FACTORY LEVEL DETERMINANTS OF SUGAR PRODUCTION AMONG SELECTED SUGAR PROCESSING FIRMS IN KENYA

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DECLARATION

This research paper has not been presented anywhere for the award of a Degree in any other University. It is my original work.

Signed……………………………….. Date………………………………… 11/24/2022

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This paper has been submitted with the approval of the university supervisor.

Signed… Date…25/11/2022

Dr. Fredrick Odhiambo Sule

(Supervisor)

DEDICATION

This research work is dedicated to my parents, the late Nelson Ongúti Okindo and the late Joyce Bosibori Ongúti.

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Gratitude to the Almighty God for the ability granted to enable me to complete this course.

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The views expressed here are my own and not of the named person(s) and/or institution(s). I bear solely the responsibility for any errors and/or omissions.

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ABBREVIATIONS

KALRO	Kenya Agricultural and Livestock Research Organization
AFFA	Agriculture, Fisheries and Food Authority
KSB	Kenya Sugar Board
USD	United States Dollar
MT	Metric Tonnes
COMESA	Common Market for Eastern and Southern Africa
VAT	Value Added Tax
KACC	Kenya Anticorruption Commission
ROK	Republic Of Kenya
TP	Total Product
AP	Average Product
MP	Marginal Product
MRS	Marginal Rate of Substitution
TFTA	Tripartite Free Trade Area
VIF	Varian Inflation Factor
TFP	Total Factor Productivity
GDP	Gross Domestic Product
OLS	Ordinary Least Squares

ABSTRACT

Sugar consumption has always surpassed sugar production for many years in Kenya. It is therefore imperative to improve local production so as to increase growth and efficiency in the sugar industry while at the same time reducing imports and increasing exports. This study sought to determine the factory-level determinants of sugar production in Kenya. The study was guided by the theory of production. The researcher obtained panel data for five sugar factories including; Chemelil, Muhoroni, Trans Mara, Kibos and Allied industries, together with West Kenya sugar factory. The researcher obtained data from the Kenya Sugar Board's annual reports. Data collected was for the period 2008 to 2020. The study findings indicated that capital input, labor input, and R&E had a positive insignificant effect on sugar production. Results indicated that firm size had a positive significant effect on sugar production. Results revealed that technology, firm age, governance, and cost-income ratio had a negative insignificant effect on sugar production. Based on the findings, the study concluded that capital input, labor input, and R&E positively affect sugar production among the selected sugar processing firms in Kenya. The study also concluded that firm size positively and significantly affects sugar production. Finally, the study concluded that technology, firm age, governance, and cost-income ratio negatively affect sugar production. The study recommended that sugar processing firms should review their capital input, labor input, and R&E policies to enhance efficiency in production. Equally, they should strengthen the capacity of employees through training to enhance efficiency in production. The firms should also hire enough employees, which is likely to enhance on sugar production. The study recommended that sugar processing firms should adopt appropriate modern technology in the production process. The governance structure of the firms should also be reviewed to ensure competence. The management of the firms should further review the cost-income ratio, and find ways of reducing overall costs while generating more income. The study focused on factory-level determinants of sugar production. Future studies could focus on macro-level determinants of sugar production such as inflation, foreign exchange rate and competition.

CHAPTER ONE

INTRODUCTION

1.1 Research Background

The Economy of Kenya is largely dominated by the agricultural sector. The total amount of land that receives rain and is able to sustain agricultural activity is only 10%. About 50% of agricultural income is for domestic use (subsistence production). Kenya's agricultural sector comes second after the service industry in regard to the Gross Domestic Product (GDP) contribution. According to Nyoro 2012, Productivity increases in the agricultural sector impacts on economic growth positively. It is therefore important to improve Kenya's agricultural sector so as to promote economic growth and development.

Kenya's sugar industry has made a significant contribution to the nation's development. Although important to Kenya's economy, it has continued to do badly. This has led to further shortages in sugar production. The poor performance of the industry endangers the lives of more than 250,000 farmers who rely heavily on the sector. Kenya's manufacturing sector where the sugar industry falls under remains stable in terms of GDP. A number of multi-stakeholder policy impacts need to be made to promote the industry. According to (Kenya Economic Survey, 2015), the contribution of the sugar industry has been on average 10% for more than a decade. Kenya's Vision 2030 states that the sugar industry must contribute 20% of GDP in order to achieve this goal, other key factors hindering rapid growth that need to be addressed include high investment costs, lower investment portfolios, high debt costs, and foreign competition.

According to a report by Kenya vision 2030. Kenya's economic growth and development can be improved through increased productivity in all sectors of the economy. To specifically improve the sugar industry, measurement of production levels of various sugar firms should be done regularly to check for competitiveness. In doing so, the production levels of various sugar factories will be improved. According to a study by KPMG 2012, sugar-producing firms have low sugar output and reduced profits attributed to internal inefficiencies and declining sugarcane yields.

1.2 Kenya Sugar Industry Framework.

Kenya's Sugar industry has eleven active factories which are; Nzoia , Kibos Sugar and Allied, Chemelil, Muhoroni, Trans Mara , South Nyanza, Mumias, Sukari Industries Ltd, Kwale International, West Kenya, and Butali Sugar (Mati & Thomas, 2019).

Kenya's first sugar factory; Miwani Sugar Factory was established in Kenya near Kisumu in the year 1922. This was followed by Ramisi Sugar Factory which was established in the year 1927. As the demand for sugar kept rising, the government increased involvement in sugar production by investing more on industrial production programs. This led to the formation of, Muhoroni Sugar factory in the year 1966, Chemelil in the year 1968, Mumias Sugar factory in the year 1973, Nzoia Sugar in the year 1978, South Nyanza sugar factory in the year 1979, West Kenya sugar factory in the year 1979, Butali Sugar Factory in the year 2010, Kibos in the year 2008, Soin Sugar factory in the year 2008 and Trans Mara Sugar Factory in the year 2011.

