to Jumia (2019), the ICT sector has expanded from 10% to 22% in 2017. This expansion has contributed to 1.6% of GDP in 2018. Mobile phone adoption increased to 91% while penetration rate rose to 84%. Given these statistics, Raj *et.al* (2011) observed that mobile phones intervention are capable of increasing the farmers fortunes. The truism of these statements prompted the examination of the existence of the evidence among farmers in Nyanza region.

Usman & Ahmad (2018) investigated the role of learning, as a mediator, in the relationship between social capital and the adoption of best crop management practices among farmers in Pakistan. This investigation was done on 317 small scale farmers and a structural equation modeling as well as bootstrapping was used to test these relationships. From the results, it was evidenced that explorative and exploitative learning directly acted as mediators between social capital and adoption of best crop management practices but did not moderate between social capital and adoption of best crop management practices. According to the authors, exploitative learning inferred the refinery of the existing practices, processes, products, technologies and competencies without changing their nature while explorative learning involved the search and experimentation of the existing practices, processes, products, technologies and competencies. Although this study adopted a similar methodology to that of Usman & Ahmad (2018), the point of divergence was that this study investigated the costs related to the search for this knowledge. Besides, these costs were investigated against costs of two competing agricultural outputs.

Wang, Deng & Diao (2018) examined how farmers' application of pesticides are influenced by the market returns and external pressure in China. The authors also investigated the moderating role of information acquisition into this mix. While using a multi stage sampling method among 986 farmers, a hierarchical regression analysis was conducted to test the hypothesis. Their results indicated that there was a positive and significant effect on market returns, pesticide application and information acquisition. Similarly there was also a positive effect between external pressure and application of information on pesticide acquisition. Although information acquisition and its moderating ability was investigated by Wang, Deng & Diao (2018), this study examined the cost of acquisition and also the cost of utilization and besides investigating how this information was used in the application of pesticides, an extension was done to cover other phenomena in agricultural production such as marketing, labour choices among others.

Paitoon, Piraphong & Kittisak (2019) investigated the mediating role of intention for agricultural extension service (AES) knowledge plays on the influence of farmers accounting literacy on perceived crop yield in Thailand. In order to analyze this, the authors used Structural Equation Modeling (SEM) and Confirmatory Factor Analysis(CFA) among 300 farmers who were non purposively sampled. From the results, the relationship between the farmers accounting literacy and the perceived crop yield was significantly moderated by intention for AES knowledge. These authors recommended for the replication of this study away from Thailand. Although information moderation was the center stage in both studies, Paitoon, Piraphong & Kittisak (2019) used qualitative data in the determination of the constructs. In this study, quantitative constructs on information as well as in the other variables was used and although the crop yield was perceived, this study used read output.

Ismail *et al.,* (n.d) investigated the effect of economic indicators on agricultural productivity and the moderating role of support policies. Their main interest was to establish the relationship between agricultural input and output and the clear determinants of agricultural growth. This study was conducted in malaysia and ASEAN countries. The economic indicators investigated were the physical and human capital used in agriculture while support policies were proxied by farmer training, research and development as well as fertilizer subsidy. In their results, it emerged that support policy positively moderated the relationship between physical capital and agricultural productivity. Similarly, support policy also moderated the positive relationship between human capital and agricultural productivity. They recommended that future research should be done using primary data and also recommended the inclusion of other variables that enhance agricultural productivity such as technology and innovations. Based on Ismail *et al.,* (n.d) recommendations, this study incorporated a primary data and investigated the moderation and the mediating effect of cost of information in the analysis of agricultural productivity of sugarcane and food crops.

2.3.5 Coping Strategies to Food Insecurity

Food insecurity is complex since it is an integration of three (3) dimensions. These dimensions are food accessibility, utilization and affordability. According to Ahmed, *et al.,* 2015), food insecurity is not only as a result of insufficient food supply but also involves lack of purchasing power and access, at the household as well as at the national level.

According to Gitu (2006), the densely populated areas in Nyanza province have the highest levels of poverty and major causes to food insecurity were land fragmentation in large farm lands of Homabay and Migori and lack of income to purchase food requirements. As a result of this, there was a need to investigate the strategies used to circumvent food insecurity and also measure the level of its severity.

The approach used in the determination of coping strategies, that this study used, was rather methodological than being empirical or theoretical. This was because there are various measures used in the determination of coping strategies and the measurements of food insecurity severity. According to Devereux (2001), coping strategies defines the reactions to adversarial happenings or shocks. Conversely, it may also be used to mean “the deliberate actions that a household or a family uses to limit their expenditures in order to meet the provisions of their basic needs in order to maintain their societal welfare,” Snel & Staring (2001). Measurements of such adversarial happenings can be done through the Months of Adequate Household Food Provisioning (MAHFP), Bilinsky & Swindale (2010) or through the Coping Strategy Index (CSI), (CARE International, 2008).

According to Bilinsky & Swindale (2010), once the average of the households’ participation is established, the respondents identify the months (in the last 12 months) that they had no access to adequate food. The scoring of the months is done on a binary scale where months of access are scored “0” while months of inadequate access are scored “1”. The indicators are categorized into low, moderate and high. If the results are ≤ 9, then food access is low, if the value is 10-11, then food access is moderate but if the value is 12, then food access is high. However, the strategies to cope with food insecurity are divided into four namely; the strategies related to managing or rationing food shortages; strategies related to reducing the number of those who are supposed to eat; strategies to changing the diet from more expensive food to less expensive ones and lastly the strategies to adopting short tern financial solutions.

Cordero-Ahiman, Estrada, & Garrido (2018) studied food insecurity among 123 female respondents who were cross sectionally selected from 337 households spread across 38 communities in Mexico. Using a face to face interview, they adopted the Months of Adequate Household Food Provisioning (MAHFP) as a methodology. Their results indicated that 54.47% of the households had low access to food and used a variety of approaches to circumvent food shortages and these approaches mainly included the consumption of cheaper food stuff and reduction of food portions. However, the sample size they used was so low hence these results may not be representative. In this study, a representative sample size was used to draw results and the conclusions.

Ahmed *et al.*, (2015) examined the status and the determinants of small farming households to food production in Punjab, Pakistan. They used dietary/calorie intake assessment method (DIA) to calculate food insecurity among 576 households. This assessment was based on the respondents' recall for 7 days. From their analysis, conclusions were that 78% of the households had enough food while 22% had inadequate food. According to the logical regression analysis adopted, the conclusion was that food production was related, positively, to monthly income and inversely related to transport costs, health expenditure, debt and increases in food prices. Although the authors used DIA, they emphasised that the cost of its actualization is higher, hence the resolve to use the coping strategy index.

Uddin, (2012) conducted a study in Bangladesh among the marginal farmers affected by storm surge. From the findings, these marginal farmers compromised the frequency and amount of food they took as the most common coping strategy. This was then followed by taking loans and consuming wild uncultivated food.

Wagah, Obange, & Ogindo (2018) also used MAHFP methodology to assess the poverty level among 841 households in Kisumu, Kenya. They adopted questions linked to the lived poverty index (LPI) to determine the food insecurity situation. Such an index examines the frequency at which households encounter shortfalls in the basic needs and not necessarily food. Their study targeted settlements within the urban centres and from their analysis, they ascertained that 71% of surveyed households were modestly as well as or heavily food insecure. However, there was a departure from Wagah, Obange, & Ogindo (2018) study in that this study targeted households within agricultural settlements in Nyanza region.

According to CARE International (2008), the determination of the Coping Strategy Index, as a measure of food insecurity, is by summing up the average coping index. If the index is from 34 - 50, there is no food insecurity and the severity reduces as the value tends to 34; if the index is from 51-100, then there is food insecurity and the severity increases as the value tends to 100. This is the methodology that was adopted in this study to measure the different coping strategy and the severity index. This is because food production measurements are expensive and difficult because they are ever changing. The measure is endorsed because of its ease of use, analysis and its ability to provide actual information, (Maxwell & Caldwell, 2008).

To investigate the coping strategies to food insecurity and household involvement in agriculture among the Embo community in Kwazulu Natal, Mjonono, Ngidi, & Hendriks (2009) through the implementation of a survey questionnaire, used the coping strategy index (CSI) to study 200 respondents. From the results, it was ascertained that the people used a number of strategies ranging from reducing the number of meals in a day, relying on friends/relatives, borrowing food, among others. However, they also ascertained that agricultural contribution towards food production is not detached; therefore, other activities not related to farming were recommended for further studies.

While using a cross sectional design to study coping strategies to food insecurity Farzana *et al*. (2017) sampled 23,374 households in Bangladesh from 2011 to 2013. Coping strategy was investigated from the dimensions of financial and food compromises. According to them, they used household food insecurity access scale (HFIAS) and categorized the levels of food compromises into mild, moderate and severe. Multinomial logistic regression using financial coping as the base, showed that coping strategy through food adoption and financial strategies for families with modest food insecurity was 4.54 times higher and those with very serious food insecurity, it was 0.3 times lower hence the likelihood to adopt food and financial compromise as to survive.

In Tanzania, among poor household such as those in small businesses or petty trading and casual labour, sale of livestock, charcoal burning and carpentry are some of the coping strategies to food insecurity (Ngongi, 2013). This result was arrived at after using a primary data sampled from 150 farm households chosen from a population of 3,796 farm households living in Kahama district, Tanzania. In that study, there was a concern on whether the area covered was representative enough and thus recommended for an expansion of the area of study. This is what this study set out to do by expanding the scope of coverage and therefore examining the 3 counties in Nyanza region in Kenya.

In Uganda, Mwavu *et al.,* (2018) used a descriptive statistics to analyze the coping strategies employed by farmers to cope with food insecurity. From the results, they reported that most of the farmers offered their labour for food. Some borrowed or rationed food and sometimes even stole from their neighbours. However, Mwavu *et al.,* (2018) report did not determine the level of severity, a gap that was filled by this study.

2.4 Summary of Literature

This study investigated the role of information adoption and utilization costs on the relationship between sugar cane production costs and food production among farmers in Nyanza region, Kenya. This was against the backdrop of specifically analyzing the extent of adoption and utilization of information; determining the relationship between cost of sugarcane production and food production; determining the cost efficiency level between sugar cane production and food production; assessing the effect of cost of adoption and utilization of information on the relationship between cost of sugarcane production and food production as well as examining the coping strategies to food insecurity among farmers in Nyanza region, Kenya.

This study adopted and modified the cost minimization theory. The theory examines a simple cost minimization aspect and the possibility of factor substitution based upon the relative price level of the various factors used in the production process. In this case, the cost of labour, cost of land and the cost of capital were incorporated. The Cobb Douglas function was adopted but modification was done by linearizing this function. Although, the cost of production entails the cost of land, capital, labour, entrepreneurship and technology, considerations were accorded to the cost of main and compulsory agricultural outputs namely labour, capital and land while the cost of technology and entrepreneurship were fixed at least in the short run. Herein, the cost of information adoption and utilization was investigated to observe whether they acted as a catalyst towards resource allocation made in sugarcane or food production or not.

With reference to information adoption and utilization, Bridges to Technology Corp (2005) as well as Varzaly & Elashmawi (1984) definitions were adopted. Although studies have recommended for the adoption and utilization of information, Riddell & Song (2012) conducted a closed door study of employees, Mwombe *et al.*, (2013) conducted their study among banana farmers while Ani *et al.*, (2015) conducted their study in Nigeria. In this study, area of study was domesticated in Kenya and openly operationalized the findings among sugarcane and food crop farmers.

On the determination of the relationship between cost of sugarcane production and food production, most studies observed factors that either affected the cost of sugarcane production separately or those that affected the cost of food crop production separately. Where the two crops were studied together, the outcomes relied on perceptions and not measurable facts. This study considered the costs that are perceived to influence the production of sugarcane and food crops and their association upon each other was investigated crop wise and also jointly.

On the issue sugarcane production and food production efficiency, Narayan (2004), used time series data and Cobb Douglas function, Fatima & Yasmin, (2016) assessed the technical efficiency while Nyanjong' & Lagat (2012) narrowed the scope by examining cost efficiency in Sony out-grower zone. Given all these, this study dwelt on the cost efficiency and adapted the use of primary data and adopted the stochastic frontier analysis approach that takes into consideration both the incidental and random error terms besides widening the scope to investigate all the sugar belts in Nyanza region which also included Sony out grower zone.

Regarding the objective of information adoption and utilization in agriculture, Springer (2001) and Alastair (2014) concluded that it was necessary in increasing the level of output by promoting the use of knowledge providing opportunities and platforms for exchanging knowledge. However, Wongsim, Sonthiprasat, & Surinta (2018) established that such information are yet to cascade to the small scale farmers. Besides examining the pre harvest period Raj, *et.al*., (2011); Ali, Jabeen, & Nikhitha (2016) used OLS to draw their conclusion, while Abdul-Salam & Phimister (2015) used stochastic frontier model to estimate a panel data to also draw conclusions. In this study, emphasis was placed both on the pre harvest and the post harvest use of information and considered cross sectional primary data and used path analysis to measure the levels of dependence among the various constructs in the measurements of information. besides, there is no study that has dwelt on investigating moderation or mediating effect among two competing agricultural products.

On the coping strategies to food insecurity, a well laid down procedure that examines four main measurements of the different coping strategies to food insecurity are clearly laid down by Bilinsky & Swindale (2010). Most of the studies on the coping strategies adopted the Months of Adequate Household Food Provisioning (MAHFP). However, investigations into the literature revealed that Cordero-Ahiman, Estrada, & Garrido, (2018) used smaller sample size; Wagah, Obange, & Ogindo (2018) investigated the urban households. Because of the ability to give real time information, this study adopted the CSI. Besides, the rural agricultural households (where food insecurity is more pronounced) were investigated and the study area was expanded to cover three counties in order to make this study be more representative.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines how this study was carried out. Included herein are the research philosophy, research design, area of study, target population, sampling procedure and sample size, data collection methods, validity test for data collection instrument, reliability test for data collection instrument, methods of data analysis and ethical considerations.

3.2 Research Philosophy

This study was based on positivist philosophy. Such a philosophy entails operating with social realities that are observable and which can be generated into law – like generalizations. Research philosophy is the development of knowledge which need not lead into a new theory but which can be used to solve a particular problem (Saunders, Lewis, & Thornhill (2009).

The inclination towards positivist philosophy arose from the epistemological measurements of observable facts on the variables that this study chose. Such observable and measurable characteristics inclined towards the production of reliable and meaningful data. Besides this, the determination of the relationship between cost of sugarcane production and cost of food production; the cost efficiency level between the cost of sugar cane production and cost of food production and the assessment of the moderating as well as the mediating effect of cost of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya, bordered on the "causal-effect" and therefore the results generated were helpful in explaining and predicting the behavior patterns among the farmers in Nyanza region. Likewise, the whole study was premised on the cost theory do develop various tesTable hypothesis.

3.3 Research Design

This study adopted correlational research design because the design is helpful in providing a rigorous and replicable procedure for understanding relationships as well as direction of association between quantifiable variables (Oso & Onen, 2009). This study specifically investigated the role of cost of information adoption and utilization on the relationship between the cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya.

3.4 Study Area

The study was done in Nyanza region, Kenya and lies along latitudes 0°15'N and 1°45'S and longitudes 35°15'E and 34°E. Western region borders it to the north, rift valley region is on the east, Uganda to the west and Tanzania to the south, (Jaetzold, Schimdt, Hornetz, & Shisanya, 2009). It is one of the eight Kenya's administrative provinces before the promulgation of the constitution in 2010. Its administrative functions were devolved to the six counties, namely Kisumu, Homabay, Kisii, Nyamira, Siaya and Migori. The region is dominated by the Luos but also contains the Kisii/Gusii, the Kuria and the Luhya totaling to 5,442,411 people and it is considered one of the poorest regions in Kenya (Kenya National Bureau of Statistics , 2011). According to World Bank (2018), the absolute poverty and extreme poverty in Nyanza is 36.7% and 6% respectively. The region is humid and experiences a lot of climatic and weather inconsistencies which affects its agricultural sector and food production (Macoloo *et al.*, 2013). According to Rao, *et al.* (2015), the major cash crops grown in the region are sugarcane, coffee, tobacco and cotton. It is home to Muhoroni, Chemelil, Sukari, Sony, Kibos and Transmara sugar companies. The major food crops planted in the region are sorghum, rice, beans, cassava, maize and sweet potatoes (ICT Authority, 2017).

3.5 Target Population

The target population was 73,000 farmers. This population comprised of both the sugarcane farmers and food crop farmers since the two crops are complementary to each other (Wiggins, Henley, & Keats, 2015) and majority practice them together. Complementarity is exhibited on issues to do with factor inputs for example fertilizer use where food crop production can benefit from fertilizer use in cane production if a farmer is practicing rotational farming. Because of this, it was not easy to isolate a pure farmer type. This population was derived from the four major sugar belts spread across three counties in Nyanza region. Kisumu County has two sugarcane zones namely Chemelil and Muhoroni; Homabay County has Ndhiwa zone while Migori County has Sony zone. The distribution was as follows:-

Table 3.1 Target Population

Zone	Number of farmers	Percentage(%) proportion
Muhoroni	16,000	21.92
Chemelil	5,000	6.84
Sony	25,000	34.25
Ndhiwa	27,000	36.99
Total	73,000	100

Source: Muhoroni, Chemelil and Sony Sugar company websites

3.5.1 Sample Size and Sampling Procedure

This study used multistage random sampling technique. The design entails sub division of the population of interest into some smaller population called strata, and sample selections done autonomously across each stratum (Oso & Onen, 2009). Fienburg (2013) explains that sub populations that form a stratum are the domains of a study and thus separate information/ estimates are needed for each stratum.

In this study, Farmers were clustered according to the sugar belts that they came from (Chemelil, Muhoroni, Ndhiwa and Sony). These farmers were re-grouped according to their farming practices (either sugarcane or food crop farmers). From the various groupings, a total of 384 samples of both sugarcane and food crop farmers were selected (refer to equation 3.1) from a combined target population of 73,000 farmers in Nyanza region. Because it is expensive to gather quantitative data from an entire population Becker (2008), the target population was decomposed into small sample frames in order to reduce such cost and use the results from such samples to generalize information about the targeted population. Identification of the farmers was achieved through the assistance of the research assistants who were seconded by the area chief.

Those targeted were farmers above 25 years with more than 5 years experiences in farming or more. From this target group, simple randomization was used to undo bias. Just in case the sample did not totally/exactly match real owners of sugarcane or food farms within these regions, a 5% margin of error was accorded to the sample selected (Oso & Onen, 2009).

Based on Mugenda & Mugenda (2003), calculation of a sample size from a population 10,000 or more, can be done using the Cochran (1963:75) formula as follows,

$$N = \frac{pqz^2}{e^2} \quad \text{……………………………………………………………………………(3.1)}$$

Where;

$p =$ Population proportion with given characteristic

$n =$ Minimum sample size

$q = 1 - p$ i.e. the estimate of the variance

$z =$ Standard deviation on the confidence level

$e =$ Margin of error

Because this study assumed a 95% confidence level, $z = 1.961$ and $e = \pm 0.05$, the formula below was used to calculate the sample size.

$$N = \frac{(0.50)(0.50)(1.96)^2}{0.05^2} = 384$$

From the above calculation, 384 farmers were selected and distributed proportionately according to the farming population within the three (3) zones. As a result, the sample size from each of the three zones was distributed by considering the product of the percentage proportion in Table 3.1 and total sample size. The result was as follows:

Table 3.2 Sample Size

Zone	**Sample Size**
Sony	132
Chemelil	26
Muhoroni	84
Ndhiwa	142
Total	384

Source: Survey Data (2020)

3.6 Type of Data

Quantitative primary data was used in this study. Primary data was preferred because they were assumed to be original and their degree of accuracy was high and realistic (Hox & Boeije, 2005).

3.6.1 Data Collection Procedure

This study used quantitative data collected through multistage sampling techniques. The approach was chosen because it made generalizations much easier and practical for collecting primary data (Bacon-Shone, 2015). It is also flexible and since they can lead to subdividing the population as many times as possible (Fraenkel, Wallen, & Hyun, 2012). The methodology was economical and investigative (Nachmias & Nachmias, 2009).

Although other forms of collecting primary data exists, Mathers, Fox, & Hunn (2007), this study used structured questionnaires. According to Abawi (2013) questionnaires contain a chain of questions and other prompts that aided in collecting information from respondents. The questions that were asked, in this study, were precisely decided in advance and asked in the same sequence and style to all the respondents to avoid potentially embarrassing moments since Trueman (2015) opined that the questionnaires must be standardized and explored if potentially embarrassing moments are to be avoided. Debois (2016) indicated that structured questionnaires are comparatively faster, simple to formulate; code and understand hence the reason why this form of data collection was chosen.

These questionnaires were constructed both in closed and in open ended format (Reddy, 2011). Closed ended format took the form of multiple choices and users were constrained to answer as per the options given. They were made easier and quicker to answer, compare and analyze (Wyse, 2011). Open ended format was also used since it gave the participants an avenue to give their opinions and suggestions freely (Trueman, 2015). Two formats were used concurrently in the construction of the closed ended format. The first format involved the likert scale which grouped information at intervals of 1-5 with 1 assuming the worst case scenario and 5 assuming the best case scenario. In the second format, nominal approach was adopted especially on the bio data where a binary of 0 and 1 was used to categorize such information. Secondary data that was gathered from government website e.g. Government of Kenya, and other relevant institutions involved in agriculture and food production matters e.g. Food and Agriculture Organization, Kenya Sugar Board,United Nations, were used as reference points.

Once the questionnaires were prepared and validated, they were batched together and administered after an introductory letter from Maseno University Ethical Review Committee (MUERC) was received. Training, on how to administer these questionnaires, was done to ten (10) research assistants. Given the different dialects within the study area, careful choice of these research assistants was done to enable easy interpretation of the research questions and to also ensure better results (Hutchinson & Moran, 2005).

Once the introductory letter was issued, permission was sought from the respondents before commencing the data collection. After data collection, the research assistants thanked the respondents for their support.

3.6.2 Testing for Reliability

The Reliability of the data instrument was achieved through the use of Cronbach's alpha. According to (Joppe, 2000), an instrument is reliable if it can be replicated over time and can be measured through its internal consistency and stability (Trochim, 2006). Through a test retest, stability can be achieved. A higher degree of stability reflects a higher reliability and vice versa (Trochim, 2006).

According to Mohsen & Reg (2011) internal consistency examines how items in a group are closely related and measurement of this closeness was achieved through the use of Cronbach's alpha given by the formula below:

$$\alpha = \frac{N \times \bar{C}}{\bar{V} + (N-1)\bar{C}} \quad \ldots\ldots(3.2)$$

Where;

N = The number of items.

$\bar{C} =$ The average covariance between item-pairs

$\bar{V} =$ The average variance

As a rule, the following considerations are adhered to:

Table 3.3 Interpretation of Cronbach's Alpha

Coefficients	Verdict
Greater than 0.9	Excellent
Between 0.8- 0.9	Good
Between 0.7- 0.8	AccepTable
Between 0.6-0.7	Questionable
Between 0.5-0.6	Poor
Between 0-.05	UnaccepTable

Source: Mohsen & Reg (2011)

However, high values for Cronbach alpha is not a unidimensional measure. This is to say that they are measuring only one latent variable.

The result for internal consistency was good as seen from the Table 3.4. Although the Cronbach coefficient for information adoption was less than the global average, given the limited number of the items within the subscale, it was considered adequate.

Table 3.4 Reliability Statistics

Item	Items	Cronbach Alpha
Sugarcane	49	0.808

Food production	41	0.773
Information adoption	4	0.565
Information utilization	10	0.867
Coping strategies	12	0.808
Global average		0.757

Source: Survey Data (2020)

A pilot test was conducted to measure the stability of the data instrument. This test was done in Mumias since this sugarcane growing area has a population that exhibits fairly the same characteristics as those that the study worked with.

3.6.3 Testing for Validity

According to Field, (2005) validity refers to a situation where the outcome measures exactly what it is suppose to measure. Joope (2000) in Lakshmi & Mohideen (2013) classified validity into three namely content, construct and criterion validity.

Content validity judges how suiTable items in the questionnaire are measuring the objectives of the study from the viewpoint of the experts, Yaghmale (2003). Cardinal questions in content validity are whether data collection instrument contains everything it should and nothing it should not. It also examines how well the constructs are measured in the data collection intruments. It can be established through internal consistency and opinion of judges (Trochim, 2006). In the opinion of Eaves & Suzanne (2011) criterion validity is the level in which a particular measure forecasts or approximates another in terms of behaviors, events, outcomes or attitudes.

This study adopted the content validity by sending the questionnaires to the supervisors for purposes of verification, precision and significance. The supervisors compared the contents in the questionnaire and the objectives that this study intended to achieve. Through this approach, additional information that lacked in the questionnaire but which were of relevance to actualize the objectives, were added. The questionnaire that was ultimately used ensured that everything that ought to have been measured, were actually measured.

3.7 Model Specification and Estimation

3.7.1 Extent of Information Adoption and Utilization

Descriptive statistics was used to analyze this objective because they were useful in describing the elementary characteristics of data in a more summarized manner. This was achieved by examining the measures of the central tendency (mean, kurtosis and skewness) as well as the dispersions (standard deviation). In this study, the extent of information adoption and utilization inferred the degree to which mobile phones, radios, TVs and computers were owned and used by the farmers in Nyanza region.

Apart from establishing information adoption and utilization among the farmers, generally, this study also addressed the extent of adoption and utilization with respect to gender, education strata and farmer type. To obtain the actual measure of this objective, the results were categorized given weights according to the six categories classified as shown in Table 3.5.

Table 3.5 Categorization of the Extents

Category (%)	Extent	Weights
0	No extent	0
1-20	Small extent	1
21-40	Some extent	2
41-60	Moderate extent	3
61-80	Great extent	4
81-100	Very great extent	5

Source: Fagenson-Eland, Ensher, & Burke, (2004)

3.7.2 Relationship between Cost of Sugarcane Production and Cost of Food Production

In order to establish the relationship between cost of sugarcane production and cost of food production, this study employed the use of correlation analysis (to confirm the degree of association) and regression analysis (to establish the relationship) by using the Structural Equation Modeling (SEM). SEM established the links between the various constructs in sugarcane production and food production. These constructs were the cost labour, cost of land and cost of capital. According to Cherry (2019), the determination of the "cause-effect" relationship between variables is best done by examining the levels of correlation (association) and regression analysis to gauge the direction of association and magnitude of such association through a linear model.

Given that there were a number of factors involved in generating the constructs, this study broke down the analysis of correlation into four parts. Part (1) investigated the correlation between the factors that comprised sugarcane production costs. These costs were the costs of labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs. Part (2) involved the investigation of the factors that formed the constructs in the cost of food production and similarly, the cost of labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs used in food production was analyzed. The formula was given as follows

$$r = \frac{n(\sum_{i=1}^{n} x_i y_i) - (\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} y_i)}{\sqrt{\left[n\sum_{i=1}^{n} x_i^{2} - (\sum_{i=1}^{n} x_i)^2\right]\left[n\sum_{i=1}^{n} y_i^2 - (\sum_{i=1}^{n} y_i)^2\right]}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.3)$$

Where;

x_i and y_i represented the costs of factors of production (labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs) per farmer that influenced the constructs in the cost of sugarcane production and the cost food production in part (1) and (2) respectively.

n = Number of observations

Correlation analysis assessed the existence of a linear association between the variables. It normally rotates around -1 and + 1. Correlation of +1 is a signal for the existence of a strong positive association while correlation of -1 signals the existence of a strong negative association. Correlation coefficient approaching zero points to a weak association or no association at all. Less than 5% probability values are indications of significant correlation.

Part (3) involved the categorization of these costs into the cost of labour, capital and land used in sugarcane production and food production respectively. Once the sums were generated, correlation analysis depicting the cost of land, labour and capital was performed on the cost of land, labour and capital used in food production to study the trade-offs.

Finally, in part (4) all the costs in sugarcane production were summed together to form the overall cost of sugarcane production and similarly, all the costs in food production were also summed together to form the overall cost of food production and correlated.

Once correlation was established, a regression analysis to establish the relationship was done using the Structural Equation Modeling shown in figure 3.1 below;

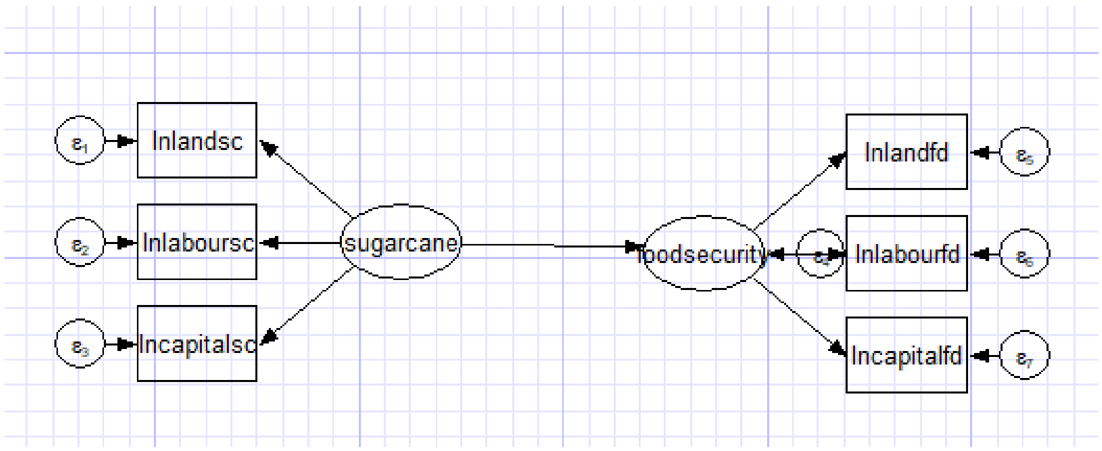


Figure 3.1 Relationship between Cost of Sugarcane Production and Food production

According to figure 3.1, cost of sugarcane production contained three constructs namely the cost of land, the cost of labour and the cost of sugarcane. On the other hand, the cost of food production also contained the cost of land, cost of labour as well as the cost of capital as its constructs. The arrow from sugarcane to food security is the investigative indicator from the independent variable to the dependent variable.

3.7.3 The Cost Efficiency Level between Sugar Cane Production and Food production

This study adopted a multinomial logit model and stochastic frontier analysis (SFA) as method of estimation premised on the assumption that farmers always tend to optimize their profits, output as well as to their cost. However, not all producers succeed in solving their optimization endeavors in all circumstances. Such inabilities may stem from the farmers' inefficiencies or random shocks even if they are given the same inputs and technology (Kumbhakar & Lovell, 2000). Such random shocks or inefficiencies may be due to the wrong choices that are likely to be made by the farmers in the process of production. Removal of such inefficiencies through best technology adoption has the potential to increase productivity (Ghebru & Holden, 2015).

According to Kokkinou (2010), consistency of stochastic frontier approach with the theory, their versatility as well as the relative ease of estimation, has made it become popular and accepTable within production economics, hence a modified cost function was used since it portrays a better forecast in production. It also portrays a better linkage between possible outputs and two or more factor inputs (Price, 2017). The cost of the factor inputs was considered since the cost functions allows an analyst to play around with multiple inputs in analyzing efficiencies.

The total cost function is given as below (Emerson, 2019).

$TC(L,K) = w_1 L + w_2 K$ ………………………………………………………………………. (3.4)

Where;

TC = The total cost given the cost of Labour and cost of Capital inputs.

L = The quantity of labor used (measured in hours)

K = The quantity physical capital input

w_1, w_2 = The prices of labour and capital respectively

$w_1 L$ = The cost of labour

$w_1 K$ = The cost of Capital

In this study, equation (3.6) was modified to consider a general cost function involved in producing either sugarcane, food crops or both, depending on the farming type encountered. These costs were measured per yield. As such, the general cost function was given as follows;

$TC_{iS} = AL^{\alpha_1} K^{\alpha_2} D^{\alpha_3} \mu^{\varepsilon_i}$ ……………………………………………….(3.5)

Where;

TC_{iS} = The total cost of sugar cane produced (in shillings) given the cost of factor inputs

L_i = Cost of labor used. These are the man hours times the cost per day per yield

K_i = Cost of capital per yield. These are the particular machine times cost of purchase or hire

D_i = Cost of land used. These are the cost of land per acre

ε_i = The error term was assumed to have a zero mean and a constant variance. It is meant to take care of the changes in whether patterns, production mistakes as well as any other factor that is beyond the control of the farmer.

The stochastic functional form equation was obtained by getting the logs of equation (3.5) and was expressed as follows;

$$TC_{iS} = \ln A + \alpha_1 \ln L_i + \alpha_2 \ln K_i + \alpha_3 \ln D_i + \varepsilon_i \quad \text{……………………………………………….(3.6)}$$

Where;

$\ln A$ = Cost efficiency component

$\alpha_1, \alpha_2, \alpha_3$ = Coefficients of input costs of labour, capital and land for a farmer

ε_i = Error term from an individual farmer and contains both the random error and the inefficiency error

i = The cross sectional inputs from an individual farmer

Because the variable estimates were measured in Kenya shillings but the summation of the total costs were 3- 6 figures, they were log transformed. The log transformation is widely used to address skewed data, and due to its ease of use and popularity, it is mostly used in research, (Changyong, et al., 2014). Ln(Y) is often used to denote the natural logarithm of a number Y. Ln(Y) is defined as the power that is required to raise e in order to end up with Y ; i.e. $e \log(Y) = Y$.

.

Given that there were sugarcane farmers, food crop farmers as well as those practicing mixed farming, cost estimates were considered separately for the 3 outputs. Equations (3.9; 3.10 and 3.12) were formulated to represent the costs of sugarcane production, food production and mixed farming respectively. The assumption was that they were correctly specified since if mis-specified, the equations may not justify the linkage between the exogenous and the endogenous variables (Tastan, 2012).

$$\ln(TC_{Si}) = \alpha_0 + \alpha_1 \sum_{si=1}^{n} \ln(L_{Si}) + \alpha_2 \sum_{si=1}^{n} \ln(K_{Si}) + \alpha_3 \sum_{si=1}^{n} \ln(D_{Si}) + \varepsilon_{si} \quad \text{……………………(3.7)}$$

Where:

α_0 is the cost efficiency in sugarcane production

$\alpha_1, \alpha_2, \alpha_3$ were the coefficients of labour, capital and land respectively;

$\ln(L_{Si}), \ln(K_{Si}), \ln(D_{Si})$ were the cross sectional independent variables on cost of labour, cost of capital and cost of land, respectively, on sugarcane and represent the deterministic part of the frontier;

$\ln(TC_{Si})$ was the cost of sugar produced;

$\varepsilon_{Si} \sim N(0, \sigma^2{}_s)$ is the error term in estimating cost of sugarcane production.

s_i is the individual sugarcane farmer.

After examining the reaction of the cost of labour, land, and capital in sugarcane production, the effects of the production parameters were examined on the cost of food production as per the equation below:

$$\ln(TC_{fi}) = \beta_0 + \beta_1 \sum_{fi=1}^{n} \ln(L_{fi}) + \beta_2 \sum_{fi=1}^{n} \ln(K_{fi}) + \beta_3 \sum_{fi=1}^{n} \ln(D_{fi}) + v_{fi} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.8)$$

Where:

β_0 is the cost efficiency in food production

$\beta_1, \beta_{2,} \beta_3$ were costs coefficients of labour, capital and land used in food production per yield per farmer

$\ln(L_{fi}), \ln(K_{fi}), \ln(D_{fi})$ were the actual cross sectional costs for labour, capital and land used in food production.

$\ln(TC_{fi})$ was the cost of food produced per yield;

$v_{fi} \sim N(0, \sigma^2{}_{vf})$ was the error term in measuring the cost of food production.

fi is the individual food crop farmer.

The practice of mixed farming was conceptualized based on the land use/system change theory. This theory examines the usage of land among competing elements as was enshrined by (Smith, 2013). As encapsulated by Otieno & Muchapondwa (2016) , land use theory suggests that an individual/ farmer always chooses a particular farming practice (determined by the biological, physical, social or economic reasons) that generates the highest profits, although, profit motive is never the only motive (Rufino, Reidsma, & Nillesen, 2011).

Given a particular land size (Ls), Otieno & Muchapondwa (2016) assumed that a profit maximizing landowner can include livestock (L_l) and wildlife (L_w) in the same land over time such that;

$$L_{lt} + L_{wt} = Ls \quad \text{………………………………………………………………………………(3.9)}$$

Instead of analyzing livestock and wildlife, this study modified equation (3.12) to read sugarcane and food production under the assumption that those farmers undertaking mixed cropping are assumed to either allocate their factor inputs to produce both sugarcane and food crops in order to maximize their utility and hence avoid risks that may be associated with cultivating only one aspect of an agricultural produce. Again, this study assumed a case of no intercropping.

Hence the ultimate modified equation was given as;

$$TC_{(S_i,F_i)} = F_{(L_i,K_i,D_i)} + S_{(L_i,K_i,D_i)} \quad \text{…………………………………………………………(3.10)}$$

Where;

$F_{(L_i,K_i,D_i)} =$ Total cost of food output arising from the factor inputs disposed to food production i.e. $F_{(L_i,K_i,D_i)} = \sum_{i=1}^{n} L + \sum_{i=1}^{n} K + \sum_{i=i}^{n} D$

$S_{(L_i,K_i,D_i)} =$ Total cost of Sugarcane output arising from factor inputs disposed to sugarcane production i.e. $S_{(L_i,K_i,D_i)} = \sum_{i=1}^{n} L + \sum_{i=1}^{n} K + \sum_{i=i}^{n} D$

$T_{(L_i,K_i,D_i)} =$ Total cost arising from the factor inputs at the disposal of the farmer.

Therefore, if the farmer chooses to plant food crops, then all his/her resources are devoted to food crops only and vice versa and incase he/she chooses to do both, then resources would be allocated according to the profits each product generates, less the cost of conversion.

In this study, the choice between what to produce by a farmer practicing mixed cropping depends on the past experience with regard to the levels of costs incurred which by extension, is affected by the levels of return and therefore equation (3.11) above was modified to include three variables. The dependent variable $T_{L,K,D}$ was proxied by total quantity of sugarcane and food produced whereas the independent variable $F_{L,K,D} + S_{L,K,D}$ were proxied by the total factor inputs devoted towards sugarcane and food crops. The modified equation was expressed below;

$$\ln TC_{(S_i,F_i)} = \delta_0 + \delta_1 \sum_{(f,s)=1}^{n} \ln(L_{fi} + L_{si}) + \delta_2 \sum_{(f,s)=1}^{n} \ln(K_{fi} + K_{si}) + \delta_3 \sum_{(f,s)=1}^{n} \ln(D_{fi} + D_{si}) + u_{(f,s)i}$$

……………………………………………………………………………………..(3.11)

Where;

$\ln TC_{(S_i,F_i)}$ = The total cost of sugarcane and food crops production per yield from an individual farmer;

$\ln(L_{fi} + L_{si})$ = The overall labour cost in sugarcane and food crops production;

$\ln(K_{fi} + K_{si})$ = The overall cost of capital in sugarcane and food crop production;

$\ln(D_{fi} + D_{si})$ = The overall cost of land in sugarcane and food crop production;

$\delta_1, \delta_{2,} \delta_3 =$ The coefficients of costs of labour, capital and land used in sugarcane production and food production respectively;

$u_{(f,s)i} \sim N(0, \sigma^2{}_{u(f,s)}) =$ The error term

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

3.7.4 Role of Information Adoption and Utilization on Cost of Sugarcane and cost of Food Production

3.7.4.1 Cost of Information Adoption as a Moderator

A moderating variable alters the strength or direction of an effect between two variables either by improving, decreasing or altering the effect of the independent variable (Fairchild & MacKinnon, 2009). It is a third variable that affects the level of association between two variables and can increase or decrease the level of association between variables. They can be confirmed by examining the change in the ANOVA value and the R-square. If the change in R^2 or the ANOVA value for the interaction term is statistically significant then information adoption and utilization has a moderating effect (Hayes, 2013).

In this study, the component of cost of information adoption and utilization was added to the relationship between the cost of sugarcane production and cost of food production through an additive function to monitor its effect. This effect was analyzed based on the cost of production according to farmer type which considered a multinomial logit. Sugarcane only farmers were coded (1), mixed farmers were coded (2) while food crops only were coded (3). The general equation, without the moderator, and the cost of yield according to the farmer type was given by equation (3.11).

Given equation (3.11) above, operationalization of cost of information adoption and utilization as a moderator on the cost of sugarcane production and cost of food production was done in 3 phases.

In the 1st phase, cost of information "adoption only" was considered. The functional equation with cost of adoption was given by equation (3.11) whereas the functional with cost of information adoption introduced as a moderator transformed equation (3.12) into equation (3.13).

$$\ln TC_{(S,F)i} = \delta_0 + \delta_1 \sum_{(f,s)=1}^{n} \ln W_i + \delta_2 \sum_{(f,s)=1}^{n} \ln X_i + \delta_3 \sum_{(f,s)=1}^{n} \ln Y_i + \delta_4 \sum_{(f,s)=1}^{n} \ln A_i + v_{(f,s)i} \ldots\ldots\ldots\ldots\ldots\ldots (3.12)$$

$$\ln TC_{(S,F)i} = \delta_0 + \delta_1 \sum_{(f,s)=1}^{n} \ln W_i + \delta_2 \sum_{(f,s)=1}^{n} \ln X_i + \delta_3 \sum_{(f,s)=1}^{n} \ln Y_i + \delta_4 \sum_{(f,s)=1}^{n} \ln A_i + \delta_5 \sum_{(f,s)=1}^{n} \ln(WA)_{i(s,f)}) +$$
$$\delta_6 \sum_{(f,s)=1}^{n} \ln(XA)_{i(s,f)} + \delta_7 \sum_{(f,s)=1}^{n} \ln(YA)_{i(s,f)} + v_{i(f,s)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.13)$$

Where;

$\ln TC_{(s,f)i}$ = The total cost of sugarcane and food crop production

$W_i = (L_{fi} + L_{si})$ = The sum of costs of labour used in food production and in sugarcane production;

$X_i = (K_{fi} + K_{si})$ =The sum of cost of capital used in food production and in sugarcane production;

$Y_i = (D_{fi} + D_{si})$ = The sum of cost of land used food production and in sugarcane production

$L_{fi}; K_{fi}; D_{fi}$ = The cost of labour, cost of capital and cost of land on food production;

$L_{si}; K_{si}; D_{si}$ = The cost of labour, cost of capital and cost of land on sugarcane production;

$A =$ Cost of information adoption;

$(WA)_i$ = The cost of labour times the cost of information adoption used in sugarcane and food production

$(XA)_i$ = The cost of capital times the cost of information adoption used in sugarcane and food production;

$(YA)_i$ = The cost of land times the cost of information adoption used in sugarcane and food production.

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

In the 2nd phase, the effect of cost of "utilization" only was introduced into equation (3.11) thereby transforming it into a functional relationship as depicted by equation (3.14) below;

$$\ln TC_{(S,F)} = \delta_0 + \delta_{1i} \sum_{(f,s)=1}^{n} \ln W_i + \delta_{2i} \sum_{(f,s)=1}^{n} \ln X_i + \delta_{3i} \sum_{(f,s)=1}^{n} \ln Y_i + \delta_{4i} \sum_{(f,s)=1}^{n} \ln U_i + \mu_{(f,s)} \text{.....................(3.14)}$$

By injecting the cost of information as a mediator in equation (3.14), the new functional relationship was given by equation (3.15)

$$\ln TC_{(S,F)i} = \delta_0 + \delta_{1i} \sum_{(f,s)=1}^{n} \ln W_i + \delta_{2i} \sum_{(f,s)=1}^{n} \ln X_i + \delta_{3i} \sum_{(f,s)=1}^{n} \ln Y_i + \delta_{4i} \sum_{(f,s)=1}^{n} \ln U_i + \delta_{5i} \sum_{(f,s)=1}^{n} \ln(WU)_{i(s,f)}) +$$

$$\delta_{6i} \sum_{(f,s)=1}^{n} \ln(XU)_{i(s,f)} + \delta_{7i} \sum_{(f,s)=1}^{n} \ln(YU)_{i(s,f)} + v_{i(f,s)} \text{..(3.15)}$$

Where;

$W_i = (L_{fi} + L_{si})$ = The sum of costs of labour used in food production and in sugarcane production;

$X_i = (K_{fi} + K_{si})$ =The sum of cost of capital used in food production and in sugarcane production;

$Y_i = (D_{fi} + D_{si})$ = The sum of cost of land used food production and in sugarcane production

$L_{fi}; K_{fi}; D_{fi}$ = The cost of labour, cost of capital and cost of land on food production;

$L_{si}; K_{si}; D_{si}$ = The cost of labour, cost of capital and cost of land on sugarcane production;

U = Cost of information utilization

$\ln TC_{(S,F)i} =$ The farmer's total cost of production (either as a sugarcane farmer or food crop farmer)

$(WU)_i$ = The cost of labour times the cost of information utilization used in sugarcane and food production

$(XU)_i$ = The cost of capital times the cost of information utilization used in sugarcane and food production

$(YU)_i$ = The cost of land times the cost of information utilization used in sugarcane and food production

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

In the 3rd phase, summation of the cost of adoption and the cost of utilization was generated. Used as a combined figure, and introduced into equation (3.11), the equation transformed into equation (3.16) below;

$$\ln TC_{i(S,F)} = \delta_0 + \delta_{1i} \sum_{(f,s)=1}^{n} \ln W_i + \delta_{2i} \sum_{(f,s)=1}^{n} \ln X_i + \delta_{3i} \sum_{(f,s)=1}^{n} \ln Y_i + \delta_{4i} \sum_{(f,s)=1}^{n} \ln(AU)_i + \delta_{5i} \sum_{(f,s)=1}^{n} \ln(WAU)_{i(s,f)}) + \delta_{6i} \sum_{(f,s)=1}^{n} \ln(XAU)_{i(s,f)} + \delta_{7i} \sum_{(f,s)=1}^{n} \ln(YAU)_{i(s,f)} + v_{i(f,s)} \qquad (3.16)$$

Where:

$W_i = (L_{fi} + L_{si})$ = The sum of costs of labour used in food production and in sugarcane production;

$X_i = (K_{fi} + K_{si})$ =The sum of cost of capital used in food production and in sugarcane production;

$Y_i = (D_{fi} + D_{si})$ = The sum of cost of land used food production and in sugarcane production

$L_{fi}; K_{fi}; D_{fi}$ = The cost of labour, cost of capital and cost of land on food production;

$L_{si}; K_{si}; D_{si}$ = The cost of labour, cost of capital and cost of land on sugarcane production;

$\ln TC_{(S,F)i} =$ The farmer's total cost of production (either as a sugarcane farmer or food crop farmer or both)

δ_0 = The cost efficiency in production

$\delta_{1i}, \delta_{2i}, \delta_{3i}, \delta_{4i}$ = The coefficients of the main effect of labour, capital, land and information adoption on sugarcane production and food production respectively;

$\delta_{5i}, \delta_{6i}, \delta_{7i}$ = The coefficients of the moderating effect of information adoption and utilization on the labour, capital and land constructs.

AU = The summation of the cost of information adoption and the cost of information utilization.

$(WAU)_i$ = The cost of labour times the cost of information adoption and utilization used in sugarcane and food production

$(XAU)_i$ = The cost of capital times the cost of information adoption and utilization used in sugarcane and food production

$(YAU)_i$ = The cost of land times the cost of information adoption and utilization used in sugarcane and food production

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

3.7.4.2 Cost of Information Adoption and Utilization as a Mediator on the Relationship between Cost of Sugarcane Production and Cost of Food Production

The test for mediation in this study was achieved through the use of structural equation modeling. According to MacKinnon, Fairchild, & Fritz (2007) a mediator is a behavioral, psychological, biological or social constructs that spreads the influence of one variable into another. They signify a mechanism through which predictor is able to affect the predicted, Hayes (2013). These thoughts suggest that in moderation, the independent variable must cause the mediator which then again causes the dependent variable. For mediation to take place, the relationship between the predictor and the predicted must be significant before testing the mediation effect. If the resulting relationship becomes insignificant, then there is a mediating effect and vice versa (Jin-Sun, Kaye, & Wright, 2001).

To test for mediators, Kim (2016) proposed a simple step that should be followed i.e. (a) all the variables to be tested must be significantly correlated, and the predictor must be significant in regression model, (b) a simple regression with just the predictor, and the mediator as the outcome variable must be run to see if the predictor variable is significant in the new model, (c) enter the predictor and mediator in the same block and if the predictor is no longer significant or if there are weaknesses in the power/exponentials, then there is a mediation effect. This can be summarised below according to

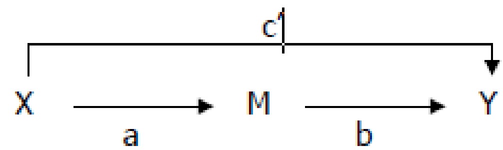


Figure 3.2 Steps in Mediation

Given that M is the mediator variable, in this case cost of information adoption and utilization and X is sugarcane production and Y is the cost of food production, the injection of the cost of information adoption and utilization as a mediator into the cost of sugarcane production and the cost of food production was examined in 3 phases.

Phase (1) involved the use of information adoption only. Given this, equation (3.11) was transformed to become equation (3.17);

$$TC_{i(S,F)} = \delta_0 + \delta_1 \sum_{(f,s)=1}^{n} \ln W_i + \delta_2 \sum_{(f,s)=1}^{n} \ln X_i + \delta_3 \sum_{(f,s)=1}^{n} \ln Y_i + \delta_4 \sum_{(f,s)=1}^{n} \ln A_i + \delta_5 \sum_{(f,s)=1}^{n} \ln(\frac{W}{A})_{i(s,f)}) +$$
$$\delta_7 \sum_{(f,s)=1}^{n} \ln(\frac{X}{A})_{i(s,f)} + \delta_7 \sum_{(f,s)=1}^{n} \ln(\frac{Y}{A})_{i(s,f)} + \mu_{i(s,f)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.17)$$

Where:

$W_i = (L_{fi} + L_{si})$ = The sum of costs of labour used in food production and in sugarcane production;

$X_i = (K_{fi} + K_{si})$ =The sum of cost of capital used in food production and in sugarcane production;

$Y_i = (D_{fi} + D_{si})$ = The sum of cost of land used food production and in sugarcane production

$L_{fi}; K_{fi}; D_{fi}$ = The cost of labour, cost of capital and cost of land on food production;

$L_{si}; K_{si}; D_{si}$ = The cost of labour, cost of capital and cost of land on sugarcane production;

$(\frac{W}{A})_i$ = The cost of labour divided by the cost of information adoption used in sugarcane and food production;

$(\frac{X}{A})_i$ = The cost of capital divided by the cost of information adoption used in sugarcane and food production;

$(\frac{Y}{A})_i$ = The cost of land divided by the cost of information adoption used in sugarcane and food production;

$\ln TC_{i(S,F)}$ = The farmer's total cost of production (either as a sugarcane farmer or food crop farmer)

δ_0 = The cost efficiency in production

$\delta_1, \delta_2, \delta_3, \delta_4$ = The coefficients of the main (direct) effect of labour, capital, land and information adoption on sugarcane production and food production respectively;

$\delta_5, \delta_6, \delta_7$ = The coefficients of the mediating (indirect) effect of cost of information adoption on the labour, capital and land constructs.

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

The structural equation modeling diagram was given below.

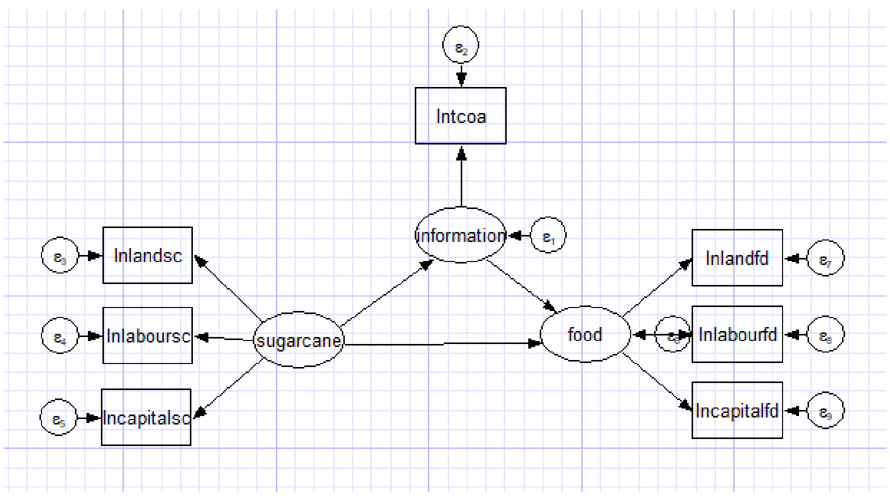


Figure 3.3 Mediating Role of Cost of Information Adoption

Figure 3.3 portrays the mediating role of cost of information adoption on the relationship between cost of sugarcane production and cost of food production. The cost of sugarcane production was given as the sum of the cost of land, cost of capital and cost of labour. Their effect is first transferred to the cost of information adoption and lastly to the cost of food production given by the cost of land, cost of capital and cost of labour used in food production.

The 2nd phase took into consideration the cost of mediating effect of information utilization. This also transformed equation (3.11) to become equation (3.18);

$$TC_{i(S,F)} = \delta_0 + \delta_1 \sum_{(f,s)=1}^{n} \ln W_i + \delta_2 \sum_{(f,s)=1}^{n} \ln X_i + \delta_3 \sum_{(f,s)=1}^{n} \ln Y_i + \delta_4 \sum_{(f,s)=1}^{n} \ln A_i + \delta_5 \sum_{(f,s)=1}^{n} \ln(\frac{W}{U})_{i(s,f)}) +$$

$$\delta_6 \sum_{(f,s)=1}^{n} \ln(\frac{X}{U})_{i(s,f)} + \delta_7 \sum_{(f,s)=1}^{n} \ln(\frac{Y}{U})_{i(s,f)} + \mu_{i(s,f)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(3.18)$$

Where:

$W_i = (L_{fi} + L_{si})$ = The sum of costs of labour used in food production and in sugarcane production;

$X_i = (K_{fi} + K_{si})$ =The sum of cost of capital used in food production and in sugarcane production;

$Y_i = (D_{fi} + D_{si})$ = The sum of cost of land used food production and in sugarcane production

$L_{fi}; K_{fi}; D_{fi}$ = The cost of labour, cost of capital and cost of land on food production;

$L_{si}; K_{si}; D_{si}$ = The cost of labour, cost of capital and cost of land on sugarcane production;

$(\frac{W}{U})_i$ = The cost of labour divided by the cost of information utilization used in sugarcane and food production;

$(\frac{X}{U})_i$ = The cost of capital divided by the cost of information utilization used in sugarcane and food production;

$(\frac{Y}{U})_i$ = The cost of land divided by the cost of information utilization used in sugarcane and food production;

$\ln TC_{i(S,F)}$ = The farmer's total cost of production (either as a sugarcane farmer or food crop farmer or both)

δ_0 = The cost efficiency in production

$\delta_1, \delta_2, \delta_3, \delta_4$ = The coefficients of the main effect of labour, capital, land and information adoption on sugarcane production and food production respectively;

$\delta_5, \delta_6, \delta_7$ = The coefficients of the mediating effect of cost of information utilization on the labour, capital and land constructs.