The government got actively involved in the sugar industry to address the increasing consumption requirements. Sugar production had to be increased to reduce excessive imports and increase sugar exports to promote foreign exchange on sugar. According to (Sserenkuma and Kimera, 2006), increased sugar production will improve life standards in the rural areas through creation of job opportunities and creation of wealth, hence accelerate economic development.

The Kenya Sugar Directorate which operates under the Agriculture Fisheries and Food Authority (AFFA) governs Kenya's sugar industry. It has a mandate to regulate, develop and promote the industry. The Sugar Research Institute (SRI) which is under the Kenya Agricultural and Livestock Research Organization (KALRO) is the body mandated to conduct research on sugar production starting from sugarcane cultivation. It does so by researching on efficient technologies to be put in place for greater yields.

Changes in Kenya's sugar industry.

Kenya's sugar industry experienced a huge financial crisis between 1998 and 2001 (KACC 2001). Policy measures were put in place to rescue the industry leading to the establishment of the Kenya Sugar Board. Further, reforms were put in place to direct and regulate the operations of sugar industry stakeholders (Ssrenkuma and Kimera, 2006). Kenya's sugar industry operations are funded by the Sugar Development Fund (SDF), established in the year 1992 with the aim of extending industry loans for industrial restructuring and sugarcane development, together with providing operational grants.

Sugar industry challenges in Kenya.

According to a report generated by the Kenya Sugar Board in the year 2007. Kenya's sugar industry incurred very high costs in sugar production. This largely reduced the industry’s competition with other players. Production cost in Kenya was estimated at USD 870 per MT; this figure was double the production cost in other COMESA countries. According to a report by (Kenya National Assembly, 2015), the cost of sugar production in Kenya was very high in comparison to other countries such as Zimbabwe that was producing at 300 USD, Swaziland at 340 USD, Malawi at 350 USD, Sudan 340 USD, and Zambia producing at 400USD.

Among other challenges established included; low productivity levels, uncertain harvest times, huge debts, sugarcane sourcing problems, poor management practices, volatile and unreliable weather conditions, poor or obsolete technology, outdated tools and equipment, low technical efficiency and management inefficiencies leading to poor operational efficiency by industries (KSI 2009 and KSB 2010).

Kenya being a member of COMESA has to abide by free trade protocol provisions which allow the sale of sugar from COMESA free trade area countries to Kenya with no activity restrictions or quotas. The GOK benefited from the import safeguards granted by the COMESA secretariat limiting duty free imports from COMESA countries to 350,000 MT annually. The latest extension given to Kenya for a two-year period expired in February 2019. The expiry led to an influx of sugar imports at very low prices compared to locally produced sugar. Kenya was expected to perform specific changes to spur the sugar sector and make it competitive. Further, COMESA’s secretariat (under Article 61 of the COMESA treaty) extended Kenya’s sugar import safeguard to last to 2021. The grant of import safeguards has so far been extended nine times for sixteen years. The grant required Kenya to privatize government owned sugar mills, introduce advance payments to farmers yielding sugarcane with sucrose content and provide a reliable transport network in sugar growing areas. Kenya has not so far affected any of the corrective measures. The COMESA Committee further proposed to its Council to grant Kenya an additional extension of import safeguards from March 2021 to February 2023. This grant is yet to be approved by its Council

Kenya’s sugar is taxed not like other food items that are tax exempt and therefore attracts 16 percent VAT. Additionally, sugar mills charge sugar development levy charged at a rate of 4%. Equally, imported inputs are taxed. Kenyan sugarcane farmers don’t receive government subsidies as is in other countries such as Egypt. This leads to very high production costs compared to countries that don’t tax sugar and enjoy government subsidies. According to (Monroy et al, 2013), sugar products are double taxed, since taxes are levied on machinery used in production and on the final output. He attributes double taxation to the main reason behind South Africa’s highly priced sugar. He further gives suggestions of classifying sugar under food items such as maize for it to be zero rated.

According to a report by KACC (2010), corruption is sighted as a major challenge facing the management of sugar companies. This includes; cases of discrimination and bias in appointment of senior sugar industry officials, factory recruitment and employment, high factory sugar theft cases, lack of transparency by the Kenya Sugar Directorate in approval and disbursement of loans and accreditation and non-compliance to the set regulations in the Sugar Act (2001) in regard to licensing of new sugar factories.

1.3 Sugar Production Overview in Kenya.

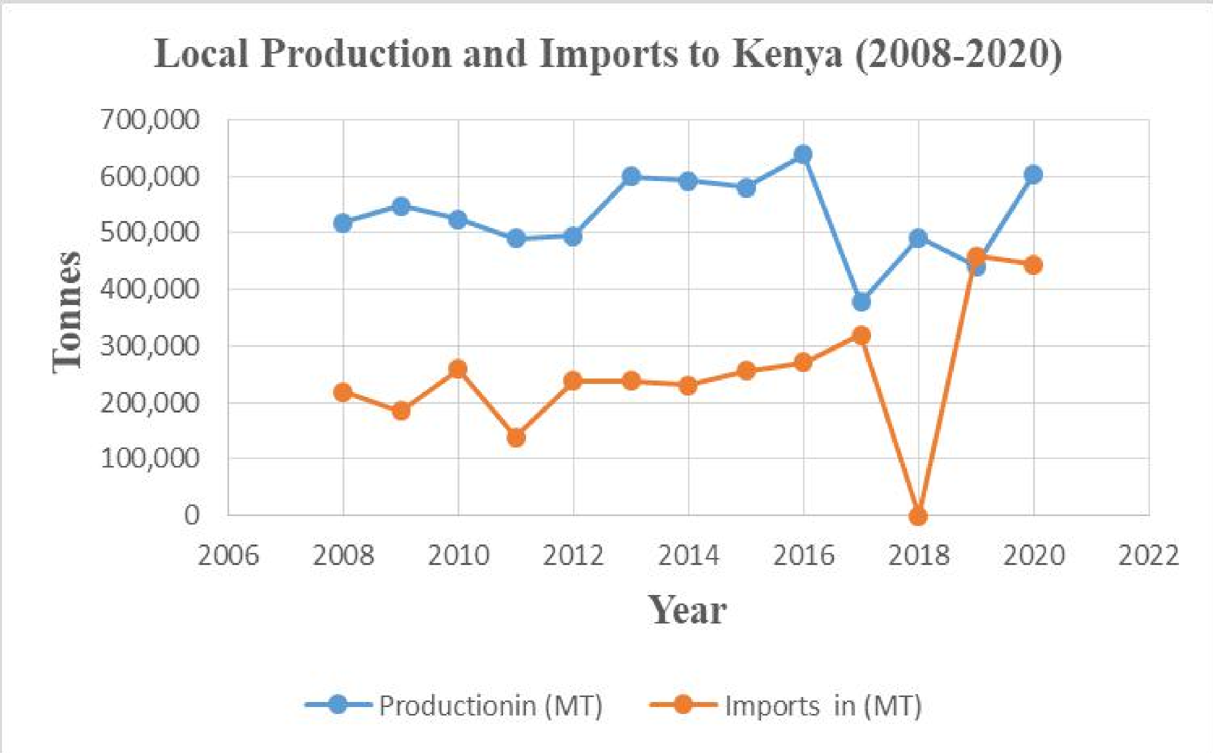
Kenya's sugar production has been fluctuating over the years. From the year 2009 to 2010 the amount of sugar produced in Kenya decreased from 548,207 MT to 523,652 MT. In addition, sugar production dropped from 638,340 MT to 377,126 MT between 2016 and 2017. The continued decline in domestic sugar production necessitated the need for importation. Kenya registered the lowest sugar production at 377,126 MT in the year 2017. This necessitated an increase in sugar imports to sustain the high demand. The imports were at 320,000 MT which was a very high increase compared with the previous year’s imports at 270,000. MT. In the year 2018, sugar production increased to 532,032 MT leading to a decline in imports from 320,000 MT to 284,200 MT.

Table 1.1: Sugar Production Output and Imports (2008 – 2020)

Year	Production output (MT)	Imports (MT)
2008	517,667	218,607
2009	548,207	184,531
2010	523,652	258,578
2011	490,210	139,076
2012	493,937	238,589
2013	600,179	238,046
2014	592,034	230,000
2015	580,000	256,000
2016	638,340	270,000
2017	377,126	320,000
2018	491,000	284,200
2019	440,900	458,600
2020	603,800	444,500

Source: KSB Data, 2020

Figure 1.1: Sugar Production in comparison to Imports (2008 to 2020)



Source: KSB Data, 2020

Sugar Production, Consumption and Export status.

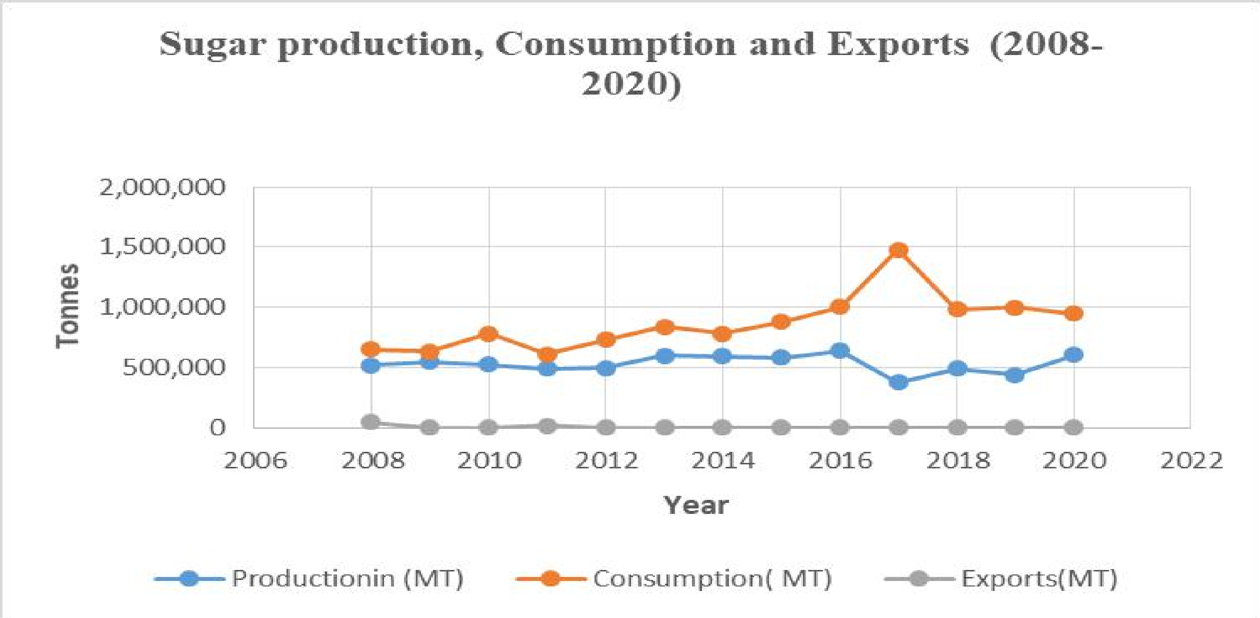
Table 1.2 shows production, Consumption and Export quantities from the year 2008 to 2020. Consumption levels are depicted to be higher than production levels from the years 2008 to 2020. The export levels are lower than both production and consumption. The high sugar consumption levels are met by imports. The table also shows that Kenya mostly doesn't gain from trading in foreign exchange from sugar exports. Hence the need to increase production by sugar factories.