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

The structural equation modeling diagram was as given below;

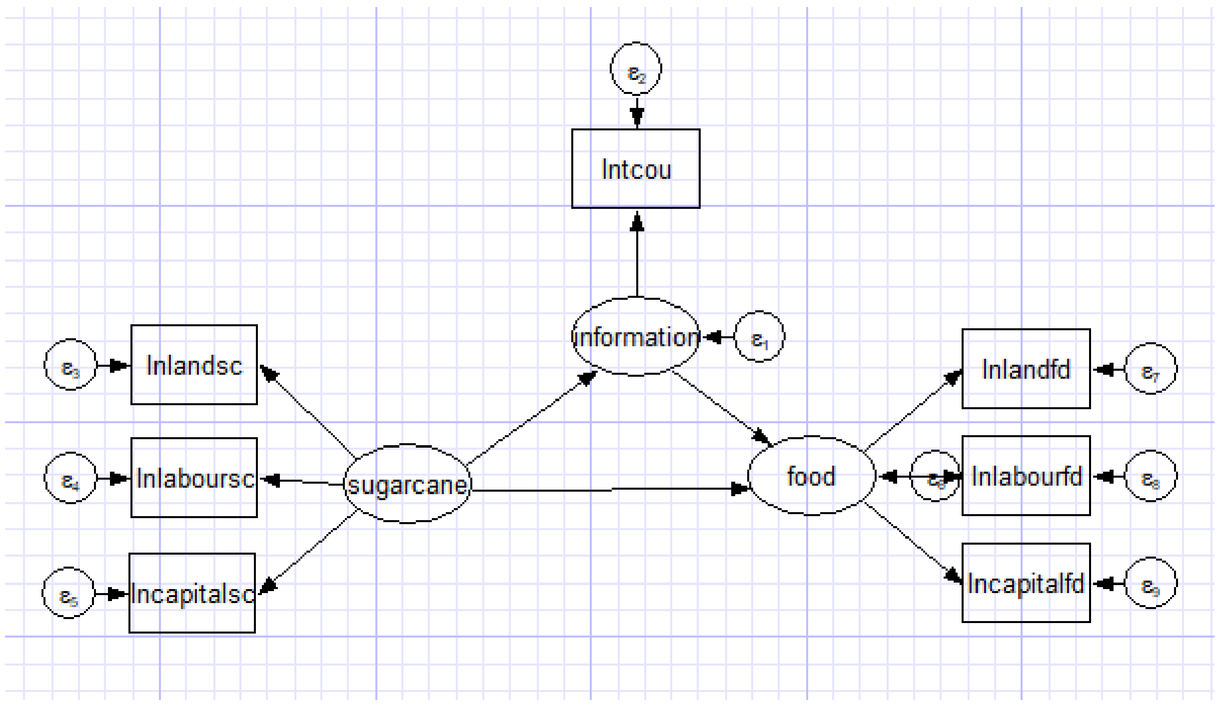


Figure 3.4 Mediating Role of Cost of Information Utilization

Figure 3.4 portrays the mediating role of cost of information utilization on the relationship between cost of sugarcane production and cost of food production. The cost of sugarcane production was given as the sum of the cost of land, cost of capital and cost of labour. Their effect is first transferred to the cost of information utilization and lastly to the cost of food production given by the cost of land, cost of capital and cost of labour used in food production.

In the 3rd phase, summation of the cost of information adoption and the cost of information utilization was performed and introduced into equation (3.11) to become;

$$TC_{i(S,F)} = \delta_0 + \delta_1 \sum_{(f,s)=1}^{n} \ln W_i + \delta_2 \sum_{(f,s)=1}^{n} \ln X_i + \delta_3 \sum_{(f,s)=1}^{n} \ln Y_i + \delta_4 \sum_{(f,s)=1}^{n} \ln A_1 + \delta_5 \sum_{(f,s)=1}^{n} \ln(\frac{W}{AU})_{i(s,f)}) + \delta_6 \sum_{(f,s)=1}^{n} \ln(\frac{X}{AU})_{i(s,f)} + \delta_7 \sum_{(f,s)=1}^{n} \ln(\frac{Y}{AU})_{i(s,f)} + \mu_{i(s,f)} \qquad (3.19)$$

Where:

$W_i = (L_{fi} + L_{si})$ = The sum of costs of labour used in food production and in sugarcane production;

$X_i = (K_{fi} + K_{si})$ =The sum of cost of capital used in food production and in sugarcane production;

$Y_i = (D_{fi} + D_{si})$ = The sum of cost of land used food production and in sugarcane production

$L_{fi}; K_{fi}; D_{fi}$ = The cost of labour, cost of capital and cost of land on food production;

$L_{si}; K_{si}; D_{si}$ = The cost of labour, cost of capital and cost of land on sugarcane production;

$(\frac{W}{AU})_i$ = The cost of labour divided by the sum of cost of information adoption and utilization used in sugarcane and food production;

$(\frac{X}{AU})_i$ = The cost of capital divided by the sum of cost of information adoption and utilization used in sugarcane and food production;

$(\frac{Y}{AU})_i$ = The cost of land divided by the sum of cost of information adoption and utilization used in sugarcane and food production;

$\ln TC_{i(S,F)} =$ The farmer’s total cost of production (either as a sugarcane farmer or food crop farmer or both)

δ_0 = the cost efficiency in production

$\delta_1, \delta_2, \delta_3, \delta_4$ = the coefficients of the main effect of labour, capital, land and information adoption on sugarcane production and food production respectively;

$\delta_5, \delta_6, \delta_7$ = the coefficients of the mediating effect of cost of information utilization on the labour, capital and land constructs.

f = Food crop farmer;

s = Sugarcane farmer.

$f + s$ = Mixed farmer

The structural equation modeling was expressed diagrammatically as follows;

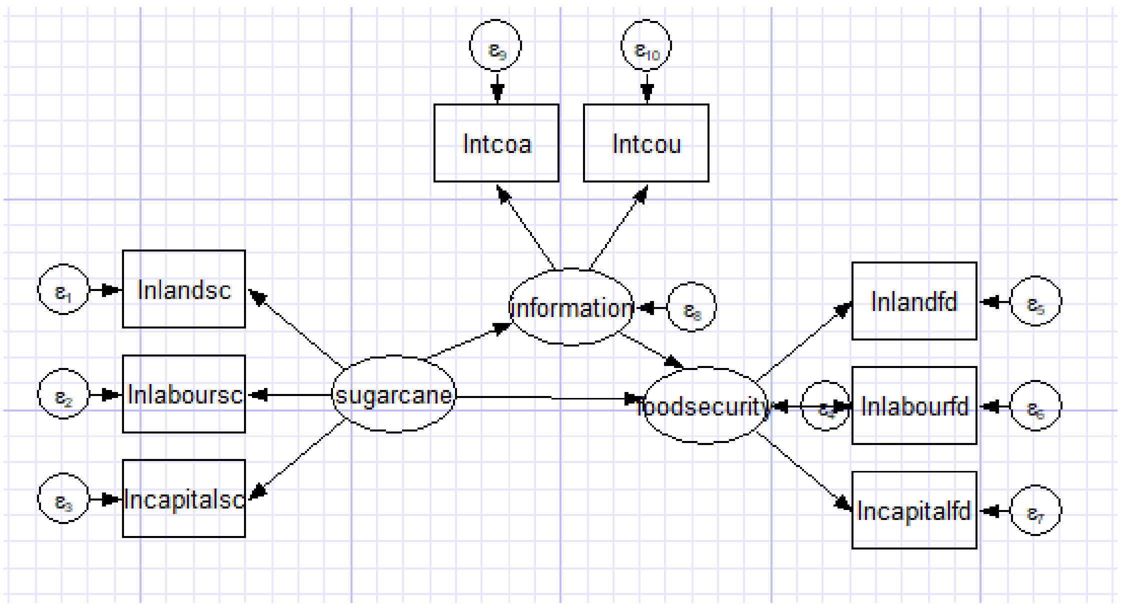


Figure 3.5 Mediating Effects of Information Adoption and Utilization Costs

Figure 3.5 portrays the mediating role of sum of cost of information adoption and utilization on the relationship between cost of sugarcane production and cost of food production. The cost of sugarcane production was given as the sum of the cost of land, cost of capital and cost of labour. Their effect is first transferred to the sum of cost of information adoption and utilization then lastly to the cost of food production given by the cost of land, cost of capital and cost of labour used in food production.

3.7.5 Examining the Coping Strategies to Food Insecurity among Farmers

Given that coping strategies are answers to adversarial situations Devereux (2001), this study examined strategies such as rationing strategies, dietary change, food availability increase in the short term and reduced number of dependents. These categories were examined by disaggregating them into their latent variables such as taking porridge, prioritizing children over adults, decreasing the daily meals, reducing food portions, eating less preferred staples, changing curry ingredients / variety / food quality, borrowing food from neighbors / relatives, eating immature crops, eating bush meat or plants, purchasing food on credit, reducing health expenditures and saving the left overs and thereafter analyzing their descriptive statistics by ranking them on a 1-5 likert scale where 1 denotes strong disagreement while 5 denotes strong agreement.

Advantages based on Maxwell & Caldwell (2008) recommendations led to the adoption of CSI to determine the various coping strategies with regard to food production measures likely to be adopted by the farmers domiciled in the study area as well as among the demographic components that this study examined.

The determination of the average coping strategy index was given by the formula below;

$$\bar{x} = \sum_{i=1}^{n} \frac{f(x_i)}{n} \qquad (3.20)$$

Where;

$\bar{x}$ = Mean of the latent variables in food insecurity

n = The total scale observations

$f(x_i)$ = The number of observations

However, food insecurity measure was determined by the summation of the average coping index and the conclusion of level of CSI was given by the formula;

$$34 \leq \sum_{i=1}^{n} \bar{x}_i \leq 100 \qquad (3.21)$$

Where;

$\sum_{i=1}^{n} \bar{x}_i$ = The summation of the CSI averages from *i to n*

If $34 \leq \sum_{i=1}^{n} \bar{x}_i \leq 50$, there is no food insecurity and the severity reduces as the value tends to 34

If $51 \leq \sum_{i=1}^{n} \bar{x}_i \leq 100$, there is food insecurity and the severity increases as the value tends to 100

To get food insecurity severity index, the total number of the respondents who chose a particular coping strategy on each row were then divided by the total sample size i.e.

$$\text{Severity} = \frac{Totals}{Sample\ size} \qquad (3.22)$$

To get the coping strategy index, the severity indexes were summed up using the formula indicated below;

$$\text{Coping Strategy Index } = \sum_{i=1}^{n} severity \text{..(3.23)}$$

3.7.6 Assumptions of the Model

Building a linear regression model is not fully accomplished unless it conforms to the assumptions of linear regression namely Normality, homogeneity of variances, linearity and uncorrelated errors terms (Prabhakaran, 2017).

3.7.7 Diagnostics of Regression Model

Since the study considered multiple linear regression analysis with the assumptions of normality, homogeneity of variances, linearity and uncorrelated errors terms, the diagnostic tests were conducted first.

3.7.7.1 Testing for Normality

Normality was tested using skewness, kurtosis and Jarque Bera (Tabachnick & Fidell, 2001). Skewness is a measure of balance of a distribution or data set. A distribution is considered normal if its skewness rotates around the mean i.e. zero. If a data set is symmetrical, then the portion on the right is the same as the portion on the left. The negativity or positivity of the skew indicates the direction of the variation. Meanwhile kurtosis measures the shape of a randomized probability distribution. Normal distributions are considered mesokurtic if the measurement is about zero, leptokurtic if the measure is positive, tall and has a thick tail, platykurtic if the distribution is short or flatter, negative and has a thin tail.

These normality tests were conducted for all the variables namely cost of sugar cane production, food production as well as information adoption and utilization using kernel density and the results indicated a bimodal normality in all the series.

3.7.7.2 Testing for Homogeneity of Variances

This is a test of the constant nature of the variance. The measure of homogeinity of the variances is measured using the ANOVA test (F statistics). This study used Levene’s test to test for variances homogeinity at 5% level. The assumption was that if the probability of each sub group of the data portrayed a non-significant Chi square test result, then the assumption of homogeneity of variances was not violated. This was done by comparing the means under independent sample test. The variables were grouped under gender and farmer type. The Levene's test results on information use, cost of utilization as well as the cost of adoption across gender, were given in Table 3.6 and Table 3.7.

Table 3.6 Independent Sample Test Based on Gender

		Levene's Test for Equality of Variances				
		F	Sig.	t	Df	Sig. (2-tailed)
Information use	Equal variances assumed	1.617	.204	.547	315	.585
	Equal variances not assumed			.530	155.811	.597
utilization cost	Equal variances assumed	.553	.458	1.053	315	.293
	Equal variances not assumed			1.137	197.418	.257
adoption cost	Equal variances assumed	.257	.613	-.025	315	.980
	Equal variances not assumed			-.025	163.122	.980

Source: Survey Data (2020)

From Table 3.6, the probabilities of the F statistics were insignificant at 5% level. This implied that there were no differences in variance in information use, utilization cost as well as the cost of adoption across gender. Therefore, this study concluded that information use, utilization costs as well as cost of adoption across gender, had a constant variance.

Based on the farmer type, the Levene's test results were captured in Table 3.7.

Table 3.7 Independent Samples Test

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Information use	Equal variances assumed	.012	.913	.054	151	.957
	Equal variances not assumed			.053	49.357	.958
Utilization cost	Equal variances assumed	18.368	.000	2.403	151	.017
	Equal variances not assumed			1.597	35.481	.119
Adoption cost	Equal variances assumed	.011	.917	5.625	151	.000
	Equal variances not assumed			5.208	46.296	.000

Source: Survey Data (2020)

From Table 3.7, the probabilities of the F statistics were insignificant at 5% level on information use and on cost of adoption. This implied that there were no differences in variance in information use and cost of adoption across the farmer type. However, on cost of utilization, the F statistics probabilities were significant, meaning that there were differences in variances across the farmer types. Because of this phenomenon, the data on the adoption costs were log transformed to achieve a constant variance.

3.7.7.3 Testing for Linearity

According to Howard (2002), linearity defines a situation where data expressed in a straight line, through the use of OLS method, can still be able to provide a good fit just like any other mathematical function. A better correlation among variables should not be more than 0.80, otherwise, correlation test for linearity of the variables was done using Pearson's product moment correlation coefficient and the general formula was;

$$r = \frac{\sum xy - (\sum x)(\sum y)}{\sqrt{(\sum x^2 - \left(\frac{\sum x}{n}\right)^2)(\sum y^2 - \left(\frac{\sum y}{n}\right)^2)}} \qquad (3.24)$$

This study investigated the level of correlation between the costs of information adoption on the following gadgets (mobile phones, radios, TVs and computers) as well as the correlation between the costs of information utilization on the above mentioned gadgets.

From Table 3.8, the cost of mobile phones adoption significantly correlated with the cost of adopting radio ($r = 0.198$; $p = 0.000$), cost of adopting TV ($r = 0.297$; $p = 0.000$) and cost of adopting computers ($r = 0.157$; $p = 0.005$). These implied that an increase in the cost of mobile phone adoption is likely to result into a significant increase in the cost of radios by 0.198; the cost of TV by 0.297 and the cost of computers by 0.157.

Apart from the cost of adopting mobile phones, adoption costs of radios are significantly correlated with that of TVs $(r = 0.133; p = 0.018)$ but insignificantly correlated with that of computers $(r = 0.022; p = 0.702)$. This meant that a unit increase in the cost of adoption of radios is likely to result into the cost of TVs increasing significantly by 0.133 and that of computers increasing insignificantly by 0.022. Apart from mobile phones and radios, adoption costs of TVs are also significantly correlated with adoption cost of computers $(r = 0.296; p = 0.000)$. This meant that unit increases in the cost of TVs are likely to result in a significant increase in the cost of computers by 0.296.

Table 3.8 Correlation on Cost of Adoption of Information Gadgets

		Mobile phones	Radio	TV	Computers
Mobile phones	Pearson Correlation	1			
	Sig. (2-tailed)				
Radio	Pearson Correlation	.198**	1		
	Sig. (2-tailed)	.000			
TV	Pearson Correlation	.297**	.133*	1	
	Sig. (2-tailed)	.000	.018		
Computers	Pearson Correlation	.157**	.022	.296**	1
	Sig. (2-tailed)	.005	.702	.000	

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Source: Survey Data (2020)

Given Table 3.9, the cost of utilization of mobile phones is insignificantly correlated with the cost of utilization of radios ($r = 0.088; \rho = 0.120$) and TVs ($r = -0.012; \rho = 0.827$) but significantly correlated with cost of computers ($r = 0.196; \rho = 0.000$). This meant that as the cost of utilization of mobile phones increases, there is a likelihood that the cost of utilization of radios may also increase by 0.088 although insignificantly; the cost of utilization of TVs is likely to decline by 0.012 as the cost of mobile phones increases by a unit. The costs of utilization of computers are likely to increase significantly by 0.196 as the costs of mobile phones increase by a unit. As the cost of utilization of radios increases, the cost of utilization of TV is also likely to increase insignificantly ($r = 0.032; \rho = 0.565$) whereas the cost of utilization of computers is likely to increase significantly ($r = 0.111; \rho = 0.048$). Utilization cost of TVs was insignificantly correlated with the cost of utilization of mobile phones, radios as well as computers.

Table 3.9 Correlations on Cost of Utilization of Information Gadgets

		Mobile phones	Radio	TV	Computers
Mobile phones	Pearson Correlation	1			
	Sig. (2-tailed)				
Radio	Pearson Correlation	.088	1		
	Sig. (2-tailed)	.120			
TV	Pearson Correlation	-.012	.032	1	
	Sig. (2-tailed)	.827	.565		
Computers	Pearson Correlation	.196**	.111*	.046	1
	Sig. (2-tailed)	.000	.048	.417	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Source: Survey Data (2020)

3.7.7.4 Testing for Statistical independence of the errors

This tested for serial correlation. Serial correlation refers to a situation where the error terms generated by a given data are correlated. The existence of serial correlation portends two things namely biasedness of the coefficient estimates or an outrageous t –statistics as well as standard errors. The null hypothesis was that there was no serial correlation and therefore expected the Durbin-Watson test to center around 2.0 otherwise, with the existence of a serial correlation tending toward 1, Durbin-Watson test then tends towards 0 (Tabachnick & Fidell, 2001).

3.7.7.5 Testing for Multicollinearity

This tested for the independence of the exogenous variables in a regression model. if the exogenous variables are correlated, problems may occur when a model is fit and the interpretation of the results may not be correct. According to Frost (n.d) Structural multicollinearity occurs when other variables are created from existing variables while Data multicollinearity occurs within the data itself. When data has multicollinearity problems, then the coefficient estimates may become very sensitive to small changes in the model and the statistical power of the regression analysis may become weaker because of the reduced the correctness of the estimated coefficients. This was tested using the Variance Inflation Factor (VIF). The results were as follows;

Table 3.10 Multicollinearity Diagnostics

	Collinearity Statistics	
	Tolerance	VIF
Cost of Sugarcane Production	.992	1.008
Cost of Adoption	.863	1.158
Cost of Utilization	.866	1.155

Dependent Variable: Cost of Food Production

Following the rule of thumb that VIF value of 1 is a sign of no multicollinearity; a VIF value between 1 and 5 is a sign of moderate multicollinearity and VIF value greater than 5 showing serious multicollinearity levels, this study concluded that there were no cases of multicollinearity among the variables.

3.7.8 Measurements of Variables

3.7.8.1 Cost of food production:

Food production was measured through its availability i.e. the cost of making it become available in the market. Given that the households acted as firms, according to the cost minimization theory, they would contribute by producing the food crops and availing them to the market. In this study, the cost of production was measured by considering all the costs in producing the total yield i.e. cost of yield per acre was estimated and multiplied by the total number of acres. These costs were the cost of inputs used in production which included the cost of labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs

3.7.8.2 Cost of Sugarcane production:

The measurement cost of sugarcane production was done by summing up the costs incurred in producing it. This was obtained by estimating the total cost of yield per acre and then multiplied by the number of acreage at the behest of the farmer. The factors of production that this study examined were the cost per acre of capital, land and labour. Similarly, these costs included the cost of labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs.

3.7.8.3 Cost of information adoption and utilization

This was the total cost of providing reference and information services, information resources, circulation services and awareness creation. This was measured quantitatively based on the cost of purchase of the gadget being used and the cost of maintenance and the cost of acquisition of information through expenditures on Sms, voice calls and data bundles to those using either their phones or computers to access and use information generated from such medias. Such information services were examined from the perspective of being able to let the sugar cane farmer make informed choices regarding sugarcane production as well as food crop production.

3.7.8.4 Labour cost

This was measured by summing up the cost of engaging workers in agricultural production and was measured in terms of wages per worker per day and included both the direct labour cost used on the farm as well as the opportunity cost in case an individual opts to work on the farm alone or engages the family members.

Labour cost = $no.of\ workers\ \times wage\ rate\ \times no.of\ days\ worked$ ………………(3.25)

3.7.8.5 Agricultural Output.

This referred to the gross farm output per season. The gross value (cost) of production was taken into consideration as its measure.

3.7.8.6 Land Productivity

Given that land is scarce, land productivity can be achieved through increasing the levels of output per acre, incorporating crops with high value as well as intensive land. Because the study area had scarce land and had a high population, increasing the average output per acre is the only solution to food production (Dorward, 2013). Total crop yield (both sugarcane and food products) was measured in terms of kilograms and then divided by the total number of hectares cultivated under sugarcane/ food crop.

Land productivity/= $\frac{Total\ crop\ yield}{Total\ hectares\ under\ crop\ production}$ …………………………………..(3.26)

3.7.8.7 Capital Productivity

This measured the cost of all resources used in agriculture by the farmers, Apart from labour and incorporated the cost of irrigation, seeds, fertilizers, machinery and equipment, land reclamation, etc. According to Dharmasiri (2009), given the diverse nature of the capital used in agriculture, its measurements is very difficult and hard to interpret. Because of this, this study relied on the memory of the farmers with regard to the costs on capital and the formula outlined below was used to calculate the productivity of capital.

Capital productivity= $\frac{Total\ value\ of\ output/production}{Total\ costs\ of\ capital\ inputs}$ ………………………………….(3.27)

3.8 Data Analysis

According to Kelley *et al.,* (2003), data are analyzed to enable the consumers understand the easily as well as offering solutions based on the objectives of the study. This study used STATA version 15 to analyze the preliminary data and test the hypothesized model discussed in (3.4) above.

3.8.1 Data Coding and Editing

After data collection, the received data were pre coded. Consistency and fullness was achieved through editing given that it is the first stage in data treatment and analysis (Sahifa, 2014). Only those questionnaires that were 75% complete were considered (Sekaran, 2000). Detection of incomplete questionnaires was realized only after the entry into the data file was done. Such incompleteness was corrected by making references to the original questionnaires.

3.8.2 Data Screening

In order to ensure that the data was properly entered and to obtain assurance that their distribution was normal, screening was done, by examining the missing data as well as the outliers (Coakes & Steed, 2003).

3.8.2.1 Treatment of Outliers and Missing Data

According to Hair *et al.,* (2001); Coakes & Steed (2003), it is impossible to obtain a set of data that are fully responded to. There must be some missing data and once such missing data are detected, Tabachnick & Fidell (2001) prescribed two approaches to deal with them. An evaluation of the amount missing data must first be done followed by gauging the pattern of such omission to detect whether they occurred randomly or were item specific. Because there was questionnaire and data file comparison, there were no errors attributed to data entry mistakes. All the missing responses were due to the respondents' failure to answer the questions fully, hence, mean replacement approach was used to account for the missing responses. This was done by going into "transform, replace" in SPSS and under the methods, series mean was selected.

3.8.2.2 Outliers

These are observation that are isolated from the rest of the observations and are as a result of measurement inconsistencies or errors in experiments. They are often detected through the use of box plots and Hair *et al.,* (2001) suggested for their exclusion from a set of data.

3.9 Ethical Considerations

According to May (2011), ethics defines conducts that separates the good from the bad and also assists in differentiating behaviours that are accepTable from the ones that are not. According to Resnik (2015), they are needed because research activities require cooperation and coordination in order to encourage morals that are important in any shared work. These morals include fairness, mutual respect, accountability and trust. Besides, they also enable the researchers remain accounTable to the public and also enjoy their support.

The general objective of this study was to determine the role of information adoption and utilization on the relationship between sugar cane production and food production among farmers in Nyanza region, Kenya and the specific objectives which were to: determine the extent of adoption and utilization of ICT among sugar cane and food farmers; determine the relationship between cost of sugarcane production and food production among farmers; determine the cost efficiency level between sugar cane production and food production among farmers; assess the effect of adoption and utilization of ICT on the relationship between cost of sugar cane and food crop production among farmers as well as examine the coping strategies to food insecurity among farmers in Nyanza region, Kenya.

To fully answer these objectives, respondents' were asked about their financial as well as other social characteristics. Such intrusion may, ordinarily, cause psychological, economic or social harm. The Psychological risks might have included the anxiety, shame, or guilt as a result of the embarrassing or sensitive information that this study sought. Economic risks might have involved the loss of opportunity to accrue cash during the time of the interview as the respondents took time off to respond to the questionnaires. Social risks might have occurred due to lack of interaction of the respondents to their families, friends and/or relatives.

These risks, however, were minimized when the researcher informed the participants about the day and the time that this research was to be conducted and how long the interviews were to take so as to accord the respondents' time to make prior arrangements with regard to their availability. Besides, they were cognizant of their voluntary involvement hence had the freewill to withdraw, ask any question or decline to answer any question within the set time limits without giving reasons for such actions. Meanwhile, confidentiality and anonymity conditions were observed by changing or disguising the respondent's name and /or identity.

They were also free to seek explanation or evidence from anybody connected to this study, including Maseno University Ethics Review Committee (MUERC) besides being free to withdraw their consent within two weeks past the interview. Fortunately though, this did not happen.

In cases where there were audio recording, such, together with the signed consent forms were kept by the researcher until Maseno university examination's board confirmed the results of this study and incase of interviews, permission to use the disguised extracts from such interviews were sought before the extracts are to be quoted in conferences, dissertation or in published papers. In case any party was at risk of harm, then they were let free to make a report to the relevant authorities. However, this study experienced no such risks whatsoever.

In order to steer clear on any prior potential financial benefits to the respondents, they were implored upon not to expect any except the gains from this study findings. These gains included the knowledge of the extent of information adoption and utilization, the effect an increase in the cost of sugarcane production has on the cost of food production, the efficiency level and the factors whose costs must be controlled to reduce the levels of inefficiencies in agricultural production, the moderating and mediating effect of information adoption and utilization in cost of sugarcane production and cost of food production and lastly, the coping strategies to food insecurity. Journal papers were written to make public, these knowledge.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the frequencies on the socio demographic characteristics, frequencies and tabulations on the costs of sugarcane production as well as the costs of food production, frequencies and tabulations on the cost of information adoption and utilization as well as frequencies on the various coping strategies to food insecurity in Nyanza region. It also captures the test of differences on some selected socio demographic characteristics. Contained herein too were the results for the pre-diagnostic tests as well as the analysis and discussions of the specific objectives.

4. 2 Socio – Demographic Characteristics

4.2.1 Respondents from the Agro Ecological Zones

This study chose respondents cross- sectionally from sugarcane growing areas of Chemelil, Muhoroni, Ndhiwa and Sony. A sum of 384 questionnaires were disseminated and administered to all respondents and feedback results in Table 4.1, revealed a response rate of 82.55%. This was calculated given the 317 responses out of the sample size of 384 respondents.

Table 4.1 Respondents from the Agro Ecological Zones

	Frequency	Percent	Sugarcane farmers	Mixed Farmers	Food crop farmers
Sony	109	34.4	20 (18.3%)	7(6.4%)	82(75.2%)
Chemelil	22	6.9	0	22(100%)	0
Muhoroni	69	21.8	0	67(97.1%)	2(2.9%)
Ndhiwa	117	36.9	13(11.1%)	68(58.1%)	36(30.8%)
Total	317	100.0	33	164	120

Source: Survey Data (2020)

The distribution of the respondents across the ecological zones in Table 4.1 indicated that 109 (i.e. 34.4% of the respondents) came from Sony and out of these respondents, 20 (18.3%) were sugarcane farmers, 6.4% were mixed crop farmers while 75.2% were food crop farmers. From Chemelil, there were 22 respondents (i.e. 6.9% of the respondents) and out of this, all of them (100%) were mixed crop farmers. From Muhoroni, there were 69 farmers (i.e. 21.8% of the respondents. out of this, 97.1% were mixed crop farmers while 2.9% were food crop farmers. From Ndhiwa, there were 117 respondents (i.e. 36.9% of the respondents). Out of this, 11.1% were pure sugarcane farmers, 58.1% were mixed crop farmers while 30.8% were pure food crop farmers. In general, there were 33 pure sugarcane farmers, 164 mixed crop farmers and 120 pure food crop farmers.

4.2.2 Gender Spread of the Respondents

Results on gender spread of the respondents were given in Table 4.2.

Table 4.2 Gender Spread of the Respondents

	Frequency	Percent	Cumulative Percent
Male	226	71.3	71.3
Female	91	28.7	100.0
Total	317	100.0	

Source: Survey Data (2020)

Table 4.2 showed that farming activities within this study region were dominated by men since men were 226 representing 71.3% of the respondents whereas the female were 91 representing 28.7% of the respondents.