Table 1.2: Sugar Production, Consumption and Exports (2008-2020).

Year	Production in (MT)	Consumption (MT)	Exports (MT)
2008	517,667	648,475	44,332
2009	548,207	630,440	1,952
2010	523,652	782,250	47
2011	490,210	612,610	16,716
2012	493,937	732,137	434
2013	600,179	838,079	104
2014	592,034	784,157	400
2015	580,000	879,275	100
2016	638,340	1,004,065	100
2017	377,126	1,477,283	400
2018	491,000	980,000	2000
2019	440,900	1,000,000	979
2020	603,800	950,000	554

Source: Author, KSB Data 2020

Figure 1.2: Sugar Production, Consumption and Exports (2008-2020)



Source: KSB Data 2020

Sugar Production Outputs, and Market share of Manufacturers in Kenya.

According to a report by the KSB in the year 2014, Mumias Sugar Factory had the largest percentage in market share in the year 2014. There is a need to investigate the factors contributing to the different production levels of the active sugar factories. This is on the basis of low production levels and the variances in production by the sugar factories at different times coupled with the collapse of some sugar factories e.g., Mumias sugar factory.

Table 1.3 indicates output by the largest sugar manufacturers in Kenya during the first quarter of the year 2020.

Table 1.3: Sugar Production and Market Share of sugar factories in Kenya; January to April 2020.

Rank	Factory	Sugar Production	Market Share %
1	West Kenya	57,317	29.62
2	Butali	31,108	16.07
3	Kibos Sugar & Allied Industries	27,732	14.35
4	Sukari Industries Ltd	27,706	14.26
5	Trans Mara	25,122	12.98
6	Nzoia	3,832	1.98
7	Muhoroni	3,784	1.96
8	Chemelil	1,442	0.75
		TOTAL	**100%**

Source: Author, KSB Data 2020

1.4 Research Problem

Kenya's sugar production costs have been established to be higher than in other sugar-producing East African Countries and COMESA member countries where Kenya belongs. According to Kenya's Sugar Industry strategic plan (2010-2014), the cost of sugar production in Kenya is set at USD 415-500USD / ton. While in Tanzania and Uganda the costs are between USD140-180USD/ ton and USD180-190USD/ ton respectively. The strategic plan stipulates that low production is greatly attributed to challenges such as; outdated factory equipment and machinery, insufficient labor input, outdated technologies, inadequate industrial research and development, high sugar costs, inefficient factory operations coupled with low sugarcane produce (RoK, 2015).

COMESA protections limiting the importation of sugar to Kenya to 350,000 MT annually, ended in March 2021 and were extended to February 2023. The grant required Kenya to comply with specific conditions including; privatization of government owned sugar factories, introduction of payments to farmers yielding sugarcane with sucrose content and the provision of a reliable transport infrastructure network in sugar growing regions. Unfortunately, Kenya has not complied with this corrective measures.

Sugar consumption has always surpassed sugar production for many years in Kenya. It is therefore imperative to improve local production so as to reduce imports and increase exports for trading in the foreign market. Failure to do this; the sugar sector could collapse leading to reliance on imported sugar leading to a loss in tax revenue for the government. The lives of over 250,000 farmers relying on this sector will be put to risk due to loss of income. This will subsequently increase poverty levels in sugar-producing areas. (KSB, 2016). Many studies have been done in the sugar industry, but this far no study has been done focusing on factory level sugar production. The researcher thus aimed to close this existing gap.

1.5 Research Questions

What factors affect factory level sugar production among the five sugar factories in Kenya?

1.6 Research Objectives

1. To establish factors affecting sugar production at factory level.
2. To estimate the impact of the factors established on sugar production.
3. To draw conclusions and formulate policy recommendations based on the findings.

1.7 Justification of Study

Many studies have been carried out in the sugar industry; no study has been done focusing on factory level sugar production. The researcher thus aims to close the existing research gap. Research findings and recommendations drawn will be helpful towards formulating policies that will improve production output growth and efficiency in the sugar industry. Additionally, analysing the factory level sugar production in Kenya is important since increases in sugar production are necessary to meet the high sugar consumption levels and further produce exports for foreign exchange.

1.8 Organization of Sections

The study is divided into five chapters. The first one covers the research background, Kenya's sugar industry framework, the research problem, the research objectives, the justification of the study, and the scope of cover. The second chapter discusses the theoretical literature, the empirical literature, and an overview of the literature review. The third chapter outlines the research design, the theoretical framework, the model specification, variable description, measurement, the diagnostic tests used, and lastly the references used by the researcher. The fourth chapter the outlines research findings and discussion. The fifth chapter highlights conclusions and policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The chapter has three sections; the theoretical literature which outlines on the theoretical foundation of the research topic, the empirical literature that outlines on empirical studies that have been conducted relating to the researcher's topic, and the overview of the literature review, which gives a summary of the literature review.

2.1 Theoretical Literature

This research paper focuses at the production theory.

The theory of production:

Production is described as process through which inputs are employed to yield an output. The production theory aims to explain the principles by which a company makes decisions on the quantity of how much it will produce and how much inputs it will use. That includes; capital, labour input etc.

A production function will define the qualitative relationship between inputs and outputs for a given state of technological know-how. It can be defined as;

$Q = f(a, b, c\ldots\ldots\ldots, z;\ m_1, m_2\ldots\ldots m_n)$ where by $a, b, c\ldots\ldots\ldots z$. Are the variable inputs used while $m_1, m_2\ldots\ldots m_n$, are the fixed inputs. While Q is the expected output. Such inputs can be defined as; a, being *capital*, b, being *labor* etc. While m_1, can be land, m_2 machinery etc. If labor and capital are the only involved inputs then the equation can be rewritten as; Q = F (K, L) where by K denotes capital and L denotes labor.

A business makes three decisions to determine the quantities of inputs and outputs to employ. The decisions include;

Reducing short-term costs, increasing short-term profits and increasing long-term profits. Reducing short-term costs involves decisions about how to produce a given product value in a given plant size and equipment at the lowest cost. Increasing short-term profits includes determining the quantity of products to be produced that will yield the most profits.

Increasing long-term profits, looks at the size of the firm in terms of one that yields highest profits.

Reduction of short-term costs; the firm may wish to produce as many goods at the lowest price possible, by taking into account product quality and input prices as provided. The firm will seek to determine the cheapest set of inputs that produces the highest output. Finding the cheapest combination of inputs to yield the highest profits is a cost minimization problem, since variable costs are the ones that keep changing. Production costs, are defined as the sum of all variable costs incurred in a production process.

This introduces a cost function; C=F (Q)**,** Where C, denotes cost and Q denotes output.

This can be broken down to;

$C=P_1a+P_2b.....+P_nz+r_1m_1+r_2m_2.....+r_n m_n$

Where P_1 is the unit price for variable *a, P_2* is the unit price for variable b, and r_1 denotes the cost of fixed element m_1, and r_2 denotes the cost of fixed element m_2 etc.

The above equation can be expressed diagrammatically using isoquants and isocosts; isoquants define the set of inputs that can yield the same output. While isocosts define all sets of inputs that cost the same amount. Isocosts and isoquants can display the right set of inputs that will yield the highest output at the lowest cost.

Production function in the Short-Run.

This is the period in the production process where one or more factors of production/inputs remains fixed. Assuming two inputs/factors of production capital and Labour. If the firm wishes to increase its profits, it can do so by increasing the quantity of labour while holding constant the quantity of capital. To increase profits, the company will produce in the area of the highest isoquant and the least possible isocost. The production function is denoted as follows;

Q=F (L)

To identify the technical relationship existing between the change in inputs and the resulting output, we define the Total Product (TP), Marginal Product (MP) and Average Product (AP)

Total Product is the quantity of output produced when all factors of production are used at a fixed period. Average Product is the output achieved when one unit of input is used. To get the AP we divide TP by the quantity of variable factor used e.g., Labor.

AP = TP/ (L) = Q/L.

Marginal Product is the change in Total Product brought about by a unit change in a variable input.

MP = $\Delta Q/\Delta L$.

The production function in the short run defines an increase in return due to an increase in the variable factor; labour. As labour continues to be increased, the TP increases but not proportional to the increase in labour. The MP diminishes, meaning the rate of increase in TP reduces. This stage defines diminishing returns due to an increase in the variable factor labour. As the labour continues to be added further, the TP itself diminishes. Meaning the MP is negative, this is the stage of negative return due to an increase in the variable factor labour. The three stages above define the law of diminishing returns defined as. "An increase in quantity of a variable factor of production holding the other factor constant will lead to the marginal and average product decreasing eventually".

Production function in the long run.

The function in this period of time defines the production process over which a firm is able to vary all its factors of production with the existing technology. In this stage a firm is also able to substitute one factor for another. E.g., more capital and less labour and vice versa to produce a fixed output. For a firm to attain profits in the long run it ensures that it adjusts all its inputs to the least costs to ensure that the cost of production is as the least possible. To be able to identify the least cost of inputs to be employed, the principle of least cost combination is introduced. The principle states that, the least cost combination of a given input for a given output will have an inverse price ratio equal to their marginal rate of substitution.

MRS of (a) for (b) = Units replaced of (a) / Units added of (b)

Price Ratio = Unit cost of the input added / Unit cost of the input replaced

= Cost of b / Cost of a

The lowest cost combination of the two inputs is obtained by equating the MRS with inverse price ratio. ($a * P_a = b * P_b$)

The Production function will exhibit returns to scale since all factors of production can be varied. A profit maximizing firm may wish to increase its profits by doubling the use of both labour and capital. It is therefore possible to increase the scale of production of a firm. This increase can only take place when the quantities of all variable factors of production are increased proportionately.

A production function in the long run may exhibit constant, increasing or decreasing returns to scale. Constant returns to scale occur when a proportionate increase in all inputs, result to an increase in output by the same proportion. Increasing returns to scale occur when a proportionate increase in all inputs results to an increase in output by a larger proportion. Decreasing returns to scale occurs when an increase in all inputs by the same proportion result to an increase in output by a smaller proportion.

Production theory criticism:

This theory has been subjected to a lot of criticism. The theory is claimed to only exist in theory and not in practice since many complex firms may not be able to exactly tell the relationship between their inputs and the related outputs. A defence for this theory was established by the subjection of observable data to logarithmic techniques. This provided a conclusion that their existed a technical relationship between inputs and outputs. The production theory has also been accused of being over-simplified since it assumes no changes in the entire economy in the period of the production process, yet their exists so many changes e.g., technological changes coupled with various risks and uncertainties facing business decisions. Equally, it is criticized on focusing on cost reduction and profit maximization which may not be the area of focus for all businesses. With the existing criticism the production theory has still been applauded as a worthwhile theory necessary to show fundamental relationships and trends in the economy.