However, there was need to establish the reason behind the practice of agriculture (both sugarcane and cash crops) by female headed households given that this activity is predominantly male dominated. To achieve this, cross tabulation was performed and tabulated in Table 4.3.

Table 4.3 Reasons for Practicing Farming by the Women Headed Households

		Reasons for practicing agriculture			Total
		Single	Husband works elsewhere	Widowed	
	Female	3(3%)	42(46%)	46(51%)	91
Total		3(3%)	42(46%)	46(51%)	91

Source: Survey Data (2020)

From Table 4.3, indications were that 51% females were widowed, 42% had spouses who were working elsewhere, 3% were single. Such predicaments made them become actively involved in agriculture.

4.2.4 Farmers' Level of Education across Agro Ecological Zones

Given that some of the gadgets used in information adoption and utilization such as computers and smart phones, depend on ones' level of education, it was therefore key for this study to establish farmers' educational level across different agro-ecological zones. The reason for this was to understand the area with more educated farmers. Results were presented in Table 4.4.

Table 4.4 Farmers' Level of Educational Across Agro Ecological Zones

		Highest level of education					Total
		Primary	Secondary	Diploma	Graduate	Post Graduate	
Agro ecological zone	Sony	15(13.7%)	50(45.9%)	40(36.7%)	4(3.7%)	0%	109
	Chemelil	13(59.1%)	8(36.4%)	1(4.5%)	0%	0%	22
	Muhoroni	32(46.4%)	32(46.4%)	1(1.4%)	4(5.8%)	0%	69
	Ndhiwa	49(41.9%)	50(42.7%)	9(7.8%)	5(4.3%)	4(3.4%)	117
	Total	109(34.4%)	140(44.2%)	51(16.1%)	13(4.1%)	4(1.2%)	317

Source: Survey Data (2020)

From Table 4.4, 208 farmers went to secondary school level and beyond (the difference between 317 and 109). This reflected a total of 65.4%. Those who fell within this category were perceived to be educated. Only 109 farmers (34.4%) went up to primary level and hence were perceived to be less educated. However, given the agro-ecological zone, the number of the educated in Sony was 94; in Chemelil were 9; in Muhoroni were 37 and in Ndhiwa were 68 reflecting 86.2%; 40.9%; 53.6% and 58.1% respectively.

4.3. Objective One – Extent of Information Adoption and Utilization in Nyanza Region

This objective measured the extent to which farmers in Nyanza region adopted and utilized information gadgets in acquiring information useful in agricultural production. This study investigated the extent of information adoption and utilization across the different socio-demographic characteristics i.e. from the perspective of gender, level of education and agro ecological zones.

4.3.1 Extent of Adoption of the Various Information Gadgets

An investigation was conducted on the extent to which information gadgets were adopted by the farmers. The gadgets that were investigated were the mobile phones, radios, TVs and computers.

Table 4.5 Farmers Adoption of Information Gadgets in Nyanza Region

	Ownership	No ownership
Mobile phones	296(93.4%) [5]	21(6.6%) [1]
Radio	266(83.9%) [5]	51(6.1%) [1]
TV	146(46.1%) [3]	171(53.9%)[3]
Computers	57(18%) [1]	260(82%) [5]
Average weights	[3.5]	[2.5]

Source: Survey Data (2020) **[ ] Weights on extent of adoption**

The extent in Table 4.5 is on the basis of Table 3.5 where 0% means to "no extent" and accorded a weight of 0; (1-20) % is accorded a weight of 1 and means to "small extent"; 21-40 is accorded a weight of 2 and means to "some extent"; (41-60)% is accorded a weight of 3 and means to a "moderate extent"; (61-80)% is accorded a weight of 4 and means to a "great extent" while (81-100)% is accorded a weight of 5 and means to a "very great extent".

Therefore, the summary in Table 4.5 indicated that 93.4 % of the respondents adopted mobile phones, 83.9% adopted radios, and 46.1% adopted televisions while 18% had computers. Based on zonal penetration of mobile phones in Table 4.6, the results indicated that 100% of the farmers in Sony had adopted mobile phones, in Chemelil, 87.6% of the respondents had adopted mobile phones while in Muhoroni and Ndhiwa, mobile phone ownership was at 84.4% and 95.9% respectively. On radios, Sony had 98.1% penetration followed by Chemelil at 85.7%, 71.9% in Muhoroni and then at 65.8% in Ndhiwa. With regard to TV penetration, Sony had the highest level at 74.8%, Ndhiwa was second at 45.2%, Muhoroni was third at 31.3% while Chemelil was last with 22.9% penetration. On Computers/ laptops adoption, the greatest adoption rate of 45.8% was experienced in Sony, Ndhiwa was at 8.8% while Chemelil was at 0.95%. There was no computer adoption in Muhoroni.

The extent of information gadgets were ownered across agro ecological zones were captured in Table 4.6.

Table 4.6 Extent of Information Gadgets Adoption across Agro Ecological Zones

	Mobile phones	Radio	TV	Computers
Sony	100% [5]	98.1% [5]	74.8% [4]	45.8% [3]
Chemelil	87.6% [5]	85.7% [5]	22.9% [2]	0.95% [1]
Muhoroni	84.4% [5]	71.9% [4]	31.3% [2]	0% [0]
Ndhiwa	95.9% [5]	65.8% [4]	45.2% [3]	8.8% [1]
Total	93.4% [5]	83.9% [5]	46.4%[3]	18.3% [1]
Average weight	[5]	[4.5]	[2.8]	[1.25]

Source: Survey Data (2020); [ ] weights on extent of adoption

From Table 4.6, the average weights were based on the respective percentages and interpretation given based on Table 3.5. Therefore, the extent of information adoption was 3.5. This meant that information gadgets were adopted to a great extent. Meanwhile, the results portrayed in Table 4.6 indicated that the average weight for the adoption of mobile phones, radios, TVs and computers across the different ecological zones were [5]; [4.5]; [2.8] and [1.25] respectively. This showed that mobile phones and radios were very great extent adopted; TVs and computers were "moderately" and to "some extent" adopted.

Although information adoption was analyzed singly, based on the individual presence of the information gadgets at the disposal of farmers and across the different agro ecological zones, this study also interrogated the information flow from these gadgets. From Table 6 (in Appendix D), results indicated that those who had the ability to receive information across the four sources were 17.9% and out of this, 44.1% came from Sony. Those who were in a position to get information from at least three sources were 23.9% and out of this, 31.2% still came from Sony. Those with the potential to get agricultural information from at least two sources were 42.9% and out of this, 91% came from Chemelil. Those with the potential to get information from at least one source were 12.3% and out of this, 18% each came from Muhoroni and in Ndhiwa. Those who had no access to such information from the gadgets were 2.8% and out of this, 6% came from Ndhiwa.

With respect to information adoption by gender, the results were presented in Table 4.8.

Table 4.8 Gender Adoption of Information Gadgets

	Mobile phone adoption	Radio Adoption	TV Adoption	Computer Adoption	Total
Male	96%[5]	84.1%[5]	45.1%[3]	19%[1]	226
Female	86.8%[5]	83.5%	49.5%[3]	16.5%[1]	91
Total	93.4[5]	83.9%[5]	46.4%[3]	18.3%[1]	317

[ ] weights on extent of adoption

Source: Survey Data (2020)

With regard to categorization of adoption of information gadgets by gender, Table 4.8 revealed that 96% of the total male farmers had mobile phones compared to 86.8% female farmers. In overall, mobile phones were adopted to a very great extent by both male and female farmers. As such, this study is in consonance with GSMA, (2019) report which also established significant increase in the number of women who own mobile phones in low and middle income countries since 2014 and that the number of such ownership had risen to 80 per cent of women across these markets. GSMA (2019) also established that there is a persistent mobile phone gender gap in such countries with 10 per cent of the women unlikely to have a mobile phone.

Considering radios, the results indicated that the total penetration of radios was at 83.9% and out of this, 84.07% of male farmers as well as 83.51% of the female farmers possessed radios. This meant that the adoption of radios was also done to a very great extent across gender. This result agrees with the findings by Kenya National Bureau of Statistics (2011) report which also reported that the population in Kenya had almost 80% access to a radio terminal. On TV and computer adoption, this report disagreed with KNBS, (2011) report which pegged the rate of access/adoption of TVs at 29.2% (some extent) while the rate of access to computers was pegged at 4.3% (small extent) among the rural dwellers in Nyanza.

In overall, the results from this study agrees with the findings of (Jumia,2019; Kenya National Bureau of Statistics, 2011; Mwombe *et al.*, 2013 and Ani *et al.*, 2015) which also ascertained that mobile phone and radio are the dominant technologies adopted by most households in Kenya and that the adoption of computers and TVs is still very low.

This study hypothesized that for the proper development of human capacity, education is essential. This is because it enables individuals to acquire knowledge besides instilling proper conduct as well as technical knowhow. Given the above underlying facts, this study collected basic information on farmers' education status.

Table 4.9 Level of Education of farmers and Information Adoption

		Mobile phone adopted	Radio adopted	TV adopted	Computer adopted	Usage	Total
Education level	Primary	88.1%[5]	78.0%[4]	23.9%[2]	2.8%[1]	17.4%[1]	109
	Secondary	95.7%[5]	87.1%[5]	52.1%[3]	19.3%[1]	14.3%[1]	140
	Diploma	100%[5]	92.1%[5]	80.4%[5]	49.0%[3]	5.9%[1]	51
	Graduate	92.3%[5]	84.6%[5]	46.2%[3]	23.1%[2]	7.7%[1]	13
	Post graduate	75.0%[4]	25.0%[2]	25.0%[2]	0%[0]	0%[0]	4
Total		93.4%[5]	83.9%[5]	46.4%[3]	18.3%[1]	13.6%[1]	317

N/B: "Use" column shows the number of those using the gadgets to seek for information

Source: Survey Data (2020)

With regard to the farmers' level of education and their level of adoption of the information gadgets, Table 4.9 revealed that mobile phones were adopted to a "great extent" a rate of 93.4%. Radios were also adopted to a "great extent" at 83.9%. Televisions were adopted to a moderate extent at 46.4%. Computers were adopted to a small extent at 18.3%.

From this result, the deduction was that although majority of the people had some form of education and also greatly adopted mobile phones and radios, such gadgets were not being used to solicit for agricultural information. This result is also in consonance with GSMA, (2019) report that also ascertained that illiteracy and the perceived lack of relevance are the most important barriers to mobile ownership and mobile internet use among the people.

The findings were also congruent with Jumia, (2019) that put the level of mobile phones penetration to 93% and also with Riddell & Song, (2012) which also suggested that the level of education is not a significant determinant to technology use. However, the results departed from Flecher, (2013) findings which ascertained that the uptake and usage of technology was higher in South Carolina.

Given that there were 3 types of farmers' namely pure sugarcane farmers, pure food crop farmers as well as mixed crop farmers, this study investigated the level of adoption across these farmer types and results are given below.

Table 4.10 Farmer Type and Information Adoption

Farmer type	Mobile	Radios	TV	Computer	Total
Sugarcane	90.9% [5]	78.8%[4]	75.8%[4]	42.4%[4	33
Mixed	92.1%[5]	82.9%[5]	29.9%[2]	2.4%[1]	164
Food crop	95.8%[5]	86.7%[5]	60.8%[4]	30%[2]	120
Totals	93.4%[5]	83.9%[5]	46.4%[3]	18.3%[1]	317

Source: Survey Data (2020); [ ] weights on extent of adoption

From Table 4.10, the results showed that food crop farmers had a higher adoption level (95.8%) than the pure sugarcane farmers (90.9%) as well as the mixed farmers (92.1%) on mobile phones. still on radio adoption, "food crop only" farmers had a higher level of adoption (86.7%) than the sugarcane only farmers (78.8%) and mixed farmers (82.9%). With regard to TV adoption, sugarcane only farmers had the highest adoption level (75.8%) than the food crop only farmers (60.8%) and the mixed farmers (29.9%). Consequently, sugarcane only farmers had the highest adoption level on computers (42.4%) than the food crop only farmers (30%) and mixed crop farmers (2.4%). On average, the level of adoption of the information gadgets across the farmer type revealed that sugarcane farmers had the highest adoption rate (72%), followed by food crop farmers (68.3%) and lastly mixed crop farmers (51.8%). The "total column" is the number of farmers in each category.

Although this study examined the role of information technology adoption as one of the variables, their utilization was also brought into perspective. This was examined from the perspective of usage costs. The rating of these costs was done and the respondents' perception about their cost of usage was sought. From Table 7 (in Appendix D), the results indicated that 74.3% of the respondents rated the cost of mobile phone utilization to be fair. 23.3% thought that the cost of utilization was high while 2.4% of the respondents felt that the cost was low. With regard to radio utilization, 72% felt that the cost was fair, 15% felt that the cost was low whereas 13% felt that the cost was high. Coming to TV utility, 55% felt that the cost was high, 39% felt that the cost was fair while 6% felt that the cost was low. Although the cost of adoption of the computers was perceived to be high, cost of utilization was considered generally fair by 76% of the respondents, 22% felt that the cost was high while 2% felt that the cost was low.

4.3.2 Utilization of Information Gadgets to Increase Agricultural Production

This study sought to find out whether the farmers were actually making use of such technologies to increase agricultural productivity or not. Results were shown in Table 4.11.

Table 4.11 Utilization of Information Gadgets to Increase Agricultural Production (%)

Technology use	SA(5)	A(4)%	I(3)%	D(2)%	SD(1)%	Verdict %	Average weights
New methods of cultivating	25.2%	16.1%	14.8%	5.0%	38.8%	41.3%	1.8
New methods of planting	24.3%	10.7%	19.9%	23.3%	21.8%	35.0%	1.9
New marketing areas	10.7%	8.2%	7.9%	34.1%	39.1%	18.9%	1.7
Sources of raw materials	10.7%	9.8%	20.8%	39.1%	19.6%	20.5%	2.1
Peer referrals /social media	1.3%	8.5%	6.9%	42.3%	41.0%	9.8%	1.8
For Remote sensing	2.2%	7.6%	6.9%	57.7%	25.6%	9.8%	1.9
To get soil data	6.0%	5%	6.9%	45.4%	36.6%	11.0%	1.7
To get weather updates	19.6%	12%	18.9%	32.2%	17.4%	31.6%	2.0
To buy farm inputs	13.5%	12.9%	18.3%	23.3%	31.5%	26.4%	2.0
Overall average weights							**1.9**

SD= strongly disagree; D= disagree; U= undecided; A= agree; SA= strongly agree;
Verdict: majority responses based on the Likert scale

Source: Survey Data (2020)

By adding the percentages in the "strongly agree" and "agree" columns in Table 4.11, results indicated that 41.3% of the farmers used information technology to learn new methods of cultivation while 43.8% did not; 35% used the technology to learn new methods of planting against 45.1% who did not; 18.9% used the technology to access new markets against 73.2% who did not use the technology; only 20.5% used the technology to access cheaper raw materials against 58.7% who did not; 9.8% of the respondents used technology to access remote sensing against 83.3% who did not; 11% used the technology to analyze the information on soil data against 82% who did not; 31.6% used the technology to get weather updates while 49.6% did not; 26.4% used technology to buy inputs while 54.8% did not; 9.8% used technology to access peer referrals against 83.3% who did not.

Likert scale of strongly disagree, disagree, undecided, agree and strongly agree were given the weights of 1, 2, 3, 4 and 5 respectively. In order to obtain the average weights that was used to depict the overall sentiments from the respondents, these weights were multiplied by the percentages of use and ultimately divided by 100%. It was clear that the average weights oscillated within 1.7 to 2.1, a clear reflection that the respondents did not use the gadgets to source for agricultural information that could be useful to increase productivity.

In order to establish the extent of the gadgets utilization to increase productivity across farmer type, the dimensions in Table 3.5 was used and the results given in Table 4.12 below.

Table 4.12 Utilization of Gadgets to Increase Productivity across Farmer Types

	Agreement on the extent of use					Total
Farmers	SD	D	I	A	SA	
Sugarcane	(36.4%)[2]	(33.3%)[2]	(18.2%)[1]	(12.1%)[1]	0%	33
Mixed	(14.0%)[1]	(14.6%)[1]	(51.8%)[3]	(17.1%)[1]	(2.5%)[1]	164
Food crops	(36.7%)[2]	(29.2%)[2]	(28.3%)[2]	(4.2%)[1]	(1.6%)[1]	120
Total	(24.9%)[2]	(22.1%)[2]	(39.4%)[2]	(11.7%)[1]	(1.9%)[1]	317

Source: Survey Data (2020); [ ] Weights

From Table 4.12, those farmers who used the gadgets to source for agricultural information linked towards increasing productivity were 13.6% (the summation of 11.7 % and 1.9%) and they used these gadgets to a smaller extent. As a result, this study established that although information adoption increased with the increases in the level of education, its usage across different farmers was negligible as depicted in Table 4.12. The results indicated that information utilization was undertaken to a small extent by 43 farmers out of a sample of 317 farmers.

Given these results, the findings agreed with Ani *et.al* (2015) observations about the low usage/utilization of information in agricultural production in Nigeria and negated that of Flecher, (2013) which established higher information utilization in South Carolina.

4.3.4 Socio- Demographic Test of Difference on Information Adoption and Utilization

To test for the differences on information adoption and utilization based on their socio- gender and the level of education among the farmers, this study used the Chi square as a non-parametric test, to determine such differences at their nominal level. The chi square test was used to determine the level of association. The probabilities were used to ascertain the correctness that the demographic characteristics (gender and education level) were different on information adoption and utilization.

The test of statistical differences was conducted on gender under the following hypotheses;

H_0: There is no statistical difference across the gender spectrum

H_1: There is statistical difference across the gender spectrum

The method was used because of its robustness with respect to the distribution of the data coupled with its ability to be used in multiple group studies (McHugh, 2013). This test was performed by analyzing the cross tabs under descriptive statistics. Thereafter the chi square was established by using Phi and Crammers V after the expected was checked under cells and percentages taken on the rows.

Table 4.13 Statistical Difference on Gender and information adoption and utilization

	Male		Female		Chi square	Probability
	No	Adoption	No	Adoption		
New methods of cultivation	98	94	41	37	5.684	0.224
New methods of Planting	102	75	41	36	3.952	0.413
Access to new markets	162	44	70	16	10.779	0.029
Access to cheaper raw materials	132	42	54	22	6.741	0.15
Access to referrals	184	22	80	9	6.074	0.194
Perform remote sensing	180	26	84	5	16.344	0.03
Access to soil data	180	26	80	9	10.39	0.035
Getting weather updates	112	67	45	33	8.928	0.063
Buying farm inputs	126	56	48	25	4.01	0.405

Source: Survey Data (2020)

From Table 4.13, the probability values under access to new markets; remote sensing and access to soil data, were less than 5%. This meant that there were significant differences in gender regarding information adoption and utilization in agricultural practices. Hence, the null hypothesis was rejected. The null hypotheses on all the remaining components were accepted. This meant that there is an association between gender and information adoption and utilization on searching for new methods of cultivation, planting, access to cheaper raw materials, referrals getting weather updates and buying of farm inputs. In all these analyses, those who were indifferent in their responses were excluded from the totals. However, the question of gender on technology adoption is not clear. As quoted by Mwangi & Kariuki, (2015), most studies have expressed mixed results with regard to the role played by women and men regarding technology adoption.

The statistical test of differences across the various levels of education was performed under the following hypothesis;

H_0 : There is no statistical difference across the level of education

H_1: There is statistical difference across the level of education

Table 4.14 Statistical Differences on Education Level and Information Adoption and Utilization

	Primary	Secondary	Tertiary	Graduate	Chi square	Probability
Methods of cultivation	61	58	5	6	60.978	0
Methods of Planting	52	47	5	4	72.623	0
Access to new markets	23	31	2	3	29.979	0.018
Cheaper raw materials	26	33	4	2	37.646	0.002
Access to referrals	16	8	4	3	21.22	0.17
Perform remote sensing	11	12	7	1	18.322	0.305
Access to soil data	8	18	7	2	24.896	0.072
Getting weather updates	44	47	6	3	48.242	0
Buying farm inputs	35	37	9	4	25.399	0.063

Source: Survey Data (2020)

From Table 4.14, reflected the results of those who were using the information gadgets on the said activities. The results indicated that probabilities on information adoption and utilization based on the levels of education were significant on the methods of cultivation, methods of planting, access to new markets, access to cheaper raw materials and getting weather updates. This led to the acceptance of the alternative hypothesis that education had an association with the said activities. However, it was not significant on access to referrals, remote sensing, and access to soil data and on buying farm inputs. In this analysis too, respondents who were indifferent were also excluded.

4.4: Objective 2 -Relationship between Cost of Sugarcane Production and Food production

The second objective in this study was to determine the relationship between the cost of sugarcane production and the cost of food production, (a proxy for food production). The null hypothesis was that cost of sugarcane production was not related to the cost of food production. In order to achieve this, the characteristics of sugarcane and its related costs of production together with the characteristics of food production and its related costs were investigated. the descriptives of sugarcane were as follows;

4.4.1 Descriptive Statistics on Cost of Sugarcane Farming

Given that this study was premised on the need to establish the relationship between the cost of sugarcane production and cost of food production, it was imperative to assess whether the respondents were sugarcane farmers or not. If on the affirmative, reasons for engaging in the plantation of the crop, was ascertained. If not, the various challenges that dissuaded farmers from undertaking this type of agriculture were also assessed. Thereafter, the various descriptive statistics and other tests were conducted on the cost of sugarcane production.

Pertaining to the reasons for engaging in sugarcane production, there were a total of 197 farmers who either engaged in pure sugarcane farming or those who practiced mixed farming of sugarcane together with food crops. By isolating sugarcane farming from this two categories, Table 7 (in Appendix D) showed that there were 197 (63.4%) of the total 317 covered by this study. From this response, 120 farmers (60.9%) perceived sugarcane farming to possess higher returns, 48 farmers (24.4%) cited favorable condition, 24 farmers (12.2%) did sugarcane farming as a tradition while 3 farmers (1.5%) gave more than one reason for opting for sugarcane growing. It was also noted that most sugarcane farmers (79.6%) practiced non-contracted farming. The rest (20.4%) were contracted (Refer to Table 6 in Appendix D).

The descriptive statistics on the actual figures of the variables used in sugarcane production was conducted. Kurtosis and skewness values indicated that the variables were not normally distributed. Skewness depicted that the variables were positively skewed. Consequently, Kurtosis values were also greater than 3, a threshold for normal distribution. This suggested that the variables were all platykurtic relative to the normal (Refer to Table 10 on the appendix).

Because of this absence of normality, confirmation was done by assessing normality plot with test (under explore). Kolmogorov- Smirnov and Shapiro-Wilk tests results showed that the probabilities were significant leading to the acceptance of the null hypothesis that the variables were not normally distributed (Refer to Table 11 on the appendix)

Investigation on the level of association between the constructs that made the cost of sugarcane production revealed that cost of renting land was significant and positively correlated with the cost of labour, planting, fertilizer use and seedling. Coefficients of Correlation were $(r = 0.282; p = 0.000); (r = 0.374; p = 0.000); (r = 0.113; p = 0.044)$ & $(r = 0.290; p = 0.000)$ respectively. This meant that as the cost of renting land increases, the cost of labour, cost of planting, cost of fertilizer use as well as the cost of seedling are likely to also increase significantly since they tend to move in the same direction. This meant that should the cost of labour, planting, fertilizers and seedlings be increased, the cost of land rents is also likely to increase. Given this, a percentage change in the cost of land tended to influence the cost of labour, cost of planting, cost of fertilizers and cost of seedlings to change by 0.282; 0.374; 0.113; and 0.290 respectively (Refer to Table 12 in appendix D).

Apart from the cost of rent, cost of labour in sugarcane production was positively correlated with the cost of planting, fertilizer and seedlings. The coefficients of correlation were $(r = 0.448; p = 0.000); (r = 0.212; p = 0.000); (r = 0.150; p = 0.008)$ respectively. This meant that as the cost of labour increases, the cost of planting, fertilizer and seedlings are also likely to increase significantly. Given this, a percentage change in the cost of labour tended to influence the cost of labour, cost of planting, cost of fertilizers and cost of seedlings to realize a percentage change by 0.448; 0.212; 0.150 respectively (Refer to Table 12 in Appendix D).

Apart from the cost of rent and cost of labour, the cost of planting was positively and significantly correlated with the cost of fertilizers, pesticides and seedlings. The coefficient of correlation (r) $= (r = 0.208; p = 0.000); (r = 0.407; p = 0.000)$ & $(r = 0.165; p = 0.003)$ respectively. This meant that as the cost of labour increases, the cost of fertilizers, pesticides and seedlings are all likely to increase significantly. This showed that a percentage change in the cost of planting tended to influence cost of fertilizers ; cost of pesticides and cost of seedlings to realize a percentage change by 0.208; 0.407; and 0.165 respectively.

Similarly, apart from the cost of rent, cost of fertilizer and cost of planting, cost of seedling was also significantly correlated with the cost of transport $(r = 0.199; p = 0.000)$, meaning that as the as the cost of seedlings increased, the cost of transport were likely to increase significantly i.e. a percentage change in the cost of transport tended to influence the cost of seedlings to change by 0.199 percent (Refer to Table 12 in Appendix D).

4.4.2 Descriptive Statistics on Cost of Food Production

In this study, food production was investigated in terms of its availability i.e. farmers' capacity to avail food into the nearest markets for sale.to make food become available, farmers incur various costs to produce it. These costs are on land, capital and labour. Although growing "own food" may be a necessary condition to food production, it may not be a sufficient condition since food can as well be bought or sold from or to the market.

The aspect of food production among the farmers was approached from two angles. This was because there were those farmers who practiced food crop farming together with sugarcane farming and there were also those farmers who devoted all their resources to food crop production only. Results indicated that out of 197 respondents who grew sugarcane, only 33 respondents (16.8%) were pure sugarcane farmers; otherwise, 83.2% were mixed crop farmers. In totality, the results indicated that 89.6% of the total respondents practiced food crop farming. The "Adoption" among sugarcane farmers was an admission to planting food crops. "No" in sugarcane farming was a denial to planting food crops (refer to Table 13 in Appendix D)

The need to investigate the percentage of farmers who practiced food crop production across the agro ecological zones was imperative. Refering to Table 14 (in Appendix D), results indicated that in Sony, 81.7% of their farmers practiced food crop farming; in chemelil, all their farmers practiced food crop farming; in muhoroni, all their farmers practiced food crop farming while in Ndhiwa sugar belt, 88.9% of their farmers practiced food crop farming. From the 284 farmers (89.6% of the total respondents) who practiced food crop farming, each farmer had a number of food crops grown.

From Table 5 (in Appendix D) 88.7% of the farmers grew maize (millet, sorghum), 83.4% grew beans (peas, green grams), 80.2% grew vegetables (sukuma, cabbages, tomatoes, kienyeji), 70.4% grew fruits (bananas, oranges). Nuts (ground nuts, pea nuts, sesame, etc.) as well as other cereals (rice, wheat etc.) were only grown by 42.1% and 19% respectively.

Given the investigation on the cost of food production, diagnostic tests on the various cost components were performed. These were the cost of land (rent), labour, planting, fertilizers, pesticides, seedlings, transport and maintenance of machineries. This study computed descriptive statistics to examine the normality of the variables. Results showed that the variables that defined cost of food production were not normally distributed given skewness and Kurtosis values. Skewness value depicted a positive skew. On Kurtosis, the values were greater than 3, the threshold of a normal distribution. This suggested that the cost of inputs in food production were all platykurtic relative to the normal (Refer to Table 15 in Appendix D)

Since the cost of inputs in food production were not normal, a further investigation to test for normality was done using Kolmogorov-Smirnov and Shapiro-Wilk techniques using normality plot with test. The Kolmogorov- Smirnov and Shapiro-Wilk tests revealed that the probabilities were significant. This study therefore accepted the null hypothesis that the variables were indeed not normally distributed and hence the choice of using non parametric test to obtain the objectives of this study (Refer to Table 16 in Appendix D).

Once the normality and the distribution tests were conducted, correlation test was also done on the cost elements that comprised the cost of food production. Results indicated that there was a positive and significantly correlation between cost of cultivation and the cost of planting, cost of fertilizer; transport and maintenance $(r = 0.815; p = 0.000)$; $(r = 0.495; p = 0.000)$; $(r = 0.341; p = 0.000)$; $(r = 0.217; p = 0.000)$ respectively. This meant that as the cost of cultivation tended to increase, the cost of planting, cost of fertilizer, cost of transport and cost of maintenance also tended to increase by 0.815; 0.495; 0.341 and 0.217 respectively (Refer to Table 17 in Appendix D).