2.2 Empirical Literature

Bancy, Mati and Michael (2019) analysed Kenya's sugar industry and investigated the production prospects at the coast. They utilized secondary and primary data sources from the coastal region for the period 2017 to 2018. The study concluded that the sugar industry requires reforms to improve production levels. The study concluded on the existence of laws to protect and preserve the industry but also concluded on lack of professionalism and accountability across all value chains. The study identified the existence of production prospects in the coastal region. This could be realised through creation of reliable irrigation infrastructure and feasible sugar value chains that capture on; markets for both inputs and outputs, factories, transport, socioeconomic safeguards, policy and institutional support.

Gitahi and Frederick K (2005) investigated on the factors influencing the supply of sugar in Kenya for the period 1970-2003. The study concluded on the existence of a gap between local production and demand. The study investigated the factors influencing sugar supply in Kenya, with the aim of increasing production. The study found out that input prices and structural policies implementation are significant factors influencing sugar production. The study did not offer any quantitative or statistical evidence to support his findings. The current study will aim to fill the gap through performing an evidence-based analysis using the Cobb Douglas production function.

Irungu, Wambugu and Githuku (2008) set to investigate Kenya's technological efficiency in the sugar industry for the period 1980 to 2007. They used panel data and a stochastic frontier approach for their evaluation. Their study also set out to investigate the factors affecting the efficiency of the technology used by sugar factories. The findings showed that all sugar factories studied experienced negative growth in technological efficiency, leading to poor production levels. The study only looked at technological efficiency as a factor of production. The current study will fill the gap of determining the other factors that affect production levels of sugar factories in Kenya. It will use a Cobb Douglass production function for its analysis.

Jabuya (2015) in his study estimated the productivity of Kenyan sugar factories. He collected data from the year 2004 to 2013 from the Kenya Sugar Board. He used Data Envelopment analysis approach to calculate productivity changes. His findings arrived at a conclusion that sugar factories faced productivity growth problems. He recommended the privatization of government owned sugar factories, adoption of better technologies in production and adoption of new innovations through research and development. His study did not suggest specific recommendations for already privatized sugar factories. It did not also give specific parameters for increased production levels for growth of sugar factories. This study will aim to fill the existing gaps by analysing the factors that affect specific sugar factories within Kenya.

Mamashila's (2017) investigated South African production decisions and export trends within the Tripartite Free Trade Area (TFTA) between the year 1996 and 2014. Both secondary and primary data were used in his study. The analytical tools used in the study were Johansen's experiments with Porter's Diamond Model. Secondary data analysis revealed sugar production fluctuations in South Africa between the years 1996 and 2014. In determining the factors that contribute to sugar production in South Africa, a number of aspects were identified such as barriers to competitiveness, a shortage of skilled workers, high levels of capital, poor infrastructure and development. His research highlighted a mythological gap since it used Johansen & Porter's Diamond Model experiment for analysis. The researcher will use the Cobb Douglas production function for its analysis.

Odhiambo (1978) set to investigate the structure of Kenya’s sugar industry and its performance emphasizing on South Nyanza sugar belt. His study concluded that the performance of sugar factories is unsatisfactory because of lack of efficiency in plant capacity utilization, lack of plant efficiency and lack of technological progressiveness. His evidence was not supported with any quantitative evidence or any statistical analysis. The current study aims to fill this existing gap. It will carry out its analysis using a Cobb Douglas production function.

Raheman, Qayyum and Afza (2009) analysed the performance of Pakistan sugar factories. Panel data was used employing data envelopment tools of analysis; whereby the Malmquist Total Factor of Productivity index was measured and the elements efficiency and technological change analysed. Findings of the study concluded that, sugar factories in Pakistan had some technological advances although, there existed a lot of management inefficiencies. Hence, production remained unchanged. The study suggested that productivity growth remained stagnant and recommended investment in technological change since it was the main determinant of production. It also suggested on the improvement of management practices. The current study will look at specific inputs in the production process analysing them with the Cobb Douglas production function.

Teodoro C Mendoza, Doreta A. De Los Santos, Fernando H Corpuz and Pablito Sandoval 2014 set to analyse sugar production in the Philippines and the implications which research and development and the National Industrial Policy have on its performance. The study which employed a value chain analysis concluded on the existence of interdependence between the sugar factories and the farms. The study therefore concluded that improving the sugar factories required improvement in the farm and vice versa. They used a value chain analysis which was not sufficient enough to give a clear aspect on which aspects needed to be improved by the sugar factories. Therefore, there exists a gap to be filled. The current study will employ a Cobb Douglas production function in its analysis to ascertain the factors that affect sugar production by Kenyan sugar factories.

Wanjere and Egessa (2015) investigated on the impact of technical training on sugar industries in South Nyanza, Kenya. The study used a descriptive research design. Research findings concluded on existence of a linear positive relationship between technical training and organizational performance. It recommended on the inclusion of a technical training philosophy. The study only measured training as a factor of sugar production and used descriptive statistics. The current study will employ statistical tools in its analysis and investigate other factors affecting the sugar industries production levels.