Apart from the cost of cultivation, the cost of planting was significant and positively correlated with the cost of fertilizers (r = 0.399; p = 0.000), cost of transport (r = 0.468; p = 0.000) and to the cost of repairs (r = 0.429; 0.000). This meant that as the cost of planting tended to increase, the cost of fertilizer, cost of transport and the cost of repairs also tended to increase by 0.399; 0.468 and 0.429 respectively(Refer to Table 17 in Appendix D).

Apart from cost of cultivation and cost of labour, the cost of fertilizers was positively and significantly correlated with the costs of pesticides (r = 0.160; p = 0.000) and cost of seedlings (r = 0.223; p = 0.000). This meant that as the cost of fertilizer tended to increase; the cost of pesticides and the cost of seedlings also tended to increase by 0.160 and 0.223 respectively (Refer to Table 17 in Appendix D).

Apart from the cost of fertilizer, cost of pesticides were significant and positively correlated with the cost of seedlings $(r = 0.327; p = 0.000)$ implying that as the cost of fertilizers tended to increase, the costs of seedlings also tended to increase by 0.327 (Refer to Table 17 in Appendix D).

4.4.3 Correlation between the Costs of Constructs in Sugarcane and Food Production

Having investigated the correlations between the costs of the various factors used in both the production of sugarcane and food production, a summary of these costs were grouped into three categories namely cost of land, cost of labour and cost of capital. As such, these input production factors formed the ultimate constructs in the analysis on the cost of sugarcane production as well as cost of food production.

Table 4.15 Correlation Matrix between Cost Elements in Sugarcane and Food Production

		Labour(S)	Capital(S)	Land(S)	Labour(F)	Capital(F)	Land(F)
Labour (S)	Pearson Correlation	1					
	Sig. (2-tailed)						
Capital (S)	Pearson Correlation	.380**	1				
	Sig. (2-tailed)	.000					
Land (S)	Pearson Correlation	.560**	.268**	1			
	Sig. (2-tailed)	.000	.000				
Labour (F)	Pearson Correlation	.091	.180**	.060	1		
	Sig. (2-tailed)	.105	.001	.284			
Capital (F)	Pearson Correlation	.019	.075	-.014	.296**	1	
	Sig. (2-tailed)	.733	.180	.798	.000		
Land (F)	Pearson Correlation	.296**	.235**	.614**	-.057	-.072	1
	Sig. (2-tailed)	.000	.000	.000	.312	.201	
	N	317	317	317	317	317	317

**. Correlation is significant at the 0.01 level (2-tailed); (S)= Sugarcane; ((F)= Food crops

Source: Survey Data (2020)

In Table 4.15, the cost of factors of production used in sugarcane production was correlated with the cost of factors used in food production. The correlation results indicated that cost of labour in sugarcane production was positively correlated with cost of capital used in sugarcane production, cost of land in sugarcane production as well as cost of land used in food production. The coefficient of correlation were $(r = 0.380; p = 0.000)$; $(r = 0.560; p = 0.000)$ $(r = 0.296; p = 0.000)$ respectively. This therefore meant that as the cost of labour in sugarcane production tended to increase, the cost of capital in sugarcane production tended to weakly increase, cost of land in sugarcane production tended to strongly increase and the cost of land in food production also tended to weakly increase.

Apart from the cost of labour in sugarcane production, cost of capital in sugarcane production was significant and positively correlated with the cost of land in sugarcane production (r =0.268; p =0.000); cost of labour in food production as well as cost of cost of land in food production. The correlation coefficients were $(r = 0.180; p = 0.001); (r = 0.235; p = 0.000)$ respectively. This meant that as the cost of capital in sugarcane production tended to increase, the cost of land in sugarcane production tended to increase by 0.268; the per unit cost of labour in food production tended to increase by 0.18 and the cost of per unit cost of land in food production also tended to increase by 0.235.

Apart from the cost of labour and cost of capital in sugarcane production, cost of land in sugarcane production was also significant and positively correlated with the cost of land in food production $(r = 0.614; p = 0.000)$. This meant that as the cost of land in sugarcane production tended to increase, the cost of land in food production also tended to strongly increase by 0.614.

Given that cost of labour in food production was significant and positively correlated with the cost of capital in food production $(r = 0.296; p = 0.000)$; it meant that as the cost of labour tended to increase, the cost of capital in food production also tended to increase by 0.296.

4.4.4 Relationship between Cost of Sugarcane Production and Cost of Food Production

The regression analysis on the cost of sugarcane production and cost of food production was performed using the structural equation model.

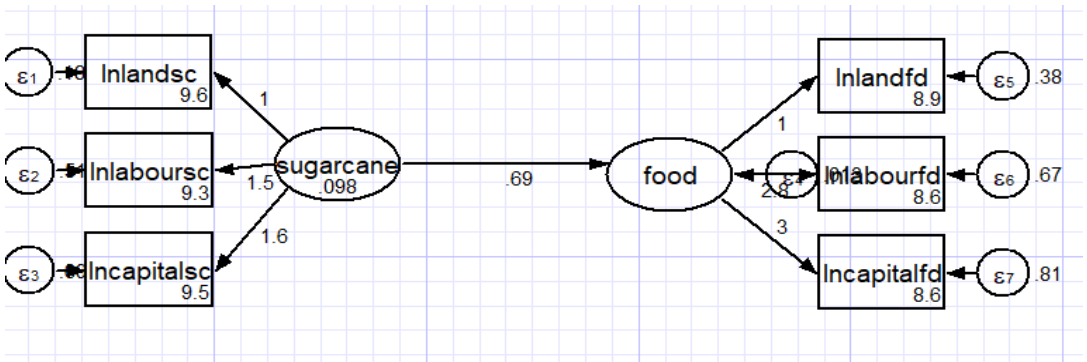


Figure 4.1 Relationship between Cost of Sugarcane Production and Cost of Food Production

Figure 4.1 depicted the results on the relationship between cost of sugarcane production and cost of food production and the generated estimates. These estimates were expressed in Table 4.16.

Table 4.16 Structural Equation Model of Sugarcane Production on Food production

Structural equation model — Number of obs = 317
Estimation method = mlmv
Log likelihood = -1305.8945

	Coef.	OIM Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
Food production						
Sugarcane	.689	.219	3.15	0.002	.260	1.117
Measurement						
lnland(sc)						
Sugarcane	1	(constrained)				
Cons	9.622	.037	258.21	0.000	9.549	9.695
lnlabour (sc)						
Sugarcane	1.465	.446	3.28	0.001	.590	2.339
Cons	9.307	.066	141.32	0.000	9.178	9.436
Sugarcane	1.590	.381	4.17	0.000	.842	2.338
lncapital(sc)						
Cons	9.466	.0706	134.00	0.000	9.327	9.604
lnland(fd)						
Food production	1	(constrained)				
Cons	8.922	.042	213.23	0.000	8.840	9.004
lnlabour(fd)						
Food production	2.810	.945	2.97	0.003	.958	4.662
Cons	8.574	.091	94.22	0.000	8.395	8.752
lncapital(fd)						
Food production	2.984	.857	3.48	0.000	1.306	4.663
Cons	8.600	.081	106.71	0.000	8.442	8.758

LR test of model vs. saturated: chi2 (8) = 29.95, Prob > chi2 = 0.0002; R-square =0.833 Sc= sugarcane; fd = food

Source: Survey Data (2020)

From Table 4.16, cost of sugarcane production is positive and significant in the determination of cost of food production $(\alpha_1 = 0.689; p = 0.002)$. This implied that the level of responsiveness to changes in the cost of food due to changes in the cost of sugarcane production is positive, significant but inelastic i.e. as the cost of sugarcane production changes by a certain proportion, the cost of food production also changes but by less than the proportionate increase in the cost of sugarcane production. With regard to the cost of the constructs (inputs) required in sugarcane farming, the level of responsiveness to changes in the cost of sugarcane production due to changes in the cost of labour is elastic, positive and significant $(\alpha_2 = 1.465; p = 0.001)$. Similarly, the level of responsiveness to changes in the cost of sugarcane production due to changes in the cost of capital is elastic, positive and significant $(\alpha_3 = 1.590; p = 0.000)$. This means that as the cost of labour and cost of capital changes, the cost of sugarcane production also changes by more than the proportionate change in the cost of labour and cost of capital respectively.

With regard to the cost of inputs used in food production, the level of responsiveness to cost of food production due to changes in the cost of labour was elastic, positive and significant $(\alpha_4 = 2.810; p = 0.003)$. Similarly, the level of responsiveness to the cost of food production due to changes in the cost of capital used in food production was elastic, positive and significant $(\alpha_5 = 2.984; p = 0.000)$. All these meant that as the cost of labour and cost of capital changes by a given percentage, the cost of food production changes by 2.810 times the change in the cost of labour and 2.984 times the change in the cost of capital.

From Table 18 (in Appendix D), the goodness of fit was 0.833 meaning that the overall cost of sugarcane production explained 83.3% variations in the cost of food production. As such, the alternative hypothesis in objective 2 was accepted i.e. cost of sugarcane production significantly influences the cost of food production.

These findings are in tandem with Cogneau & Jedwab (2012) who also ascertained that if the cost of sugarcane cash crop increases, it creates a positive upon the food prices thus bringing about food insecurity through the increases in price levels. Equally, a similar observation was witnessed by Wafula *et.al* (2010) after observing that high cost of sugarcane results in food deficiency.

4.5: Objective 3 - Determination of the Cost Efficiency Level in Production

Given that this study established the existence of three different types of farmers (sugarcane farmers only, food crop farmers only and those who practiced mixed farming i.e. sugarcane and food crops) such were coded appropriately and a multinomial logit used to determine the likelihood of adopting a particular farming practice. This is because a multinomial logit regression is appropriate when the dependent variable is nominal with more than two levels. In the categorization, sugarcane only farmers were coded (1), mixed farmers were coded (2) while food crops "only" farmers were coded (3). The chosen base/reference category was the mixed farmers. The results were captured in Table 4.17.

Table 4.17 Multinomial Regression to Determine the Likelihood of Farmer Type Adoption

Multinomial logistic regression	Number of obs = 215
	LR chi2 (6) = 116.07
	Prob > chi2 = 0.0000
Log likelihood = -105.385	Pseudo R2 = 0.355

Farmer type	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Type 1: Sugarcane						
Lnlabour	1.006	.699	1.44	0.150	-.363	2.375
Lncapital	.415	.263	1.58	0.115	-.101	.931
Lnland	-2.759	.719	-3.84	0.000	-4.168	-1.349
Cons	11.683	4.191	2.79	0.005	3.469	19.897
Type 2: Mixed farmers	(base outcome)					
Type 3: Food crops						
Lnlabour	-2.839	.881	-3.22	0.001	-4.565	-1.112
Lncapital	-.816	.405	-2.02	0.044	-1.609	-.023
Lnland	-.747	.897	-0.83	0.406	-2.506	1.013
Cons	38.555	7.955	4.85	0.000	22.963	54.147

Source: Survey Data (2020)

Based on Table 4.17, probability of the chi-square was statistically significant hence, the model was correctly specified. The Pseudo R-square was 0.3551 meaning that in overall, 35.51% of the farmer choice was as a result of these observable characteristics namely the lnlabour, lncapital and lnland. With regard to sugarcane farmers (type 1), coefficient on the cost of land was negative and significant $(\alpha_3 = -2.759; p = 0.000)$. This meant that the level of responsiveness for farmers to lean towards sugarcane farming due to changes in the cost of land was elastic, significant but negative. This implied that farmers are less likely to lean towards sugarcane farming than towards mixed farming when the cost of land increases.

With reference to food crops farming, the coefficients on the cost of labour and the cost of capital were $(\beta_1 = -2.839; p = 0.001); (\beta_2 = -0.816; p = 0.044)$. This indicated that the level of responsiveness towards food production due to changes in the cost of labour was elastic, significant and negative. With regard changes in the cost of capital, the responsiveness towards food production was inelastic, significant and negative. These coefficients implied that farmers are less likely to lean towards pure food production than to mixed farming when the cost of labour and the cost of capital increase.

In the determination of the cost efficiency level, Stochastic Frontier Analysis (SFA) with a truncated normal distribution was used. The truncated normal distribution was adopted because it allows for the approximation of stochastic frontier and inefficiency effects using a one-step approach. It interrogated the level of inefficiency based on the choice of the farmer type with regard to total output. The total cost of output was a summation of the cost of sugarcane and cost of food crops produced by the individual farmer per yield. The frontier was built on input efficiency level and results shown in Table 4.18.

Table 4.18 Major Contributors to Costs in Sugarcane Production

Stoc. frontier normal/tnormal model					Number of obs =	33
					Wald chi2(3) =	16.87
					Prob > chi2 =	0.0008
Log likelihood = 15.600						
Lnoutputsc	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Frontier						
Lnlandsc	.252	.076	3.33	0.001	.104	.401
Lnlaboursc	-.008	.006	-1.29	0.195	-.020	.004
Lncapitalsc	.013	.015	0.87	0.385	-.016	.042
Cons	9.540	.721	13.22	0.000	8.126	10.953
Usigma						
Cons	-6.430	377.266	-0.02	0.986	-745.857	732.997
Vsigma						
Cons	-3.783	.247	-15.32	0.000	-4.267	-3.299
sigma_u	.040	7.573	0.01	0.996	1.1e-162	1.5e+159
sigma_v	.151	.019	8.10	0.000	.118	.192
Lambda	.266	7.574	0.04	0.972	-14.578	15.110

Source: Survey Data (2020)

From Table 4.18, the frontier analysis indicated that the coefficient on the cost of land was positive and significant in increasing sugarcane output costs $(\alpha_1 = 0.252; p = 0.001)$ i.e. the responsiveness to the cost of sugarcane output is inelastic, positive and significant to changes in the cost of land. This means that as the cost of land changes by a certain proportion, the cost in sugarcane production also changes but by less than the proportionate change in the cost of land. Similarly, the coefficient in sigma V sigma (the random component) is positive and significant $(\alpha_5 = -3.783; p = 0.000)$. This meant that the responsiveness to the cost of sugarcane output is elastic to variations in the random component. Therefore as the random component changes by a certain proportion, cost of sugarcane inefficiencies among farmers increases by more than the proportionate change in the random component.

The standard deviation for the inefficiency term (sigma u) is 0.040 and that for the random term (sigma v) is 0.151. From these, the estimated total variance from the inefficiency variance component and from the random variance component given by $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2$ implies that;

$$\sigma_{inefficiency}^2 = 0.0016$$

$\sigma^2_{random} = 0.022801$

The total variance $\sigma^2_T = \sigma^2_{inefficiency} + \sigma^2_{random} = 0.024401.$

The variance of output due to cost inefficiency = $\frac{0.0016}{0.024401} = 0.066$;

This implies that cost inefficiency is accounting to almost 6.6% variation in sugarcane productions.

Table 4.19 Major Contributors to Costs in Food Production

Stoc. frontier normal/tnormal model — Number of obs = 164; Wald chi2(3) = 34.25; Prob > chi2 = 0.0000

Log likelihood = -187.807

Lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Frontier						
lnlandfd	.157	.050	3.12	0.002	.058	.255
lnlabourfd	.029	.016	1.81	0.071	-.002	.061
lncapitalfd	.057	.020	2.79	0.005	.017	.096
cons	8.643	.637	13.56	0.000	7.394	9.893
Usigma						
cons	-5.515	118.479	-0.05	0.963	-237.731	226.7
Vsigma						
cons	-.548	.111	-4.94	0.000	-.765	-.330
sigma_u	.063	3.758	0.02	0.987	2.38e-52	1.69e+49
sigma_v	.760	.042	18.04	0.000	.682	.848
lambda	.083	3.760	0.02	0.982	-7.287	7.453

Source: Survey Data (2020)

According to Table 4.19, the coefficients on the cost of land and cost of capital in food production are positive and significant, $(\alpha_1 = 0.157; p = 0.002)$ and $(\alpha_3 = 0.057; p = 0.005)$ respectively. This indicated that the level of responsiveness on cost of food production due to variations in the cost of land is inelastic, positive and significant. This implies that as the cost of labour changes by a certain proportion, the cost of food production also changes but by less than the proportionate increase in the cost of land. Similarly, the level of responsiveness on the cost of food production due to the variations in the cost of capital is inelastic, positive and significant. This means that as the costs of capital changes by a certain proportion, the level of food production inefficiencies also changes but by less than the proportionate change in the cost of capital. Lastly, the coefficient of the random error component (V sigma) is negative and significant ($\alpha_5 = -0.548; 0.000$). This implies that the level of responsiveness on cost of food production due to variations in the random component is inelastic, negative and significant. Due to this, proportionate changes in the random component also changes the level of inefficiency in cost of food production but by less than the proportionate change in the random component.

The standard deviation for the inefficiency term (sigma U) is 0.063 and that for the random term (sigma V) is 0.760. From these, the estimated total variance from the inefficiency variance component and from the random variance component given by $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2$ implies that;

$\sigma_{inefficiency}^2 = 0.003969$

$\sigma_{random}^2 = 0.5776$

The total variance $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2 = 0.581569.$

The variance of output due to cost inefficiency = $\frac{0.003969}{0.581569} = 0.00682;$

This implies that cost inefficiency is accounting to almost 0.682% variation in cost of food productions.

Table 4.20 Major Contributors to Cost in Mixed Production

Stoc. frontier normal/tnormal model				Number of obs =	120	
				Wald chi2(3) =	18.62	
				Prob > chi2 =	0.0003	
Log likelihood = -13.0661						
lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Frontier						
lnlandfd	.442	.168	2.63	0.009	.113	.772
lnlabourfd	.011	.049	0.22	0.824	-.084	.106
lncapitalfd	.313	.095	3.30	0.001	.127	.500
cons	3.969	1.858	2.14	0.033	.328	7.612
Usigma						
cons	-6.828	309.291	-0.02	0.982	-613.028	599.372
Vsigma						
cons	-1.793	.283	-6.34	0.000	-2.347	-1.238
sigma_u	.0329	5.089	0.01	0.995	7.6e-134	1.4e+130
sigma_v	.408	.058	7.07	0.000	.309	.538
lambda	.081	5.091	0.02	0.987	-9.897	10.059

Source: Survey Data (2020)

From Table 4.19, the coefficients on the cost of land and cost of capital in mixed production were positive and significant $(\alpha_1 = 0.443; p = 0.009)$ and $(\alpha_3 = 0.314; p = 0.001)$. This indicated that the level of responsiveness to cost of mixed production due to variations in the cost of land is inelastic, positive and significant i.e. increasing cost of land raises the cost of mixed production inefficiencies. Similarly, the level of responsiveness on the cost of mixed production due to the variations in the cost of capital is inelastic, positive and significant. This means that increasing costs of capital increases inefficiencies in cost of mixed production. Lastly, the coefficient of the random error component (V sigma) is negative and significant $(\alpha_5 = -1.793; 0.000)$. This implies that the level of responsiveness on cost of mixed production due to variations in the random component is elastic, negative and significant. Due to this, increases in the random component increases the level of inefficiency in cost of mixed production.

The standard deviation for the inefficiency term (sigma U) is 0.033 and that for the random term (sigma V) is 0.408. From these, the estimated total variance from the inefficiency variance component and from the random variance component given by $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2$ implies that;

$\sigma_{inefficiency}^2 = 0.001089$

$\sigma_{random}^2 = 0.166464$

The total variance $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2 = 0.167553$

The variance of output due to cost inefficiency = $\frac{0.001089}{0.167553} = 0.006499$;

This implies that cost inefficiency is accounting to almost 0.6499% variation in mixed crop productions.

Table 4.21 Major Contributors to Cost of production to all Farmers

Stoc. Frontier normal/tnormal model
Number of obs = 317
Wald chi2 (3) = 77.83
Prob > chi2 = 0.0000
Log likelihood = -88.110

Lnoutput	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Frontier						
Lnlabour	-.006	.049	-0.12	0.906	-.102	.091
Lncapital	.063	.028	2.24	0.025	.008	.119
Lnland	.392	.066	5.96	0.000	.263	.521
Cons	7.875	.500	15.76	0.000	6.896	8.855
Mu						
Farmer type	1.519	.336	4.52	0.000	.860	2.178
Cons	-3.303	.988	-3.34	0.001	-5.240	-1.366
Usigma						
Cons	-1.779	.449	-3.96	0.000	-2.659	-.899
Vsigma						
Cons	-2.452	.198	-12.40	0.000	-2.840	-2.065
Sigma_u	.411	.092	4.45	0.000	.265	.638
Sigma_v	.293	.029	10.11	0.000	.242	.356
Lambda	1.400	.108	12.91	0.000	1.188	1.612

Source: Survey Data (2020)

Table 4.21 depicted the frontier analysis on the cost in/efficiency level. Results indicated that cost of capital was significant and positive in increasing cost of output to all the farmers $(\alpha_2 = 0.063; p = 0.025)$. This implied that the responsiveness to the overall level of cost of output was inelastic, positive and significant due to changes in the cost of capital. Similarly, cost of land was also positive and significant in influencing cost of output $(\alpha_3 = 0.392; p = 0.000)$. This meant that the responsiveness to the overall cost of output among the farmers is inelastic, positive and significant due to changes in the cost of land.

The dependent variable for cost inefficiency component that this study investigated was the variance choices for farmer type that farmers' make.it was proxied by (Mu) and from the results the coefficient for Mu was positive and statistically significant $(\alpha_4 = 1.519; p = 0.000)$. This means that the level of responsiveness of the overall cost of production due to the changes in the choices farmers make is elastic, positive and significant. This meant that the choices farmers makes, increases their level of inefficiency.

Sigma U is the error term due to inefficiency component while sigma V is the component term due to the random component. They are all significant in reducing the inefficiency level. This means that the responsiveness to changes in the level of output due to variations in the inefficiency component and the random component is elastic, negative and significant.

According to Battese & Coelli (1995), Stochastic Frontier functions suggest the presence of technical efficiencies in output production. In this study, the cost efficiencies were examined and the calculation of the Battese –Coelli coefficient was presented in Table 4.22. Given the results in Table 4.21, the calculation of Battess- Coelli coefficient revealed the following;

Table 4.22 Battese - Coelli Coefficient of Efficiency

Variable	Obs	Mean	Std. Dev.	Min	Max
BC	317	.7496	.1913	.1883	.9326

Source: Survey Data (2020)

From Table 4.22, the results indicated that the mean BC coefficient was 0.7496. This meant that the farmers cost efficiency level was at 74.96%. However, this efficiency is bounded between 18.83% and 93.26%.

Given this information, this study estimated the total variance from the inefficiency variance component as well as from the random variance component i.e. $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2$.

From Table 4.21, the standard deviation for the inefficiency term (sigma U) is 0.411 and that for the random term (sigma V) is 0.293. Given that the variance is the square of the standard deviations,

$\sigma_{inefficiency}^2 = 0.168921$

$\sigma_{random}^2 = 0.085849$

The total variance $\sigma_T^2 = \sigma_{inefficiency}^2 + \sigma_{random}^2 = 0.25477$.

The variance of output due to cost inefficiency = $\frac{0.168921}{0.25477} = 0.66303$;

This implies that cost inefficiency is accounting to almost 66.303% variation in both sugarcane production as well as food crop production. This ratio justifies the use of a stochastic frontier model.

Results for this objective are in tandem with Narayan (2004) findings which explained that cost of labour was an insignificant determinant of cost of sugarcane production whereas the cost of land and other related costs were significant determinants of cost of sugarcane production. Similarly, the results also agreed with Fatima & Yasmin (2016) findings on the level of efficiency in sugarcane production. Although the level of efficiency in Pakistan was 73%, the result from Nyanza region was 74.96%. Farmers in Nyanza region experience some level of cost inefficiency (25.04%) in their production and therefore the results agreed with Nyanjong' & Lagat, (2012) findings which also ascertained some level of inefficiency (37.5%) in Sony Sony.

4.5: Objective 4 - Role of Information Adoption and Utilization on the Cost of Sugarcane and Food Productions

Following the need to investigate the role of the cost of information adoption and utilization on the cost of sugarcane production and cost of food production, it was apparent that a summary of frequencies be determined upon these variables. As such, costs components on sugarcane production, food production as well as the cost components in information adoption and utilization, were added together to produce one value to represent the overall cost of sugarcane, cost of food production, cost of information adoption as well as cost of information utilization. Bootstrapping was done and Bias corrected accelerated (Bca) confidence level was also preferred on the data.

On Table 19 in Appendix D, the results indicated that cost of sugarcane production was approximately Kshs. 19884.39. However, it was still positively skewed (+3.01) and leptokurtic (Kurtosis = 13.51) but the Bca 95% confidence interval produced results that were all positive implying that they were statistically significant. Regarding the cost of food production, the average cost of production was Kshs.10966.58. However, it was also positively skewed (+3.949) and leptokurtic (Kurtosis = 22.722) but the Bca 95% confidence interval was also positive implying that they were statistically significant. The results on cost of information adoption also revealed that the average cost of adoption was Kshs.5818.83. However, it was also positively skewed (+2.631) and leptokurtic (Kurtosis = 9.138). The Bca 95% confidence interval, gave positive result implying that they were also statistically significant.

Lastly, results on cost of information utilization revealed that the average cost of usage was Kshs.2160.95, had a positive skew of 4.344 and leptokurtic Kurtosis of 22.607. The 95% confidence interval was also positive implying that they were statistically significant since the statistics column exhibited values that were more than two times the standard error (Table 19 in Appendix D).

Further confirmation was done using the Levene's test of homogeneity of variances of the error terms performed under univariate analysis existing under the general linear models and results showed that all the probabilities of the standardized residuals were significant i.e. less than 0.05; hence the study rejected the null hypothesis that the residuals are constant across agro ecological zones (refer to Table 20 in Appendix D).

Because of the failure to establish normality of the variables even after collapsing them, they were log transformed to find out if any change could be established. However, the K-density results in Figure (4.2- 4.5) indicated that they were still bimodal.

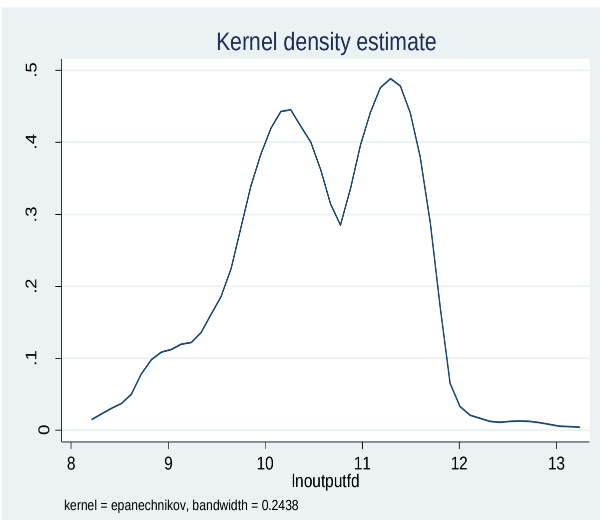


Figure 4.2 Normality test on Cost of Food Production

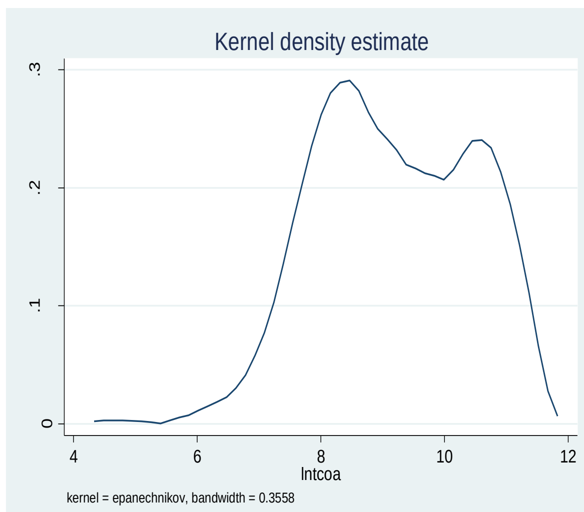


Figure 4.3 Normality Test on Cost of Information Adoption

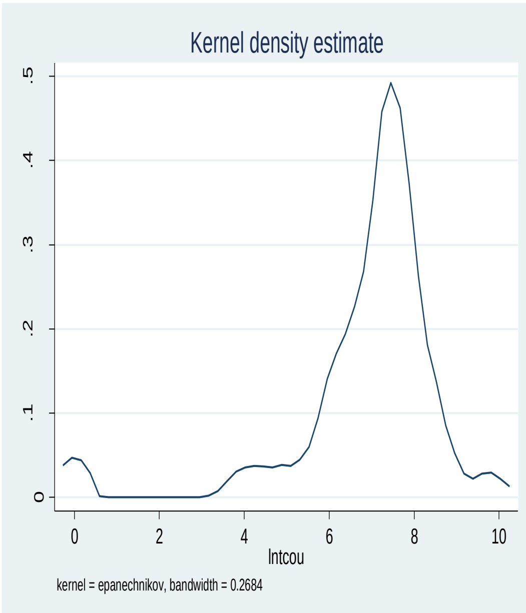


Figure 4.4 Normality Test on Cost of Utilization

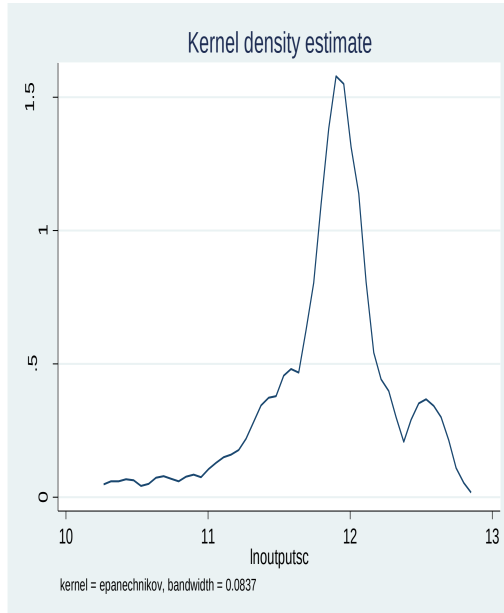


Figure 4.5 Normality Test on Cost of Sugarcane Production

The conclusion from this is that log transformation never changed the normality of the variables. As such, parametric analysis was not tenable for this study. According to Hesse, Ofosu, & Nortey, (2017), if data are not normally distributed, non-parametric tests can be used.

Given that data was collected from different sugar belts, it was imperative to investigate whether there were major differences in the costs of production. To achieve this, this study adopted the use of Mann- Whitney (Wilcoxon rank-sum) test to determine whether the costs were different across the different agro ecological zones. Results in Table 21 (in Appendix D) showed that the probabilities of the variables were significant at 5% level. This meant that the costs of variables across the agro ecological zones were the same.

After the constructs were analyzed for their individual correlations, namely information adoption (Table 3.8); information utilization (Table 3.9); cost elements in sugarcane production (Table 4.22); cost of food production (Table 4.24) and cost of sugarcane and cost of food production (Table 4.15), these totals were investigated for any likely association. The results were captured in Table 4.23.

Table 4.23 Correlations Matrix of the Main Study Variables

		Total sugarcane cost	Total cost on food	Total adoption cost	Total utilization cost
Total sugarcane cost	P.Correl	1			
	Sig. (2-tailed)				
Total cost on food	P.Correl	.143*	1		
	Sig. (2-tailed)	.011			
Total adoption cost	P.Correl	-.238**	-.025	1	
	Sig. (2-tailed)	.000	.662		
Total utilization cost	P.Correl	.055	-.080	.321**	1
	Sig. (2-tailed)	.332	.156	.000	

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data (2020)

According to Table 4.23, there was a significant positive correlation between the cost of sugarcane production and cost of food production ($r = 0.143$; $p = 0.011$). This meant that as the cost of sugarcane production tends to increase, the cost of food production also tends to weakly increase by 0.143. Similarly, there was a significant but negative association between cost of sugarcane production and cost of information adoption ($r = -0.238$; $p = 0.000$). This implied that as the cost of sugarcane production tended increase, the cost of information adoption tended to decrease significantly by 0.238.

The cost of adoption was significant and positively correlated with the cost of information utilization ($r = 0.321$; $p = 0.000$). This meant that as the cost of adoption tended to increase, the cost of utilization also tended increase significantly, though weakly, by 0.321.

4.5.1 Moderating Role of Information Adoption on Cost of Food Production

Investigations on the ultimate role of cost of information adoption and utilization on the relationship between the cost of sugarcane production and cost of food production was analyzed using a three prong approach and the methodology followed an SFA. First, the moderating effect of information "adoption only" was analyzed on the cost of sugarcane production and also on the cost on food production. This was then followed by investigating the effect of "utilization only" on the cost of sugarcane production and food production. Ultimately, the combined effect of both cost of adoption and utilization (sum of cost of adoption and cost of utilization) was analyzed on the cost of sugarcane production as well as on the cost of food production. The essence of this objective was to understand whether the cost of information adoption and utilization had any role on the overall costs of production of both sugarcane and food production.

4.5.1.1 Effect of Cost of Information Adoption as a Variable

The first part of the analysis was to investigate the effect of cost of information adoption on the cost of food production, cost of sugarcane production and cost of mixed production before the effect of the cost of information adoption and utilization was investigated for its moderation effect. The result the cost of information adoption as an exogenous variable into the cost of food production; cost of sugarcane production and on the cost of mixed production captured in Table 4.24.

Table 4.24 Information Adoption as a Variable on the Cost of Food Production, Sugarcane Production and Mixed Production

Panel 1: Cost of Information Adoption as a Variable in Pure Food Crop Production						
Log likelihood =	67.0575					
lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	4543.16			0.000		
lnlandfd	.401	.029	13.92	0.000	.345	.458
lnlabourfd	.175	.023	7.72	0.000	.131	.220
lncapitalfd	.434	.016	27.10	0.000	.403	.466
lntcoa	-.013	.010	-1.35	0.177	-.032	.006
Cons	1.128	.171	6.59	0.000	.793	1.463
Panel 2: Information Adoption as a Variable in Pure Sugarcane Production						
Log likelihood =	24.4985					
lnoutputsc	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	8126.34			0.000		
lnlandsc	.294	.034	8.65	0.000	.228	.361
lnlaboursc	.194	.058	3.36	0.001	.081	.308
lncapitalsc	.471	.034	13.73	0.000	.404	.538
lntcoasc	-.260	.090	-2.88	0.004	-.437	-.083
cons	4.357	1.073	4.06	0.000	2.254	6.459
Panel 3: Information Adoption as a Variable in Mixed Production						
Log likelihood =	5.8069					
lnoutputscfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	789.30			0.000		
lnlandscfd	.089	.029	3.04	0.002	.032	.147
lnlabourscfd	.347	.027	13.06	0.000	.295	.399
lncapitalscfd	.529	.027	19.73	0.000	.476	.581
lntcoa	-.020	.019	-1.04	0.297	-.057	.018
cons	1.829	.366	4.99	0.000	1.110	2.547

Source: Survey Data (2020)

From Table 4.24, the results indicated that cost of information adoption negatively and insignificantly influenced the cost of food production and cost of mixed production. However, this cost of information adoption negatively and significantly influenced the cost of sugarcane production $(\alpha_4 = -0.260; p = 0.004)$. This implied that the level of responsiveness of cost of sugarcane production to variations in the cost of information adoption was inelastic, negative and significant i.e. as the cost of information adoption changes by a given proportion, the cost of sugarcne production changes negatively but by less than the proportionate increase in the cost of information adoption.

4.5.1.2 Moderating Effect of Cost of Information Adoption

After the analysis of the effect of cost of information as a variable in the cost of food production; cost of sugarcane production and on cost of mixed production, the cost of information adoption was introduced into the cost of food, sugarcane and mixed production and a moderator and the results summarized in Table 4.25.

Table 4.25 Moderation Effect of Cost of Information Adoption in Food, Sugarcane and Mixed Production

Panel 1: Moderation Effect of Cost of Information Adoption in Food Production						
Log likelihood =	67.0571					
lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	4553.58			0.000		
lnlandfd	.414	.029	14.33	0.000	.358	.471
lnlabourfd	.175	.023	7.73	0.000	.131	.220
lncapitalfd	.434	.016	27.13	0.000	.403	.466
lnlandfdtcoa	-.013	.010	-1.35	0.177	-.032	.006
lnlabourtcoa	0	(omitted)				
lncapitaltcoa	0	(omitted)				
cons	1.128	.174	6.50	0.000	.788	1.469
Panel 2: Information Adoption as a Moderator in Sugarcane Production						
Log likelihood =	24.4985					
lnoutputsc	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	8127.18			0.000		
lnlandsc	.554	.105	5.27	0.000	.348	.761
lnlaboursc	.194	.058	3.36	0.001	.081	.308
lncapitalsc	.471	.034	13.73	0.000	.404	.538
lnlandtcoasc	-.260	.090	-2.88	0.004	-.437	-.083
lnlabourtcoasc	0	(omitted)				
lncapitaltcoasc	0	(omitted)				
cons	4.357	1.073	4.06	0.000	2.254	6.459
Panel 3: Information Adoption as a Moderator in Mixed Production						
Log likelihood =	5.8069					
lnoutputscfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	789.30			0.000		
lnlandscfd	.109	.035	3.07	0.002	.040	.179
lnlabourscfd	.347	.027	13.06	0.000	.295	.399
lncapitalscfd	.529	.027	19.73	0.000	.476	.581
lnlandscfdtcoa	-.020	.019	-1.04	0.297	-.057	.018
lnlabourscfdtcoa	0	(omitted)				
lncapitalscfdtcoa	0	(omitted)				
cons	1.829	.366	4.99	0.000	1.110	2.547

Source: Survey Data (2020)

From Table 4.25, the introduction of the cost of information adoption was absorbed by the cost of land in food, sugarcane and mixed production. However, the coefficient, although negative, was significant only in sugarcane production $(\alpha_4 = -0.260; p = 0.004)$. This implied that the moderation effect of the cost of information adoption affected the cost of land only. Given this, the amplification of the cost of land affected the cost of sugarcane production negatively i.e. the level of responsiveness to sugarcane production due to variations in the moderated cost of land was inelastic, negative and significant.

4.5.1.3 Effect of Cost of Utilization as a Variable

After the investigation of the effect of cost of adoption of information, the effect of the cost of utilization was analysed as an exogenous variable in the cost of food, sugarcane and mixed crop production. The results are summarized in Table 4.26.

Table 4.26 Effect of Cost of Information Utilization as a Variable in Food, Sugarcane and Mixed Production

Panel 1: Cost of Information Utilization as a Variable in Food Production

Log likelihood =	67.2015					
lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Wald Chi 2(4)	4575.28			0.000		
lnlandfd	.404	.028	14.20	0.000	.349	.460
lnlabourfd	.172	.022	7.70	0.000	.128	.216
lncapitalfd	.435	.016	27.18	0.000	.403	.466
lntcou	-.015	.010	-1.46	0.146	-.035	.005
cons	1.116	.165	6.78	0.000	.793	1.438

Panel 2: Cost of Information Utilization as a Variable in Sugarcane Production

Log likelihood =	21.4247					
lnoutputsc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Wald Chi 2(4)	789.97			0.000		
lnlandsc	.270	.044	6.21	0.000	.185	.356
lnlaboursc	.310	.054	5.78	0.000	.205	.415
lncapitalsc	.404	.032	12.48	0.000	.341	.467
lntcousc	.006	.015	0.42	0.677	-.023	.035
cons	1.251	.260	4.82	0.000	.742	1.760

Panel 3: Cost of Information Utilization as a Variable in Mixed Production

Log likelihood =	5.7055					
lnoutputscfd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Wald Chi 2(4)	787.05			0.000		
lnlandscfd	.088	.029	3.01	0.003	.031	.146
lnlabourscfd	.342	.026	13.02	0.000	.291	.394
lncapitalscfd	.532	.027	19.82	0.000	.479	.584
lntcou	-.018	.019	-0.93	0.350	-.056	.020
cons	1.803	.364	4.95	0.000	1.090	2.517

Source: Survey Data (2020)

From Table 4.26, results on the cost of information utilization had an insignificant effect on the cost of food, sugarcane and mixed production.

4.5.1.4 Moderating Effect of Cost of Information Utilization on the Cost of Food, Sugarcane and Mixed Production

Introduced as a moderator into the cost of food, sugarcane and mixed production; the moderating effect of cost of information utilization is summarized in the Table 4.27.

Table 4.27 Moderating Effect of Cost of Information Utilization on the Cost of Food, Sugarcane and Mixed Production

Panel 1: Cost of Utilization as a Moderator in Food Production

Log likelihood = 67.2009

lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Wald Chi 2(4)	4575.28			0.000		
lnlandfd	.420	.030	14.20	0.000	.362	.477
lnlabourfd	.172	.022	7.70	0.000	.128	.216
lncapitalfd	.435	.016	27.20	0.000	.403	.466
lnlandfdtcou	-.015	.010	-1.46	0.144	-.035	.005
lnlabourfdtcou	0	(omitted)				
lncapitalfdtcou	0	(omitted)				
cons	1.116	.169	6.59	0.000	.784	1.447

Panel 2: Cost of Utilization as a Moderator in Sugarcane Production

Log likelihood = 21.4247

lnoutputsc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Wald Chi 2(4)	4863.43		0.000			
lnlandsc	.265	.042	6.26	0.000	.182	.347
lnlaboursc	.310	.054	5.78	0.000	.205	.415
lncapitalsc	.404	.032	12.48	0.000	.341	.467
lnlandtcousc	.006	.015	0.42	0.677	-.023	.035
lnlabourtcousc	0 (omitted)					
lncapitaltcousc	0 (omitted)					
cons	1.250	.259	4.83	0.000	.743	1.758

Panel 3: Cost of Information Utilization as a Variable in Mixed Production

Log likelihood = 5.7055

lnoutputscfd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Wald	787.05			0.000		
lnlandscfd	.106	.035	3.03	0.002	.037	.175
lnlabourscfd	.342	.026	13.02	0.000	.291	.394
lncapitalscfd	.532	.027	19.82	0.000	.479	.584
lnlandscfdtcou	-.018	.019	-0.93	0.350	-.056	.020
lnlabourscfdtcou	0	(omitted)				
lncapitalscfdtcou	0	(omitted)				
cons	1.803	.364	4.95	0.000	1.090	2.517

Source: Survey Data (2020)

Given the results on the effect of cost of information utilization in the cost of food, sugarcane and mixed production expressed in Table 4.27, results indicate that cost of information utilization has no moderating effect on the cost of food, sugarcane and mixed production.

4.5.1.5 Moderating Effect of Cost of Adoption and Cost of Utilization on Cost of Food, Sugarcane and Mixed Production

The results upon the introduction of cost of information adoption and cost of utilization as a moderator into the cost of food, sugarcane and mixed production; are summarized in the Table 4.28.

Table 4.28 Moderating Effect of Cost of Adoption and Cost of Utilization on Cost of Food, Sugarcane and Mixed Production

Panel 1: Moderating Effect of Cost of Utilization and Adoption on Food Production

Log likelihood =	67.4728					
lnoutputfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	4603.30			0.000		
lnlandfd	.420	.029	14.26	0.000	.363	.478
lnlabourfd	.175	.023	7.75	0.000	.131	.219
lncapitalfd	.435	.016	27.29	0.000	.404	.466
lnlandfdtcou	-.011	.012	-0.91	0.360	-.034	.012
lnlabourfdtcou	0	(omitted)				
lncapitalfdtcou	0	(omitted)				
lnlandfdtcoa	-.008	.011	-0.74	0.460	-.030	.013
lnlabourtcoa	0	(omitted)				
lncapitaltcoa	0	(omitted)				
cons	1.158	.173	6.68	0.000	.818	1.498

Panel 2: Moderating Effect of Cost of Adoption and Utilization on Sugarcane Production

Log likelihood =	36.0084					
lnoutputsc	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	22153.70			0.000		
lnlandsc	.386	.064	6.00	0.000	.260	.513
lnlaboursc	.280	.023	11.97	0.000	.234	.326
lncapitalsc	.377	.019	20.26	0.000	.340	.413
landtcousc	-5.51e-10	2.37e-10	-2.33	0.020	-1.02e-09	-8.70e-11
labourtcousc	8.66e-11	1.92e-10	0.45	0.653	-2.91e-10	4.64e-10
capitaltcousc	5.45e-10	8.24e-11	6.62	0.000	3.84e-10	7.07e-10
lnlandtcoasc	-.088	.067	-1.32	0.187	-.220	.043949
lnlabourtcoasc	0	(omitted)				
lncapitaltcoasc	0	(omitted)				
cons	2.536355	.7758209	3.27	0.001	1.015774	4.056936

Panel 3: Moderation Effect of Cost of Adoption and Utilization on Mixed Production

Log likelihood =	5.9627					
lnoutputscfd	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Wald Chi 2(4)	788.80			0.000		
lnlandscfd	.101	.036	2.81	0.005	.030	.171
lnlabourscfd	.345	.027	12.95	0.000	.293	.396
lncapitalscfd	.545	.033	16.72	0.000	.481	.609
lncapitalscfdtcoa	-.015	.021	-0.72	0.472	-.056	.026
lnlandscfdtcoa	0	(omitted)				
lnlabourscfdtcoa	0	(omitted)				
lnlandscfdtcou	-.012	.021	-0.56	0.577	-.053	.029
lnlabourscfdtcou	0	(omitted)				
lncapitalscfdtcou	0	(omitted)				
cons	1.874	.376	4.99	0.000	1.137	2.610

Table 4.27 depicted the moderatining effect of cost of adoption and cost of utilization on the cost of labour, cost of land and cost of capital used in food , sugarcane and mixed production. From the results, the effect of cost of information adoption and cost of information utilization had no significant effect on the constructs forming cost of food, sugarcane and mixed production.

4.5.2 Mediating Role of Cost of Information Adoption and Utilization

To ascertain the mediating effect of cost information adoption and utilization on the relationship between cost of sugarcane production and cost of food production, this study developed a Structural Equation Modeling (SEM) to come up with such a relationship. Various constructs of sugarcane and food production were isolated (disaggregated), logged and then measured. Although there were zero values in some of the variables, they were necessary hence the estimation was considered at the maximum likelihood levels to achieve the path values. The analysis was also considered on three fronts namely, the analysis of the mediating effect of cost of "adoption" on the relationship between cost of sugarcane production and cost of food production constructs; the mediating effect of cost of "utilization" on the relationship between cost of sugarcane production and cost of food production constructs and lastly the combined mediating effect of cost of adoption and cost of utilization on the costs of sugarcane and cost of food production constructs.

The Structural Equation Model of cost of information adoption on the relationship between sugarcane production and food production results were given in Table 4.28.

Table 4.29 Mediating Effect of Cost of Information Adoption between sugarcane and food production

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
Food						
Information (a)	-.0521419	30.13047	-0.00	0.999	-59.10678	59.0025
Sugarcane	.9668699	14.62383	0.07	0.947	-27.69532	29.62906

From the results in Table 4.29, the coefficient of cost of information adoption was insignificant $(\delta_1 = -0.052; p = 0.999)$ in influencing the interaction between the cost of food production and the cost of sugarcane production (Refer also to Table 22 on Appendix D).

The mediating effect of cost of information utilization was also investigated on the relationship between cost of sugarcane production and cost of food production. The results were given below.

Table 4.30 Mediating Effect of Cost of Information Utilization on the Relationship between Cost of Sugarcane Production and Cost of Food Production

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Structural						
Food <-						
Information	.137	316.313	0.00	0.999	-619.826	620.100
Sugarcane	.875	78.030	0.01	0.991	-152.062	153.812

LR test of model vs. saturated: chi2(11) = 46.60, Prob > chi2 = 0.0000
Source: Survey Data (2020)

From Table 4.30, the coefficient of cost of information utilization was positive and insignificant $(\delta_1 = 0.137; p = 0.999)$ on the interaction between the cost of sugarcane production and the cost of food production (Refer to Table 23 in appendix D).

Table 4.31 Mediating Effect of Information Adoption and Utilization on Cost of Sugarcane Production and Cost of Food Production

	Coef.	OIM Std. Err.	z	P>|z|	[95% Conf. Interval]	
Structural						
Food						
Information	.055	.066	0.83	0.407	-.075	.185
Sugarcane	.997	.269	3.71	0.000	.471	1.525

LR test of model vs. saturated: chi2(17) = 44.06, Prob > chi2 = 0.0003; Goodness of Fit = 0.819
Source: Survey Data (2020)

Table 4.31 refers to an investigation of cost of information adoption and the cost of information utilization on the relationship between the cost of sugarcane production and food production. From the results, cost of information (adoption and utilization) was insignificant in affecting the relationship between the cost of sugarcane production and cost of food production (Refer also to Table 24 in Appendix D). The results in Table 25 (in Appendix D) indicated that information adoption and utilization explained 81.9% of the relationship between cost of sugarcane production and cost of food production.

Such a results is in tandem with Ali, Jabeen, & Nikhitha, (2016) position which also established that information communication and technology was positive yet insignificant in affecting agricultural productivity but negated Abdul-Salam & Phimister, (2015) finding that established a significant positive influence of information access on agricultural productivity. With regard to the results on information mediation, this study results are in agreement with Usman & Ahmad, (2018) results which also established that information mediated between social capital and best crop management practices. However, with regard to information acting as a moderator, the results in this study negated Paitoon, Piraphong, & Kittisak, (2019) finding that established a mediating role of agricultural extension services on accounting literacy and perceived crop yield.

4.6 Coping Strategies to Food Insecurity

Given the observations by the various County Integrated Development Plans (CIDP) over food situations in Nyanza and the underlying fact that donors are pumping billions of shillings in order to address food insecurity within Nyanza region, (Thuita, 2016) ; this study investigated the various coping strategies to food insecurity among farmers in Nyanza region, Kenya. The preliminaries began by investigating the existences and the perceptions of farmers regarding this insecurity.

Frequencies towards the prevalence of food insecurity are contained in Table 4.33 after the respondents were asked whether the agricultural production were sufficient to sustain their food requirements.

Table 4.33 Prevalence to Food Insecurity

	Frequency	Percent	Cumulative Percent
Adoption	192	60.6	60.6
No	125	39.4	100.0
Total	317	100.0	

Source: Own Computation

From Table 4.33, results indicated that 39.4% of the respondents were food insecure and that they could not sustain their food requirements from their own agricultural productions.

4.6.1 Sources of Food to Supplement Own Food Requirements by the Farmers

Given the inadequate food production by the respondents, this study also investigated other possible sources of food for the farmers.

Table 4.34 Sources of Food to Supplement Food Requirements by the Farmers

	Agree (%)	Indifferent (%)	Disagree (%)
Purchasing food	76.7	1.6	21.8
Government support	8.2	6.6	85.2
NGOs support	6.9	6.3	86.8
Donations from friends	30.9	7.3	61.8
Exchange other items for food	40.7	14.8	44.5
Foraging	54.2	12	33.7
Exchange work for food	40.4	16.1	43.6

Source: Own computation

The summary in Table 4.34 indicated that 76.7% purchased food while 21.8% disagreed. Even though there were cases of outstanding food deficiencies among the respondents, there was little support from the Government, NGOs and friends since 85.2%, 86.8% and 61.8%, respectively, did not get such support from these sources. The need to survive drove the respondents to forage for food (54.2%), exchange work for food (40.4%) as well as sell part of their belongings (40.7%) to ensure that they have something to eat.

4.6.2 Food Sufficiency throughout the Season

Table 4.35 reflects admissions to the farmers' ability to sustain their food requirements throughout food production period.

Table 4.35 Admission to Food Sufficiency throughout the Season

	Enough food throughout the food production period		
	Enough	Not enough	Total
Sugarcane /mixed farmers	115 (57.2%)	86(42.8%)	201
Food crop farmers	73(62.9%)	43(37.1%	116
TOTAL	188 (59.3%)	129(40.7%)	317

Source: Survey Data (2020)

From Table 459, Out of the 201 farmers who planted sugarcane, either purely or mixed, 115 (57.2%) admitted that they have /can afford to have enough stock of food to last them throughout food production season. Out of 116 pure food crop producers, 62.9% of them indicated that they have sufficient food stock to last them throughout food production season. In summary, the total number of farmers who were able to sustain their food requirement throughout food production season were 188 i.e. 59.3% of the respondents.

4.6.3 Deficient Food Stuffs among Farmers

Given Table 4.35, results showed that 40.7% of the total farmers were experiencing food deficiencies. Therefore, they were asked to indicate the types of foods that they were lacking mostly.

Table 4.36 Food Stuffs that Farmers were Deficient on

	Frequency	Percent	Cumulative Percent
Maize	139	43.8	43.8
Other cereals	111	35.1	78.9
Potatoes	33	10.5	89.4
Beans	22	7	96.4
Nuts	6	1.8	98.2
Poultry	6	1.8	100
Total	317	100	

Source: Survey Data (2020)

Results given in Table 4.36 indicated that 43.8% faced a deficit in maize (millet and sorghum) 35.1% faced a deficit in other cereals (rice and wheat), 10.5% faced deficits in potatoes while 10.6% of the residents had a combined deficits on beans, nuts and poultry.

By acknowledging food deficiency and the inability to get support from the Government, NGOs and from friends and relatives, this study examined the coping strategies to such food deficiencies and broadly categorized them into four main groups. These groups were the dietary change, increase short-term household food availability, decrease numbers of people, rationing strategies. These categories were then disaggregated into prioritizing children over adults for food, reducing the number of daily meals, reducing food portions, consuming less preferred staples, changing curry ingredients / variety / food quality, borrowing food from neighbors / relatives, eating immature crops, eating bush meat or plants, purchasing food on credit, reducing health expenditures and saving the left overs.

These indices towards food insecurity were then ranked on the basis of the frequency of reponses. A particular category with higher number of responses was ranked highly (5) and lowly (1) for a category with fewer responses. Results were shown in Table 4.37.

Table 4.37 Coping Strategy Ranking

	Coping strategy	SD	D	U	A	SA	% agreed
A	Taking porridge	4.1%	2.8%	1.6%	67.8%	23.6%	91.4%
B	Prioritizing children over the elderly	4.1%	8.2%	5.0%	68.1%	14.5%	82.6%
C	Reducing the number of daily meals	2.5%	11.4%	65.3%	7.2%	13.6%	20.8%
D	Reducing food portions	4.1%	8.8%	65.9%	9.1%	12.0%	21.1%
E	Consuming less preferred staples	4.7%	7.9%	69.7%	8.2%	9.5%	17.7%
F	Changing food quality	2.5%	13.9%	65.9%	5.4%	12.3%	17.7%
G	Borrowing from neighbors / relatives	9.8%	10.4%	66.6%	7.2%	6.0%	13.2%
H	Eating immature crops	4.1%	12.0%	64.7%	8.2%	11.0%	19.2%
I	Eating bush meat or plants	3.2%	9.1%	5.0%	68.8%	13.9%	82.6%
J	Purchasing food on credit	5.0%	9.1%	63.1%	10.1%	12.6%	22.7%
K	Reducing health expenditures	10.1%	12.6%	64.4%	6.3%	6.6%	12.9%
L	Saving the left overs	6.0%	8.5%	0.6%	67.5%	17.4%	84.8%

( ) are the absolute frequencies. SD= strongly disagree; D= disagree; U= undecided; A= agree; SA= strongly agree

Source: Survey Data (2020)

From Table 4.37, the results on frequencies were converted into percentages and from the results, those who “agreed” and “strongly agreed” were summed together and the results used to infer “agreed”. Similarly, those who marked “disagreed” as well as “strongly disagreed” were also summed together to infer “disagreed”. Converted into percentages, the results indicated that 91.5% of the respondents ate porridge, 84.6% admitted to eating left overs, 82.7% admitted to eating bush meat and plants while 84.9% admitted to prioritizing children over adults during meals. With regard to reducing the number of daily meals, reducing food portions, consuming less staple foods, changing food quality, borrowing food from neighbours, eating immature crops, purchasing food on credit as well as reducing health expenditures, the respondents were majorly indifferent or disagreed.

4.6.4 Analysis of the Main Coping Strategies across the Agro Ecological Zones

From Table 4.37, this study concentrated on the four major coping strategies to food insecurity that was given prominence by the respondents. An analysis was done across the agro ecological zones to gauge which one was the most preferred coping strategy.