Yasmeen, S. Patil and N. Ananda (2018) set to investigate the factors affecting cooperative-sugar factories performance in North Eastern Karnataka. Their study concluded that, to improve production of sugar factories. The factories have to plan carefully at the start of the season. This is necessary for them to be able to meet the set capacity utilization through availability of sugarcane as an input. To achieve this, factories need to extend financial assistance to the farmers so that they can afford to buy inputs early for farming. This measure will ensure the factories maintain their set capacity utilization. The study used financial estimates to determine the economic potential of the sugar industry. The current study aims to examine broadly at other elements of production and provide statistical evidence by estimating a Trans log Cobb Douglas production function.

2.3 Literature Review Overview

A review of the literature presented of various study areas, indicate the existence of gaps that the current study will fill. Looking at Mamashila's (2017) who investigated on sugar production decisions together with export trends within the Tripartite Free Trade Area (TFTA) between 1996 and 2014 in South Africa. A gap is noted on the analytical tools used in the study. That is Johansen's experiments with Porter's Diamond Model. The current study will use a Cobb Douglas production function for analysis. Equally, Jabuya (2015) analysed

Kenya's Sugar factory productivity from the year 2004 to 2013. He used Data Envelopment analysis approach to calculate productivity changes. The study did not suggest specific recommendations for already privatized sugar factories. It did not also give specific parameters for increased production levels for growth of sugar factories. The current study will aim to fill this gap. In addition, Teodoro Mendoza, Doreta De Los Santos, Fernando H Corpuz and Pablito Sandoval 2014 set to analyse sugar production in the Philippines and the implications of research and development together with the National Industrial Policy on its performance. The study employed a value chain analysis which presented a gap. The findings did not give any scientific evidence; hence they are considered unreliable. The current study employed a Cobb-Douglas Production regression analysis which provides evidence-based findings.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The research methodology provides a framework of the research. It further goes ahead to define the model specification and provide an interpretation of the variables. Through the methodology the researcher explains the data collection methods and analytical tools employed.

3.1 Theoretical framework

The researcher employed a Cobb-Douglas production function.

The Cobb Douglas production was first developed by Charles Cobb and Paul Douglas in the 20th Century. They specified the production function as;

$\mathbf{Y = A\,K^{\alpha}\,N^{1-\alpha}}$ Where $0 < \alpha < 1$………………………… **(1)**

Where Y denotes output, K capital input, N labor input, and A denotes the Total Factor Productivity (TFP).

To get the marginal product of labor (MPN), we obtain the derivative of equation (1) with respect to N; holding capital input (K) and Total Factor Productivity (TFP) (A) constant,

$$\mathbf{MPN = \delta Y/\delta N = (1-\alpha)\, A\, K^{\alpha}\, N^{1-\alpha-1}}$$

$$\mathbf{= (1-\alpha)\,(N^{-1})\,(AK^{\alpha}\,N^{1-\alpha})}$$

$$\mathbf{= (1-\alpha)\,Y/N > 0 \text{ …………………………….. } (2)}$$

To check whether the Cobb Douglas production function satisfies the law of diminishing returns, we take the derivative of MPN with respect to N, equally we obtain the second derivative of Y with respect to N.

$$\mathbf{\delta MPN/\delta N = \delta^2 Y/\delta^2 N = (-\alpha)\,(1-\alpha)\,(A\,K^{\alpha}\,N^{1-\alpha-2})}$$

$$\mathbf{= -\alpha\,(1-\alpha)\,(N^{-2})\,(A\,K^{\alpha}\,N^{1-\alpha})}$$

$$\mathbf{= -\alpha\,(1-\alpha)\,Y/N^2 < 0 \text{ …………………………. } (3)}$$

The Cobb Douglas function exhibits a positive but diminishing returns since the second derivative is negative while all other multiplicative functions remain positive.

The Cobb Douglas production function shows a positive but diminishing marginal product to capital (MPK). This is evidenced by examining what happens to MPK, when capital (K) is increased while holding labour (N) and total factor productivity (TFP) Constant.

$$\mathbf{MPK = \delta Y/\delta K = \alpha A K^{\alpha-1} N^{1-\alpha}}$$

$$\mathbf{= \alpha\,(A K^{\alpha} N^{1-\alpha})\,K^{-1}}$$

$$\mathbf{= \alpha\,Y/K > 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (4)}$$

Hence the MPK is positive. Differentiating MPK with respect to K

$$\mathbf{\delta MPK/\delta K = \delta^{2} Y/\delta K^{2}}$$

$$\mathbf{= (\alpha-1)\,\alpha A K \alpha N^{1-\alpha}}$$

$$\mathbf{= (\alpha-1)\,\alpha\,Y/K^{2} < 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (5)}$$

Hence MPK's second derivative is negative showing diminishing returns to capital (K). Examining what happens to MPN when capital input is increased and also what happens to MPK when labour is increased. This implies we find the cross-partial derivatives.

$$\mathbf{\delta MPN/\delta K = \alpha\,(1-\alpha)\,A K^{\alpha-1} N^{1-\alpha-1}}$$

$$\mathbf{= \alpha\,(1-\alpha)\,(A K^{\alpha} N^{1-\alpha})\,K^{-1} N^{-1}}$$

$$\mathbf{= \alpha\,(1-\alpha)\,Y/KN > 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (6)}$$

This implies increases in capital increases the marginal product of labour.

Looking at,

$$\mathbf{\delta MPK/\delta N = (1-\alpha)\,\alpha\,A K^{\alpha-1} N^{1-\alpha-1}}$$

$$\mathbf{= (1-\alpha)\,\alpha\,Y/KN > 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (7)}$$

This implies that an increase in labour (N) also increases the Marginal Product of capital. The two cross partials are identical. An increase in Total Factor productivity (A) increases the Marginal products of both capital and labour as depicted by Equations (2) and (3).