Table 4.38 Agro-Ecological Zones and Coping Strategies

	Taking porridge	Prioritizing children over the elderly for food	Eating bush meat or plants	Saving the left overs
Sony	97.2%	97.2%	95.4%	95.4%
Chemelil	97.1%	71.4%	68.4%	84.8%
Muhoroni	96.8%	96.8%	96.8%	71%
Ndhiwa	72.6%	71.2%	78.1%	75.3%

Source: Survey Data (2020)

The summary in Table 4.38 indicated that 97% of the respondents acknowledged taking of porridge in Sony, followed by Muhoroni at 97%; Chemelil at 95% and lastly by Ndhiwa at 82%. Regarding the issue of prioritizing children over adults, Sony at 97% took the lead followed by Chemelil at 82%; Ndhiwa at 78% and lastly Muhoroni at 68%. Eating of bush meat and plants was majorly experienced in Sony 95%, followed by Ndhiwa at 81% then by Chemelil at 77% and lastly by Muhoroni at 67%. Saving on the left overs was done mainly in Sony at 95%; Chemelil at 91%; Muhoroni at 81% and lastly Ndhiwa at 76%.

4.6.5 Educational Level and Coping Strategy

With regard to the link between education and food production, previous studies have portrayed mixed reactions with some showing a negative effect of education on food production (Amali, 2012) while others finding a positive association (Faye *et al.*, 2011) and (Bashir & Schilizzi, 2013).

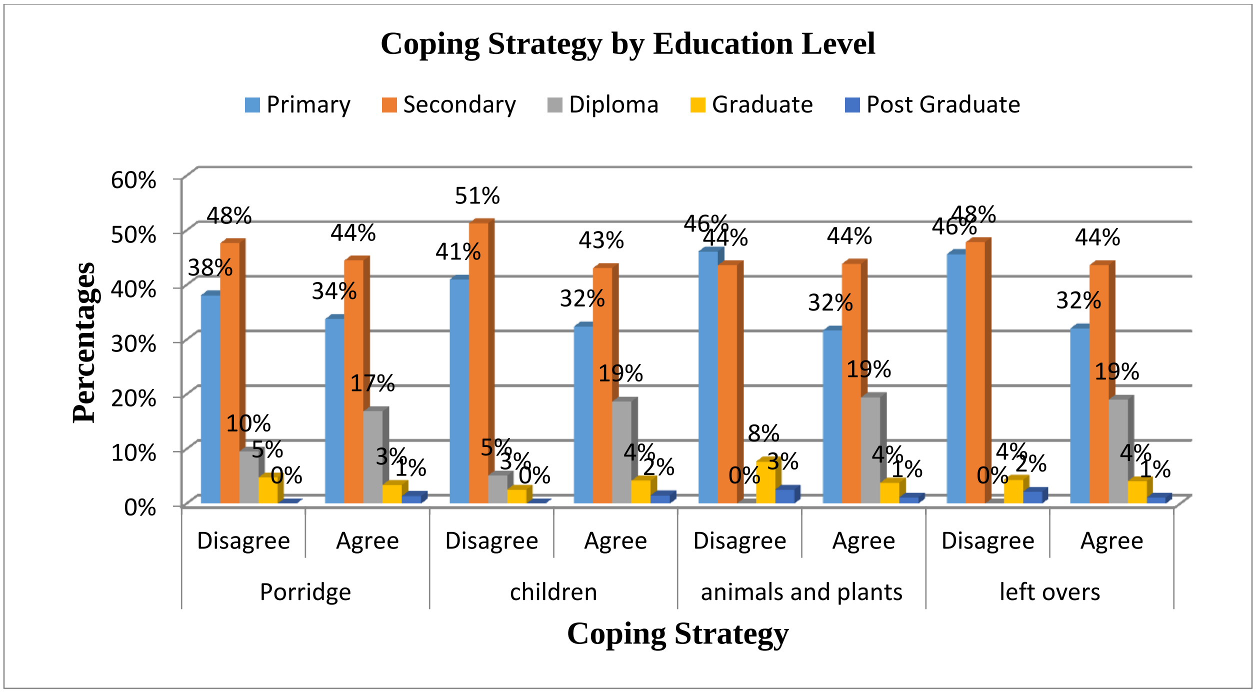


Figure 4.6 Education Level and Coping Strategy

Translated into relative percentages, the results in the Figure 4.6 indicated that 34% of the respondents with primary education were likely to take porridge compared to 65% with secondary education and above.

With regard to prioritizing children over adults, the results indicated that 32% of the respondents with primary education as opposed to 68% of those with secondary education and above were likely to adopt this strategy.

By examining the consumption of wild fruits and plants, the results indicated that 32% of those with primary level of education against 68% were likely to adopt this coping strategy. With regard to consumption of the left overs, 32% of those with primary level of education against 68% of those with secondary level of education adopted the strategy. Hence, this study concluded that education and food insecurity are negatively related. This is in line with the (Amali, 2012) findings.

4.6.6 Likert Scale on the Coping Strategies

To enable the calculation of severity, results in Table 4.37 were given weights. Strongly disagree was assigned a weight of 1 while disagree, undecided, agree and strongly agreed were assigned a weight of 2, 3, 4 and 5. In Table 4.38, the weights were multiplied by the frequencies in Table 4.37.

Table 4.39 Likert Scale on the Coping Strategies

	Weights	1	2	3	4	5		
	Coping strategy	SD	D	U	A	SA	Total weight	Severity
A	Taking porridge	13	18	15	860	375	1281	4.04
B	Prioritizing children over the elderly for food	13	52	48	864	230	1207	3.81
C	Reducing the number of daily meals	8	72	621	92	215	1008	3.18
D	Reducing food portions	13	56	627	116	190	1002	3.16
E	Consuming less preferred staples	15	50	663	104	150	982	3.1
F	Changing curry ingredients / variety / food quality	8	88	627	68	195	986	3.11
G	Borrowing food from neighbors / relatives	31	66	633	92	95	917	2.98
H	Eating immature crops	13	76	615	104	175	983	3.1
I	Eating bush meat or plants	10	58	48	872	220	1208	3.81
J	Purchasing food on credit	16	58	600	128	200	1002	3.16
K	Reducing health expenditures	32	80	612	80	105	902	2.85
L	Saving the left overs	19	54	6	856	275	1210	3.82
	Totals	191	728	5115	4236	2425	**12695**	40.05

SD= strongly disagree; D= disagree; U= undecided; A= agree; SA= strongly agree

Source: Survey Data (2020)

The frequencies in Table 4.39 are borrowed from Table 4.38 but were multiplied by the weights i.e. 1-5 respectively and their summations generated along the “total weight” column. The severity column was the divisor between the summation of the total weight (12695) and the respective total weight.

According to CARE International, (2008), an index of 0-49 implies that the families are not food insecure while an index of more than 50 implies that the families are food insecure. From Table 4.38, CSI index in Nyanza region is 40.05 implying that the food situation is not dire.

Results on the coping strategies employed by the respondents regarding consumption of cheaper stuff such as taking porridge as well as reducing the daily means and food portions are in confluence with Cordero-Ahiman, Estrada, & Garrido, (2018) findings. However, this study finding departed slightly from Mjonono, Ngidi, & Hendriks, (2009) who established that the main coping strategies in Kwazulu Natal were borrowing food, and relying on friends.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the findings, the conclusions, limitations in this study as well as suggestions for further studies.

5.1 Summary of Findings

Generally, the information gadgets are adopted to a great extent by all farmers. Specifically, mobile phones and radios are the gadgets that were adopted to a very great extent across all the farmer type and across the agroecological zones. Comparatively, male headed households had the greatest level of adoption of the information gadgets than the female headed households. However, the extent of information gadgets utilization is low across all the farmer types despite the fact that most of the farmers agreed that the cost of usage on these gadgets is fairly priced.

On the relationship between cost of sugar production and cost of food production, results indicated that there exists a positive and significant relationship. However, the variations in the cost of food production due to the variations in the cost of sugarcane production are inelastic.

With regard to cost efficiency on sugarcane and food production, results indicated that there were cost inefficiencies in both sugarcane production and food production. Equally, those who practiced mixed farming also experienced cost inefficiencies. However, the percentage of variations in total production accounted for by the level of cost inefficiencies differed from one farmer type to the other. On cost of sugarcane production, the cost of land significantly increased the cost of sugarcane production. However, the variation in cost of sugarcane production was inelastic to changes in the cost of land. On food production, cost of land and cost of capital were significant in increasing cost of food production. However, variations in food production inefficiencies were inelastic to changes in the cost of labour and cost of capital. On mixed production, cost of land and cost of capital were significant in contributing to the cost of mixed production. Equally, such variations in the cost of land and cost of capital were inelastic in affecting the cost of mixed production.

Regarding the effect of cost of information adoption and utilization either as a moderator or as a mediator, it emerged that the cost of information adoption was negative and significant in moderating the cost of land in sugarcane production. However, it moderated neither the constructs in food production nor in mixed production. Cost of utilization did not moderate the construct in sugarcane production, food crop production or mixed production. When combined together in the same regression equation, cost of utilization moderated the cost of land and cost of capital in sugarcane production. Introduced into the regression equation as amediator, cost of information andoption and utilization had no effect.

On the coping strategies to food insecurity, the results indicated that the food situation is not dire and majority of the farmers were food secure and could produce sufficient food for their consumption. However, respondents who could not produce enough supplemented the dificits by either purchasing more from the local markets or foraging for more food. The greatest food deficits arose from maize and other cereals such as rice and wheat. The coping mechanisms adopted by the respondents towards food scarcity were namely taking porridge, prioritizing children over adults, saving left overs and eating bush meat and plants.

5.2 Conclusion

Based on the extent of adoption and utilization of information among sugarcane farmers and food crop farmers, this study concluded that the the extent of information adoption of mobile phones and radios are adopted at a great extent, TVs are adopted at a moderate extent while computers are adopted at a low extent across all the farmer type. However, these gadgets are not being used by either the sugarcane farmers or food crop farmers to better their agricultural production since the extent of utilization is done at a small extent.

On the relationship between the cost of sugarcane production and cost of food production, this study concludes that changes in the cost of sugarcane production positively and significantly affect cost of food production although this relationship is inelastic.

On the cost efficiency in sugarcane production and food production, this study concludes that both the sugarcane and food crop farmers still operate in a cost inefficient manner. What significantly raises the cost of sugarcane production is the cost of land while what raises the cost of food crop production and mixed crop production are the cost of land as well as the cost of capital.

By assessing the moderating and the mediating effect of cost of information adoption and utilization, this study concludes that cost of information adoption negatively and significantly moderates cost of land in cost of sugarcane production but when used together with cost of information utilization, the effect of cost of information utilization is felt more by the cost of land and cost of capital in sugarcane production.

By examining the coping strategies to food insecurity among farmers, this study concludes that there is no serious food insecurity in the region and to those who experiences deficits, their coping strategies are taking porridge, saving the left overs, prioritized children over adults as well as eating of bush meat and plants.

5.3 Recommendations

Since both sugarcane farmers and food crop farmers have adopted information gadgets greatly but least used them to better their agricultural production, this study recommends for the intensification of agricultural extension services. These services should be about the nature and kind of information available on radios and mobile phones and how best to use such information to better agricultural productivity. Moreover, given that mobile phones and radios are the most adopted, agricultural information must be transmitted through these platforms for ease of access since the cost of usage are have also been deemed to be fair by most farmers.

Given that the cost of food production is positive and significantly varies with cost of sugarcane production, although inelastic, this study recommends for an indepth analysis of the cost of sugarcane production, ceteris paribus. Policies should be placed to tame adhoc increases in cost of sugarcane production since such cost increases inadvertently results into increases in the cost of food production.

Variations in cost of sugarcane production are attributed to variations in the cost of land. As such, this study recommends for policy checks that brings about stability to land prices used for sugarcane production. Variations in cost of food production are due to the variations in the cost of land as well as the cost of capital. Similarly, variations in cost of mixed production are as a result of variations in cost of capital and cost of land. As such, this study also recommends for policies that assure stability in the cost of land and cost of capital used for food production as well as mixed production. Given that the variations in output due to cost inefficiencies are lower in mixed production, farmers are encouraged to adopt mixed production of both sugarcane and food crops.

Given that the cost of information adoption alone, is a significant moderator to the cost of land in both sugarcane production and food crop production while cost of information utilization alone is a significant moderator in the cost of labour and cost of capital in both sugarcane production and food production. Since the total cost of information adoption and utilization mediates the cost of sugarcane production and cost of food production and the net effect is absorbed by the cost of labour, this study recommends for their use in finding more about the cost of labour in both sugarcane production as well as food crop production.

Although food insecurity situation is not severe in Nyanza region, majority of the respondents who experiences some form of deficits in maize and other cereal (rice and wheat) , mitigates such food deficits through purchasing them from the local markets and foraging. As such, this study recommends for easing of trade restrictions among counties to enable food availability across the region. because of the aspects of eating bush meat, this study recommends for the adoption of animal husbandry and farmers must be trained on the importance of animal keeping to supplement deficits in crops output.

5.4 Contributions of the Study

5.4.1 Contribution to Academia

This study centered on the role of information adoption and utilization on the relationship between the cost of sugarcane production and cost of food production among farmers in Nyanza region, Kenya. Given that no known study had been done before among the sugar belts in Nyanza, this study is the first.

Most studies have examined the moderating role of information generally but have not factored in the cost elements of information adoption and utilization. As such, the incorporation of the cost elements greatly enhanced this study's contribution to the field of academia.

Methodologically, few studies have incorporated the structural equation modeling to observe the relationship between the cost of sugarcane production and the cost of food production, taking into consideration the interplay of the competing constructs of the cost of labour, cost of capital and cost of land.

5.4.2 Contribution to Policy Makers

Given the high adoption of the information gadgets especially the mobile phones and radios within the region, this study implores upon the policy makers in the agricultural sector to increase information dissemination through radios and mobile phones. Once this is accomplished, the policy makers must train agricultural officers to ensure that such information is used by farmers for the betterment of their crops.

In as much as the government may make efforts to stabilize food product cost, such efforts may not matter much if the cost of sugarcane production are not checked. As a result, the government must look at the aspect of cost stability of the agricultural products wholesomely.

The cure to the current dwindling sugarcane crop uptake by farmers and that of food production has been premised on the assumption that farmers need to practice mixed farming of these two crops. However, the findings of this study revealed that even in mixed farming, cost inefficiencies exist and this is attributed to the cost of land and cost of capital. The variations in cost of production of mixed production due to the variations in cost of land and cost of capital are inelastic, positive and significant. Given that the inefficiency in mixed production contributes lowly to the variations in mixed production, this study advises the policy makers consider a blend of the sugarcane production and food production to minimize the inefficiency levels and increase production by minimizing the cost of land and cosrt of capital.

Equally, policy makers also need to streamline the prices of food products and eliminate trade bottlenecks within the region to make food products become available to those farmers who are unable to produce enough to meet thir subsistence requirements.

5.4.3 Contribution to Farmers

Solving most of the problems facing farmers lies on the extent of information available to them. Most of the information is passed through radios, telephones, TVs and computers. This study therefore advises farmer to make good use of their mobile phones and radios to access information on the best practices in agriculture especially information related to minimization of cost on land and cost of capital.

As a coping mechanism to food insecurity, farmers must adopt animal husbandry to supplement crop husbandry.

5.5 Limitations of the Study

There were methodological limitations. Given the data collected, there were instances where the respondents were unable to give the cost of inputs used. An example was the cost of labour. Majority of the respondents using family labour, indicated that they spent zero on labour. In this regard, finding their logarithms was not easy hence such gaps were maintained and analyzed as zeros.

Food security was proxied by food production. However, this study noted that the two are very distinct since food production entails accessibility, affordability, availability and utilization (use). As such, only one aspect of food security (availability/being able to produce) was used in exclusion of the other facets of food security. Besides, only the production of food crops (especially grains) was taken into consideration. Naturally, vegetables and animal products also form a critical base in determining food security.

The absence of secondary data prompted the use of primary data for the purposes of analysis. However, primary data are bound to possess some inherent biasedness in their estimations. Because of this problem, the smoothing of data was done by removing the outliers and average values taken into consideration on all the variables studied.

In the estimation of adoption and utilization, this study evaluated farmers’ perception with regard to costs only. However, there are other human characteristics that may influence adoption and utilization of information gadgets to seek for information. These factors may be technological, economic, institutional or even human specific.

5.6 Suggestions for Further Studies

For best articulation of food production, its availability, accessibility, utilization and affordability should be investigated to make the results more robust;

In the presence of secondary data, such data should be used to ensure steadiness of the variables and ensure consistency in their measurements;

Other technological, human specific, institutional or even economics factors Apart from costs may be investigated to determine the causes for or against adoption and utilization of information.

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LIST OF APPENDICES

APPENDIX A: INTRODUCTION LETTER

My name is Mr. Ben Jack Otieno Ochieng. I am a PhD student from Maseno University and would like to undertake a research on the role of information adoption and utilization on sugarcane production and food insecurity in Nyanza region. Your household has been requested to partake in this survey.

The choice to join in the survey is voluntary. Should you start the survey and midstream you feel that you do not want to continue, you and your household will not be victimized for whatever reason. If you agree to participate, some questions about you and your Family will be sought for and your consent before the beginning of the exercise is very important. Information you shall give will be treated with utmost confidentiality and you are at liberty to query at any stage of the exercise and you are also free to contact Maseno University Ethics Review Committee (MUERC) attention to;

Ag. Secretary
Maseno University Ethics Review Committee (MUERC)
C/o Maseno University
P.O. Box Private Bag
Maseno- Kenya.
Cell phone: +254 721 206 932

Thanking you in advance,

Yours sincerely,

Mr. Ben Jack Otieno Ochieng

APPENDIX B: RESEARCHER'S CONSENT FORM

I………………………………………………………………………………………………
voluntarily agree to participate in this research study and would wish to state as follows:

a) I consent that I have read the letter of introduction for this study and that the objective of the research is "To determine the role of information technology adoption and utilization on sugarcane production and food insecurity in Nyanza region" and that I am also free to ask further questions at any point.
b) I agree to provide information to the researchers under the conditions of confidentiality and anonymity set out in the introduction letter by changing my name and /or disguising any of my details which may reveal my identity.
c) I understand that I am free to withdraw from the study within the set time limits without giving reasons for my withdrawal or to decline to answer any particular questions in the study without any consequences of any kind by the researcher.
d) I understand that I am free to contact any of the people involved in the research to seek further clarification and information.
e) I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
f) I understand that this study is voluntary hence I will not benefit directly from participating in this research.
g) I understand that my voice can be audio-recorded and this together with the signed consent forms will be kept by the researcher until Maseno university examination's board confirms the results of this study.
h) I understand that disguised extracts from my interview may be quoted in in conferences dissertation or in published papers.
i) I understand that in case any party is at risk of harm, then a report can be made to the relevant authorities with or without my permission.
j) I understand that I am entitled to access the information that I have provided at any time while it is in storage by the researcher.

Participant's Signature: ________________________________ Date: ____________________

Participant's Name: ____

Contact details: ____

Researcher's Name: ____

Contact details:____

Researcher's Signature: ____

APPENDIX C: QUESTIONNAIRE

Date/*Tarehe*|__||___|/|___||___|/|__||__| (DD/MM/YY)

Enumerator's name: ____________________ Agro ecological zone: ____________________

Village name: ____

PART A: DEMOGRAPHY/*DEMOGRAFIA*

1.1 What is the gender of the household head? *Nani kiongozi wa boma hili?*
Male/ *Mwanaume* [ ] Female/ *Mwanamke* [ ]

1.2 If female, why? (Tick appropriately). *Kama ni mama, kwa nini?*
Single / *Sijaoleka* [ ] Husband works elsewhere / *Bwana hufanya kazi kwingine* [ ]
Separated/ *Tumetengana* [ ] Divorced/ *Tumeachana* [ ] Widowed **/** *bwana alikufa* **[ ]**

1.3 When were you born? *Ulizaliwa mwaka gani*? ______________

1.4 What is your highest level of education? *Umesoma hadi kiwango kipi?*

Primary/ *Shule ya msingi* [ ] Secondary/ *Shule ya upili* [ ]
College/ *chuo cha elimu* [ ] University**/** *Chuo kikuu* **[ ]**
1.5 How many dependents are currently leaving here? *Watu wangapi huishi hapa*?___________

PART B: SUGAR CANE FARMING/ *KILIMO CHA MIWA*

B.1 Are you currently farming sugarcane? *Je unakuza miwa kwa saa hii*?
Adoption / *Ndio* [ ] No**/** *La* **[ ]**

B.2. If Not, please give a reason. *Kama sivyo, kwa nini?*

Expensive to do/ *Ni ghali* [ ] Requires bigger land/ *Huitaji shamba kubwa* [ ]
No returns/ *Haina mapato* [ ] Unfavorable climate/ *Hali ya anga ni mbaya* [ ]
Any other (specify)/ Taja lingine/ *Taja lingine* **[ ]**

B.3 If Adoption/Ndio, please give a reason/ *Ukipanda miwa, taja sababu*

Has a higher return/ *mapato ni mengi* [ ] Favorable climatic condition/ *Hali ya anga ni mema* [ ] Tradition/ *Desturi* [ ] Any other (specify)/ *Taja lingine* **[ ]**

B.4 What is your model of sugarcane farming? *Mfano wa kilimo ni kipi*?
Contracted/ *linalo mkataba* [ ] Non contracted/*Lisilo na mkataba* [ ]

B.5 When did you begin farming sugarcane? *Ulianza lini kupanda miwa*? ________________________

B.6 How many acres did you start with? *Ulianza kupanda hekari ngapi*? __________________

B.7 How many acres are you currently farming? *Unapanda hekari ngapi kwa sasa?* __________

B.8 If there is a decline in (B6) and (B7), what are the reasons for the changes? Please tick appropriately. *Kukiwa na upungufu kwa B6 na B7, sababu ni nini?*

Expensive to do/ *ni ghali* [ ] requires bigger land/ *Inahitaji shamba kubwa* [ ]
No returns/ *halina mapato* [ ] unfavorable climate/ *hali ya anga ni mbaya* [ ]
Others (specify)/ *Taja lingine* [ ]

B.9 What is the nature of your land ownership? *Shamba lako ni la aina gani?*
Rented/leased/ *Kukodisha* [ ] Owned/ *Langu mwenyewe* [ ]
Caretaker/*Ya kuchunga* [ ]

B.9.1 If rented/leased, how much did you pay? *Kama ni ya kukodisha, ulilipa pesa ngapi*? __________________

B.10 Please indicate the usage of the following inputs in sugar cane production and their prices per acre in the previous planting season/ *Tafadhali taja matumizi ya haya kwenye ukuzaki wa miwa na uweke kiwango ya pesa ulitumia kwa kila hekari msimu uliopita*.

Input/*pembejeo*	Application/*matumizi*	Previous harvest cost /*gharama ya mavuno ya zamani*	most harvest cost/*gharama ya mavuno ya hivi karibuni*
Labour cultivation: *Kulima*	Family/*familia* [ ] Hire/*Kodesha* [ ] Tractor/*Tinga* [ ] Bullock/ *Ng'ombe* [ ]		
Labour plantation: *Upanzi*	Family/*Familia* [ ] Hire/*Kodesha* [ ] Tractor/*Tinga* [ ]		
Fertilizer/*mbolea*	Adoption/*Ndio* [ ] No/*La* [ ]		
Pesticides/*dawa*	Adoption/*Ndio* [ ] No/*La* [ ]		
Seedling/*miche*	Adoption/*Ndio* [ ] No/*La* [ ]		
Irrigation/*unyunyizi*	Adoption/*Ndio* [ ] No/*La* [ ]		
Transportation/*nauli*	Adoption/*Ndio* [ ]		

	No/*La* [ ]		
Repairs/ *Rekebisho*	Adoption/*Ndio* [ ] No/*La* [ ]		

B.11 What were the sources of funds used to purchase these inputs? *Pesa za matumizi ulitoa wapi?*

Loan/ *Mkopo* [ ] Donations/ *Mchango* [ ] Own savings/ *Akiba* [ ]
Sale of property/*kuuza mali* [ ] Others (specify)/*Taja lingine*[ ]

B.12 Indicate the output tonnage per acre/ *onAdoptionha mazao kwa kila hekari* ________________

B.13 Where did you sell your sugarcane output? *Ni wapi uliuza miwa*

Sugar factory/ *Kiwanda ya sukari* [ ] Jaggery/*sukari nguru* [ ]
Juice buyers/*wanunuzi wa juisi* [ ] Firewood/briquettes/ *Makaa* [ ]

B.14 Indicate the average cost you incurred on the following costs to deliver your sugarcane output to the miller/ *OnAdoptionha iwapo uligharamika kwa kusafirisha miwa kiwandani.*

Costs/ *gharama*	Application/ *Matumizi*	If Adoption, how much? Previous harvest/*iwapo ndio, mavuno uliopita ni pesa ngapi?*	If Adoption how much? Most harvest *iwapo ndio, mavuno ya hivi karibuni ni pesa ngapi?*
Burning	Adoption/Ndio [ ] No/La [ ]		
Cutting and loading	Adoption/Ndio [ ] No/La [ ]		
Tax	Adoption/Ndio [ ] No/La [ ]		
Loan	Adoption/Ndio [ ] No/La [ ]		
Interest rates	Adoption/Ndio [ ] No/La [ ]		
Transport	Adoption/Ndio [ ] No/La [ ]		

PART C: FOOD PRODUCTION/*USALAMA WA CHAKULA*

C.1 Apart from sugarcane, do you farm food crops? *Pasipo na miwa, je unapanda vyakula vingine?* Adoption/*Ndio* [ ] No/*La* [ ]

C.1.1 If no, why not? *La sivyo, kwa nini?*

____

____

____

C.1.2 If Adoption which ones? Indicate the quantity produced per year/ *Iwapo ndio, onAdoptionha ni mimea gani na kiwango ya mavuno kila mwaka.*

	Food items/*bidhaa*	Yield per year/*mavuno kila mwaka*
A	Maize (millet, sorghum)/*mahindi(mtama,wimbi)*	
B	Other cereals (rice, wheat etc.)/ *mchele, ngano*	
C	Potatoes (sweet, Irish, yams, cassava etc.)/ *viazi*	
D	Beans (peas, green grams etc.)/ *Maharagwe*	
E	Nuts (ground nuts, pea nuts, sesame, etc.)/*Njugu*	
F	Vegetables (Sukuma, cabbage, etc.)/*Mboga*	
G	Fruits (bananas, oranges, lemon, etc.)/*Matunda*	
H	Red meat (cow, pork, goat, sheep etc.)/*wanyama*	
I	Poultry (chicken, duck, quails, etc.)/*ndege*	
J	Fish (Mudfish, Tilapia, and Catfish etc.)/*Samaki*	
K	Milk (cheese, ghee, dried milk, etc.)/*Maziwa*	
L	Others(specify)/ *Taja zingine*	

C.2 Do you do mixed farming of these products with sugarcane*/ Je unapanda haya mimea pamoja na miwa?* Adoption/*Ndio* [ ] No/*La* [ ]

C.3 If Adoption in C.2 above, estimate the total acreage under these crops/*iwapo ndio kwa C2 umepanda hekari ngapi ya mimea haya* _____________

C.3.1 If no, please give reasons/ *La sivyo, peana sababu.*

____

____

C.4 Do you use inputs such as labour, fertilizers and pesticides in the production of these commodities/ *je unatumia wafanyikazi, mbolea na madawa kwa upanzi?*

Adoption/*Ndio* [ ] No/*La* [ ]

C.4.1 If Adoption, please indicate the average cost of farm inputs used costsin the last harvest/*iwapo ndio, taja ni nini unatumia nani kwa gharama kipi msimu uliopita?*

	Input costs	Application/*matumizi*	If Adoption, how much?*iwapo ndio, gharama*
A	Labour cultivation/*kulima*	Family/*Familia* [ ] Hire/Kodesha[ ]	[ ]
B	Labour plantation/*upanzi*	Family/*Familia* [ ] Hire/Kodesha[ ]	[ ]
C	Fertilizer/*mbolea*	Adoption/*Ndio* [ ] No/*La* [ ]	[ ]
D	Pesticides/*madawa*	Adoption/*Ndio* [ ] No/*La* [ ]	[ ]
E	Seedling/*miche*	Adoption/*Ndio* [ ] No/*La* [ ]	[ ]
F	Irrigation/*unyunyizi*	Adoption/*Ndio* [ ] No/*La* [ ]	[ ]
G	Transport/*usafiri*	Adoption/*Ndio* [ ] No/*La* [ ]	[ ]
H	Repairs/ *rekebisho*	Adoption/*Ndio* [ ] No/*La* [ ]	[ ]

C.5 Once harvested, what do you do to the food crops/ *Baada ya kuvuna, unafanyia nini mazao*?

Sell all/ *uza zote* [ ]   Sell some/*uza zingine* [ ]

Keep all/*weka yote* [ ]   Donate/*peana* [ ]

C.6 Does the total food produced enough for your Family use? *je, mazao inakidhi mahitaji ya familia?* Adoption/*Ndio* [ ]   No/*La* [ ]   Somehow/*pengine* [ ]

C.6.1 If not or somehow, indicate the food stuffs that you sometimes face deficits on and indicate the quantities purchased and their prices/ *iwapo ni la au pengine, onAdoptionha vyakula havitoshelezi, kiwango na bei zao?*

	Food items/*Bidhaa*	Quantities/*Kiwango*	Price per unit/*Bei*
A	Maize (millet, sorghum)/ *Mahindi(mtama,wimbi)*		
B	Vegetables /*Mboga*		
C	Red meat (cow, pork, goat, sheep etc.)/*Nyama*		
D	Other cereals (rice, wheat etc.)/ *Mchele, ngano*		
E	Potatoes (sweet, Irish, yams, cassava etc.)/*Viazi*		
F	Beans (peas, green grams etc.)/*Maharagwe*		

G	Nuts (ground nuts, pea nuts, sesame, etc.)/*Njugu*		
H	Fruits (bananas, oranges, lemon, etc.)/*Matunda*		
I	Poultry (chicken, duck, quails, etc.)/ *Ndege*		
J	Milk (cheese, ghee, dried milk, etc.)/*Maziwa*		

C.7 Apart from the food crops, do you also keep animals/ *Badala ya mimea, je umefuga wanyama*? Adoption/*Ndio* [ ] No/*La* [ ]

C.7.1 If Adoption, indicate the type of animals that you keep, cost of maintenance and the benefits you have realized over the last 1 year/ *Iwapo ndio, onAdoptionha mifugo umeweka, gharama ya utunzaji na faida umepata miaka moja imepita.*

	Animal /*mifugo*	Number/*idadi*	Costs(Kshs) /*Gharama*	Benefits (kshs) / *Faida*
A	Cows/ *Ng'ombe*: Adoption/*Ndio* [ ] No/*La* [ ]		[ ]	[ ]
B	Goats/*mbuzi*: Adoption/*Ndio* [ ] No/*La* [ ]		[ ]	[ ]
C	Sheep/ *Kondoo:* Adoption/*Ndio* [ ] No/*La* [ ]		[ ]	[ ]
D	Poultry/*ndege*: Adoption/*Ndio* [ ] No/*La* [ ]		[ ]	[ ]
E	Fish/ *Samaki* : Adoption/Ndio [ ] No/La [ ]		[ ]	[ ]

C.7.2. If not, why not/ *Kama sivyo, mbona*?

____

____

C.8 Does food crop production and animal rearing enough to sustain your food requirements/ *Je, upanzi wa mimea na mifugo hutosheleza mahitaji yako ya chakula?*
Adoption/*Ndio* [ ] No/*La* [ ] Somehow/ *Pengine* [ ]

C.2.2 Indicate the extent to which you agree with the following statements to mitigate against food deficiency by putting a tick (√) on either strongly agree, agree, indifferent, disagree or strongly disagree in the absence of these products (in C.1.2) above/ *Ashiria kiwango ambapo unakubaliana na maneno haya kupunguza upungufu wa chakula kwa kuweka(√) kwa nakubali sana, kubali, sijali, sikubali, sikubali sana iwapo bidhaa kwa C.1.2 hapo juu zimekosa.*

	Mitigation/*kupunguza njaa*	Strongly agree/na*kubali sana*	Agree /*kubali*	Indifferent/ *Sijali*	Disagree /*sikubali*	Strongly disagree/*sikubali sana*
A	Purchase food/ *Kununua chakula*					
B	Government support/					

	usaidizi serikalini					
C	NGO's support/ *Shirika zisizo za serikali*					
D	Donations from friends and Family/ *mchango ya marafiki na Familia*					
E	Exchange with other items/ *Kubadilisha na vitu vingine*					
F	Foraging(hunting & gathering)/*chakura*					
G	Exchange work for food/*malipo kupitia chakula*					

C.8.1 If not, indicate the extent to which you agree with the following mitigation measures by putting a tick (√) on either strongly agree, agree, indifferent, disagree or strongly disagree/ *Iwapo la, ashiria kiwango ambapo unakubaliana na kupunguza yaha kwa kuweka(√) kwa kukubali sana, kubali, sijali, sikubali ama sikubali sana.*

	Coping strategy	Strongly agree/*nakubali sana*	Agree *nakubali*	Indifferent *Sijali*	Disagree *sikubali*	Strongly disagree/ *sikubali sana*
A	Taking/ *Kula uji*					
B	Prioritizing children over the adults for food/*Hulisha watoto kwanza*					
C	Reducing the number of daily meals/ *Hupunguza nambari ya chakula*					
D	Reducing food portion /*kupunguza kiwango ya chakula*					
E	Consuming less preferred staples/*tumia vyakula visivyopendeka*					
F	Changing food quality/ *Badilisha ubora wa chakula*					
G	Borrowing food from neighbors /Relatives/					

	Hukopa chakula kwa marafiki/jamii					
H	Eating immature crops/ *hula mimea hazijakomaa*					
I	Eating bush meat or plants/ *Kula wanyama na mboga pori*					
J	Purchasing food on credit/ *Hununua chakula kwa deni*					
K	Reducing health expenditures/ *hupunguza matumizi ya afya*					
L	Saving the left overs/ *Hutuza mabakio*					

PART D: INFORMATION TECHNOLOGY/*TEKNOLOGIA YA HABARI*

D.1 Indicate whether you have any of these information communication technology gadgets, the cost incurred in buying them and also rate these costs? Please tick appropriately/ *onAdoptionha iwapo una vyombo hivi vya mawasiliano, gharama ya ununuzi na ukadirie gharama.*

	Gadget/*Chombo*	Presence/*iko*	Cost/*Gharama*	Rate the cost/*kadiria gharama*
A	Mobile phone/*simu*	Adoption/*Ndio* [ ] No/*La*[ ]	[ ]	High/*Juu*[ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]
B	Radio/ *Redio*	Adoption/*Ndio* [ ] No/*La*[ ]	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]
C	Television/*Runinga*	Adoption/*Ndio* [ ] No/*La*[ ]	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]
D	Computer /laptop/	Adoption/*Ndio* [ ] No/*La*[ ]	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]

D.1.1 If any of the above gadgets are in use, what is the approximate cost of maintenance per month and how do you rate your costs? **Please indicate cost of maintenance including cost of charging and** tick appropriately/ *Iwapo unatumia vyombo haya, zinakugharimu pesa ngapi kila mwezi. tafadhali ongeza gharama ya kuchaji.*

NOTE: If the client has electricity, capture the cost of electricity/ *Iwapo mteja ana stima, weka gharama ya stima*

	Gadget/*Chombo*	Cost/month/*Gharama*	Rate the cost/ *kadiria gharama*
A	Mobile phone/ *Simu*	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]
B	Radio/*Redio*	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]
C	Television/*Runinga*	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]

D	Computer /laptop	[ ]	High/*Juu* [ ] Fair/*Kiasi*[ ] Low/*Chini*[ ]

D.2 Have you ever used information from the gadgets in D.1 above to increase your agricultural production? *Je, umetumia habari kutoka kwa vyombo haya kwenye D.1 kuongeza mapato yako ya kilimo?*

Adoption/*Ndio* [ ]   No/*La* [ ]

D.2.1 If Adoption, indicate the extent to which you agree with the following statements by putting a tick (√) on either strongly agree, agree, indifferent, disagree or strongly disagree/ *Iwapo ndio, ashiria kiwango ambacho unakubaliana na maneno haya kw kuweka (√) kwa kukubali sana, kubali, sijali, sikubali ama sikubali sana.*

	Technology use/ *Utumizi ya teknologia*	Strongly agree/ *nakubali sana*	Agree/ *nakubali*	Indifferent *Sijali*	Disagree/ *sikubali*	Strongly disagree/ *sikubali sana*
A	to Learn new methods of cultivating/*nimetumia ICT kujua mbinu mpya ya kulima*					
B	to Learn new methods of planting/ *nimetumia ICT kujua mbinu mpya ya kupanda*					
C	to access new marketing areas/ *nimetumia ICT kupata soko mpya*					
D	to get cheaper sources of raw materials/ *nimetumia ICT* kupata soko mpya					
E	I have accessed peer referrals /social media though ICT *nimepata rufaa rika kupitia ICT*					
F	for Remote sensing/ *nimetumia ICT kupata hisia za mbali*					
G	to get soil data/ *Nimetumia ICT kupata data ya mchanga*					
H	to get weather updates/ *nimetumia ICT kujua hali ya hewa*					
I	to buy farm inputs/ *nimetumia ICT kununua vitu vya shamba*					

Thank you for your response/ *Ahsante sana kwa majibu*

APPENDIX D: TABLES

Table 1: Acreage under Cash Crops

Region	Climatic condition	Total acreage (100 ha)	Sugarcane (100 ha)	Coffee (100 ha)	Cotton (100 ha)
	Semi-arid	379			
South Nyanza	Sub humid	1,255	2,413	2,095	1,707
	Humid	2,321			
Kisii	Humid	1,962	649	1,902	53
	Semi-arid	1			
Kisumu	Sub humid	847	916	449	872
	Humid	768			
	Arid	7			
	Semi-arid	322			
Siaya	Sub humid	263	1,185	973	885
	Humid	1,106			

Table 2: Nature of Land Ownership by Sugarcane Farmers

	Frequency	Valid Percent	Cumulative Percent
Rented/leased	41	20.4	20.4
Owned	148	73.6	96.0
Caretaker	12	6	100
Total	201	100.0	

Table 3: Reasons for Reducing Land Acreage

	Frequency	Percent	Cumulative Percent
Expensive to do	31	54.4	54.4
No returns	26	45.6	100
Total	57	100.0	

Table 4: Purchasers of Sugarcane

	Frequency	Percent	Cumulative Percent
Sugar factory	193	96.0	96.0
Jaggery	6	3.0	99.0
Juice buyers	1	1.0	100.0
Total	201	100.0	

Table 5: Types of Food Crops being grown

Crop type	Farming	Percentages
Maize (millet, sorghum)	219	88.7
Other cereals (rice, wheat etc.)	47	19.0
Potatoes (sweet, Irish, yams, cassava etc.)	180	72.9
Beans (peas, green grams etc.)	206	83.4
Nuts (ground nuts, pea nuts, sesame, etc.)	104	42.9
Vegetables (Sukuma, cabbage, tomatoes, Kienyeji	198	80.2
Fruits (bananas, oranges, lemon, etc.)	174	70.4

Table 6 Sources of Information Flow across the Sugarcane Zones

	Information flow to farmers					Total
	mobile phone, radio, TV and computer	mobile phone, radio, TV	mobile phone and radio	mobile phone	none	
Sony	48(44.1%)	34(31.2%)	25(22.9%)	2(1.8%)	0%	109
Chemelil	0(0%)	0(0%)	20(91%)	2(9%)	0%	22
Muhoroni	1(1.4%)	10(14.5%)	43(62.3%)	13(18.8%)	2(2.9%)	69
Ndhiwa	8(6.8%)	32(27.3%)	48(41%)	22(18.8%)	7(6%)	117
Total	57(17.9%)	76(23.9%)	136(42.9%)	39(12.3%)	9(2.8%)	317

Source: Survey Data (2020)

Table 7: Perception on Cost of Utilization of the Information Gadgets

	High	Fair	Low	Total
Mobile phones	69(23.3%)	220(74.3%)	7(2.4%)	296
Radio	35(13.2%)	192(72.1%)	39(14.7%)	266
TV	81(55.1%)	57(38.8%)	9(6.1%)	147
Computers	13(22.4%)	44(75.9%)	1(1.7%)	58

Source: Survey Data (2020)

Table 8: Farming Models

	Frequency	Percent	Cumulative Percent
Contracted	41	20.4	20.4
Non contacted	160	79.6	100.0
Total	201	100.0	

Table 9: Sugarcane Farmers' Reasons for Engaging in Sugarcane Farming

	Reasons for practicing sugarcane farming				Total
	has a higher return	favourable climatic condition	tradition	more than one reason	
Sugarcane farmers	22(66.7%)	9(27.3%)	1(3.0%)	0%	33
Mixed farmers	98(59.8%)	39(23.8%)	23(14.0%)	3(1.8%)	164
Total	123(60.9%)	50(24.4%)	25(12.2%)	3(1.5%)	201

Source: Survey Data (2020)

Table 10: Descriptive Statistics on Actual Costs of Sugarcane Production Variables

	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Labour	0	60000	4525.08	7996.584	3.509	0.137	17.047	0.273
Planting	0	139000	3606.62	10165.97	8.607	0.137	103.011	0.273
Fertilizer	0	150000	4233.47	10984.81	8.527	0.137	101.354	0.273
Pesticide	0	32000	1258.42	4032.868	4.881	0.137	27.633	0.273
Seedling	0	111000	4943.53	11275.54	4.068	0.137	26.778	0.273
Transport	0	20000	762.15	2109.705	4.714	0.137	30.766	0.273
Maintenance	0	4500	29.65	312.307	11.916	0.137	152.274	0.273

Source: Survey Data (2020)

Table 11: Tests of Normality on Cost of Sugarcane Production Variables

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Labour	.284	317	.000	.598	317	.000
Planting	.360	317	.000	.352	317	.000
Fertilizer	.349	317	.000	.370	317	.000
Pesticides	.396	317	.000	.358	317	.000
Seedlings	.378	317	.000	.504	317	.000
Transport	.419	317	.000	.425	317	.000
Maintenance	.403	317	.000	.192	317	.000

a. Lilliefors Significance Correction

Source: Survey Data (2020)

Table 12: Correlation Matrix on Cost Elements in Sugarcane Production

		Rent	Labour	Planting	Fertilizer	Pesticides	Seedlings	Transport	Machinery
Rent	P. Cor	1							
	Sig.								
Labour	P. Cor	.282**	1						
	Sig.	.000							
Planting	P. Cor	.374**	.448**	1					
	Sig.	.000	.000						
Fertilizer	P. Cor	.113*	.212**	.208**	1				
	Sig.	.044	.000	.000					
Pesticides	P. Cor	-.002	.070	.014	.407**	1			
	Sig.	.977	.213	.803	.000				
Seedlings	P.Cor	.290**	.150**	.185**	.165**	.061	1		
	Sig.	.000	.008	.001	.003	.276			
Transport	P.Corl	-.027	.079	.023	.059	.024	.199**	1	
	Sig.	.637	.163	.683	.298	.669	.000		
Machinery	P.Cor	-.068	-.078	-.038	-.047	.008	-.013	-.064	1
	Sig.	.230	.163	.501	.407	.882	.813	.258	
	N	317	317	317	317	317	317	317	317

Table 13: Farmers Admission towards Growing Food Crops

	Growing other crops		Total
	Adoption	No	
Sugarcane farmers	164(83.2%)	33(16.8%)	197
Food crop farmers	120(100%)	0%	120
Total	284(89.6%)	33(10.4%)	317

Source: Survey Data (2020)

Table 14: Food Crop Production by Farmers in the Study Area

	Food crop production		Total
	Adoption	No	
Sony	89(81.7%)	20(18.3%)	109
Chemelil	22(100%)	0%	22
Muhoroni	69(100%)	0%)	69
Ndhiwa	104(88.9%)	13 (11.1%)	117
Total	284(89.6)	33(10.4%)	317

Source: Survey Data (2020)

Table 15: Descriptive Statistics on Cost of Inputs in Food production

	Min.	Max.	Mean	Std. Dev	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Cultivation	0	25,000	1789.43	3378.505	3.281	.137	14.163	.273
Labour	0	25,000	1159.44	2794.172	4.957	.137	34.342	.273
Fertilizer	0	100,000	3337.54	9492.031	7.734	.137	72.061	.273
Pesticide	0	20,000	898.26	2684.803	5.008	.137	27.685	.273
Seedling	0	34,000	2082.65	5601.926	3.499	.137	11.699	.273
Transport	0	10,000	148.42	697.417	10.057	.137	129.374	.273
Repair	0	8,000	49.53	530.442	12.794	.137	176.387	.273

Source: Survey Data (2020)

Table 16: Tests of Normality on Food Production Variables

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Cultivation	.317	317	.000	.583	317	.000
Labour	.355	317	.000	.459	317	.000
Fertilizer	.363	317	.000	.331	317	.000
Pesticide	.369	317	.000	.365	317	.000
Seedling	.362	317	.000	.414	317	.000
Transport	.433	317	.000	.210	317	.000
Repairs	.525	317	.000	.069	317	.000

a. Lilliefors Significance Correction

Source: Survey Data (2020)

Table 17: Correlations Matrix on Costs of Food Production

		Cultivation	Planting	Fertilizer	Pesticide	Seedling	Transport	Maintenance
Cultivation	P.Cor	1						
	Sig.							
Planting	P.Cor	.815**	1					
	Sig.	.000						
Fertilizer	P.Cor	.495**	.399**	1				
	Sig.	.000	.000					
Pesticide	P.Cor	-.003	-.010	.160**	1			
	Sig.	.962	.853	.004				
Seedling	P.Cor	-.070	-.075	.223**	.327**	1		
	Sig.	.216	.185	.000	.000			
Transport	P.Cor	.341**	.468**	.037	.016	-.005	1	
	Sig.	.000	.000	.514	.778	.934		
Maintenance	P.Cor	.217**	.429**	.013	.016	-.010	.714**	1
	Sig.	.000	.000	.822	.781	.861	.000	
	N	317	317	317	317	317	317	317

Source: Survey Data (2020)

Table 18: Equation-level Goodness of Fit between Sugarcane and Food Production

depvars	fitted	Variance predicted	residual	R-squared	mc	mc2
observed						
lnlandsc	.278	.098	.180	.353	.594	.353
lnlaboursc	.724	.210	.514	.291	.539	.291
lncapitalsc	.941	.248	.693	.264	.513	.264
lnlandfd	.434	.059	.375	.136	.369	.136
lnlabourfd	1.142	.468	.674	.410	.640	.410
lncapitalfd	1.341	.528	.813	.394	.627	.394
latent						
food production	.059	.047	.013	.786	.886	.786
Overall	.833					

mc = correlation between depvar and its prediction
mc2 = mc^2 is the Bentler-Raykov squared multiple correlation coefficient

Table 19: Frequencies on Aggregates

		Statistic	Std. Error	Bootstrap[a] Bias	Std. Error	BCa 95% Confidence Interval Lower	Upper
Sugarcane	Mean	19884.39		-22.47	1561.77	17005.87	22802.49
	Std. Deviation	27609.1		-297.6	2974.01	22095.39	32646.99
	Skewness	3.01	0.137	-0.149	0.422	2.182	3.377
	Kurtosis	13.51	0.273	-1.125	3.156	9.213	15.7
Food production	Mean	10966.58		-11.9	854.89	9445.5	12607.41
	Std. Deviation	15706.98		-227.7	2135.736	11970.99	19289.61
	Skewness	3.949	0.137	-0.266	0.649	2.66	4.393
	Kurtosis	22.722	0.273	-2.64	6.514	12.575	26.443
Adoption	Mean	5818.83		6.88	284.84	5233.52	6408.7
	Std. Deviation	5147.991		-24.70	474.113	4228.211	6001.252
	Skewness	2.631	0.137	-0.054	0.256	2.17	2.965
	Kurtosis	9.138	0.273	-0.293	2.004	6.032	11.913
Utilization	Mean	2160.95		8.09	168.86	1854.88	2522.97
	Std. Deviation	3018.667		-19.888	414.18	2206.206	3754.664
	Skewness	4.344	0.137	-0.076	0.418	3.64	4.943
	Kurtosis	22.607	0.273	-0.134	5.388	14.942	32.544

Bca - Bias corrected accelerated

Table 20: Test of Homogeneity of Errors on the Study Variables

	F	df1	df2	Sig.
Sugarcane production	1.608	70	246	.004
Food production	1.780	70	246	.001
Adoption	1.930	70	246	.000
Utilization	4.623	70	246	.000

Source: Survey Data (2020)

Table 21: Mann- Whitney (Wilcoxon Rank-Sum) Test

Variables	Null hypothesis	t-stat	df	Sig.
Cost of sugarcane	The distribution of sugarcane cost is the same across the agro ecological zone	70.023	0.3	0.000
Cost of food	The distribution of food production cost is the same across the agro ecological zone	14.912	0.3	0.002
Cost of adoption	The distribution of cost of adoption is the same across the agro ecological zone	63.951	0.3	0.000
Cost of utilization	The distribution of cost of is the same across the agro ecological zone	22.987	0.3	0.000

Source: Survey Data (2020)

Table 22: Mediating Effect of Cost of Adoption between Sugarcane and Food Production

Structural equation model Number of obs = 164
Estimation method = mlmv
Log likelihood = -1014.9211
(1) [lnlandfd]food = 1
(2) [lntcoa]information = 1
(3) [lnlandsc]sugarcane = 1

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
food						
information	-.0521419	30.13047	-0.00	0.999	-59.10678	59.0025
sugarcane	.9668699	14.62383	0.07	0.947	-27.69532	29.62906
information						
sugarcane	.4853072	.2239063	2.17	0.030	.0464589	.9241554
Measurement						
lnlandsc						
sugarcane	1 (constrained)					
cons	8.73282	.0673748	129.62	0.000	8.600768	8.864872
lnlaboursc						
sugarcane	1.310557	.3148221	4.16	0.000	.6935169	1.927597
cons	8.516409	.0751652	113.30	0.000	8.369088	8.66373
lncapitalsc						

sugarcane	-.0114849	.1479303	-0.08	0.938	-.301423	.2784531
cons	9.837369	.0599352	164.13	0.000	9.719898	9.954839
lnlandfd						
food	1 (constrained)					
cons	8.348916	.0647788	128.88	0.000	8.221952	8.475881
lnlabourfd						
food	1.091046	.1413415	7.72	0.000	.8140216	1.36807
cons	7.943277	.0732546	108.43	0.000	7.7997	8.086853
lncapitalfd						
food	1.296204	.1569985	8.26	0.000	.9884928	1.603916
cons	8.599116	.0803088	107.08	0.000	8.441713	8.756518
lntcoa						
information	1 (constrained)					
cons	8.565379	.0803066	106.66	0.000	8.407981	8.722777
var(e.lnlandsc)	.3786071	.0716981			.2612124	.5487615
var(e.lnlaboursc)	.2529388	.0925426			.1234772	.5181367
var(e.lncapitalsc)	.5672368	.0638214			.454981	.707189
var(e.lnlandfd)	.1219793	.0384859			.0657237	.2263864
var(e.lnlabourfd)	.1387669	.0445609			.0739515	.2603901
var(e.lncapitalfd)	.3929944	.0766317			.268168	.5759248
var(e.lntcoa)	.0502052	536.0918			.	.
var(e.food)	.1454407	1.458612			4.23e-10	5.00e+07
var(e.information)	.9277272	536.0918			.	.
var(sugarcane)	.2594668	.0869794			.1345051	.5005239

LR test of model vs. saturated: chi2(11) = 47.69, Prob > chi2 = 0.0000

Table 23: Mediating Effect of Cost of Information Utilization on Cost of Sugar and Food Production

Structural equation model Number of obs = 164
Estimation method = mlmv
Log likelihood = -1011.385
(1) [lnlandfd]food = 1
(2) [lntcou]information = 1
(3) [lnlandsc]sugarcane = 1

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Structural						
food						
information	.137	316.313	0.00	1.000	-619.826	620.100
sugarcane	.875	78.030	0.01	0.991	-152.062	153.812
information						
sugarcane	.247	.193	1.28	0.202	-.132	.626
Measurement						
lnlandsc						

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
sugarcane	1	(constrained)				
cons	8.731	.067	129.48	0.000	8.599	8.863
lnlaboursc						
sugarcane	1.241	.313	3.96	0.000	.627	1.855
cons	8.516	.075	113.22	0.000	8.369	8.664
lncapitalsc						
sugarcane	-.0382	.146	-0.26	0.794	-.325	.248
cons	9.837	.060	164.14	0.000	9.720	9.955
lnlandfd						
food	1	(constrained)				
cons	8.353	.065	128.78	0.000	8.226	8.480
lnlabourfd						
food	1.085	.141	7.71	0.000	.809	1.361
cons	7.945	.073	108.11	0.000	7.801	8.089
lncapitalfd						
food	1.286	.156	8.25	0.000	.981	1.591
cons	8.598	.080	107.04	0.000	8.441	8.756
lntcou						
information	1	(constrained)				
cons	7.002	.078	89.62	0.000	6.849	7.155
var(e.lnlandsc)	.363	.076			.241	.548
var(e.lnlaboursc)	.266	.095			.132	.538
var(e.lncapitalsc)	.567	.064			.455	.707
var(e.lnlandfd)	.118	.039			.062	.224
var(e.lnlabourfd)	.141	.045			.075	.263
var(e.lncapitalfd)	.392	.076			.269	.572
var(e.lntcou)	.712	587.574			.	.
var(e.food)	.152	10.971			6.41e-63	3.61e+60
var(e.information)	.254	587.574			.	.
var(sugarcane)	.275	.093			.142	.534

LR test of model vs. saturated: chi2(11) = 46.60, Prob > chi2 = 0.0000

Table 24: Mediating Effect of Cost of Information Adoption and Utilization of Sugarcane and Food Production

Structural equation model Number of obs = 88
Estimation method = ml
Log likelihood = -791.71662
(1) [lnlandfd]food = 1
(2) [lntcoa]information = 1
(3) [lnlandsc]sugarcane = 1

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
Food						
Information (au)	.055	.066	0.83	0.407	-.075	.185
Sugarcane	.997	.269	3.71	0.000	.471	1.525
Information (au)						

Sugarcane	.419	.466	0.90	0.368	-.493	1.331
Measurement						
Lnlandsc						
Sugarcane	1	(constrained)				
Cons	9.607	.059	163.17	0.000	9.492	9.723
Lnlaboursc						
Sugarcane	1.714	.428	4.00	0.000	.875	2.554
Cons	9.121	.063	144.40	0.000	8.997	9.245
Lncapitalsc						
Sugarcane	1.454	.437	3.33	0.001	.598	2.311
Cons	9.451	.093	101.64	0.000	9.269	9.633
Lnlandfd						
Food	1	(constrained)				
Cons	8.814	.081	109.08	0.000	8.656	8.973
Lnlabourfd						
Food	1.936	.428	4.53	0.000	1.098	2.774
Cons	8.651	.0782	110.66	0.000	8.498	8.804
Lncapitalfd						
Food	2.007	.446	4.51	0.000	1.134	2.881
Cons	8.453	.104	81.42	0.000	8.250	8.657
Lntcoa						
Information	1	(constrained)				
Cons	8.745	.108	81.23	0.000	8.534	8.956
Lntcou						
Information	.307	.371	0.83	0.408	-.420	1.034
Cons	6.896	.164	41.95	0.000	6.573	7.218

Table 25: Calculation of the Goodness of Fit

		Variance				
Depvars	Fitted	predicted	residual	R-squared	mc	mc2
Observed						
Lnlandsc	.305	.080	.225	.262	.511	.262
Lnlaboursc	.351	.235	.117	.668	.817	.668
Lncapitalsc	.761	.169	.592	.222	.471	.222
Lnlandfd	.575	.129	.445	.225	.474	.225
Lnlabourfd	.538	.484	.054	.900	.949	.900
Lncapitalfd	.948	.521	.428	.549	.741	.549
Lntcoa	1.020	1.020	-1.00e-09	1	1	1
Lntcou	2.378	.096	2.282	.040	.201	.040
Latent						
Food production	.129	.086	.043	.667	.817	.667
Information	1.020	.014	1.006	.014	.117	.014
Overall				.819		

mc = correlation between depvar and its prediction
mc2 = mc^2 is the Bentler-Raykov squared multiple correlation coefficient

Source: Own computation

APPENDIX E: MAP Of NYANZA REGION