To find out whether the Cobb Douglass production function has Constant returns to Scale; we look at a scenario whereby labour and capital are increased proportionately assuming capital is at (K_0) and labour at (L_0). Therefore, a production function;

$$\mathbf{Y = AK_0^{\alpha} \; N_0^{1-\alpha}}$$

Increasing the input values of K and N by a constant factor *Z,* Whereby *Z*= 2. This implies that the inputs are doubled. We generate new inputs K_1 and N_1 and a new output Y_1.

Whereby $K_1 = Z K_0$ and $N_1 = ZN_0$.

Checking on how Y_0 relates with Y_1

$$\begin{aligned}
\mathbf{Y_1} &= \mathbf{AK_1^{\alpha} N_1^{1-\alpha}} \\
&= \mathbf{A\,(ZK_0)^{\alpha}\,(ZN_0)^{1-\alpha}} \\
&= \mathbf{A\,Z^{\alpha}\,K_0^{\alpha}\,Z^{1-\alpha} N_0^{1-\alpha}} \\
&= \mathbf{Z^{\alpha+1-\alpha}\,(AK_0^{\alpha} N_0^{1-\alpha})} \\
&= \mathbf{Z\,(AK_0^{\alpha}\,N_0^{1-\alpha})} \\
&= \mathbf{Z\,Y_0} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(8)}
\end{aligned}$$

This implies that if we increase the inputs by a constant value (*Z*) the effect will increase the output by the same value (*Z*). Therefore, the Cobb Douglas production function exhibits constant returns to scale.

According to Charles Cobb and Paul Douglas, a production function is said to have constant returns to scale (degree one) if $(\alpha + \beta) = 1$. If $\alpha + \beta < 1$ the function has decreasing returns to scale, and if $\alpha + \beta > 1$ it has increasing returns to scale.

A Cobb Douglas production function can be changed into a Trans log function by taking the logarithms of the variables in both sides of the equation. This is to eliminate biasness. The transcendental logarithmic function (trans-log) becomes more flexible than the original function. The Trans log function is preferred since it can estimate production relationships that are not clear to define. The transformed function can then be estimated through ordinary least square (OLS) which is expressed as;

$$\mathbf{Ln\ Y = ln\ A + \alpha\ lnK + \beta\ lnN \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)}$$

The researcher used a Cobb-Douglas production function as a tool for analysis since its simple to estimate; it is easy to specify the parameters and interpret them. Equally, there exist many applications where it has been used in analysis to yield reliable findings.

3.2 Model Specifications

The model specification is as follows:

$$\mathbf{Ln\ Y = \beta_0 + \beta_1 lnS_1 + \beta_2 lnS_2 + \beta_3 lnS_3 + \beta_4 lnS_4 + \beta 5_2 lnS_5 + \beta_6 lnS_6 + \beta_7 lnS_7 + \beta_8\ ln\ S_8 + \varepsilon \ldots\ldots(10)}$$

Where; S

Denotes the input value element

Y = Sugar production output

S_1 = Capital input

S_2 = Labor input

S_3 = Research & Development

S_4 = Technology

S_5 = Firm Age

S_6 = Firm Size

S_7 = Governance

S_8 = Cost-income ratio

While, $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \ldots\ldots\ldots\ldots \beta_8$. Are beta coefficients and ε = is the error term.

Table 3.1: Description and measurement of variables

Variables	Types	Description and Measurement	Expected sign
Sugar production output	Dependent variable	Sugar produced annually (MT)	
Capital input	Independent variable	Total costs of capital incurred annually (Kshs)	Positive
Labor input	Independent variable	Total cost of labor incurred annually (Kshs)	Positive
Research and development	Independent variable	Total costs incurred towards research and development annually (Kshs)	Positive
Technology	Independent variable	Total Cost of machinery and equipment used in production annually (Kshs)	Positive
Firm Age	Control Variable	Measured by the duration a firm has been in existence since formation to the time of the study.	Positive change
Firm Size	Control Variable	Measured by the number of employees held by the firm annually.	Positive change
Governance	Control Variable	Measured by the board size held by the firm annually.	Positive
Cost Income ratio	Control Variable	Costs incurred by a firm annually divided by the income gained annually (Kshs)	Negative

Source: Author (2022)

3.3 Diagnostic Testing

The following diagnostic tests were carried out before running the regression.

3.3.1 Multicollinearity testing

Multicollinearity is defined as an undesirable situation whereby the correlation between the independent variables is strong (Martz, 2013). Varian Inflation Factor (VIF) was used to test for multicollinearity. Two independent variables are said to be associated; when all VIFs are equal to 1. In the case where the VIF for one variable is near or greater than 5, the correlation between the variables is strong; a case of multicollinearity. According to (Cohen, Cohen, West & Aiken, 2003), in the case where multicollinearity is detected between variables, one of the independent variables should be removed from the regression model.

3.3.2 Test for Normality

According Paul and Zhang (2009) conducting a normality test helps to determine the shape of the distribution and predict scores of the dependent variables. A normality test was important to check and eliminate data that is not supposed to be included in the analysis. Skewness and Kurtosis coefficients were employed. Skewness is a measure of the extent of symmetry or asymmetry of data, while Kurtosis measures the extent which data is heavy or light tailed in a normal distribution. According to George and Mallery (2010), values of between -2 and +2 are considered acceptable to prove normal univariate distribution. According to Bryne (2010) data is considered to be normal if skewness ranges between -2 and +2 and Kurtosis ranges between -7 and +7.

3.3.3 Test for Heteroscedasticity

Heteroscedasticity defines as a situation where the variance of the dependent variable keeps changing across the data. Analysis using Ordinary Least squares (OLS) assume a constant variance ($V(\varepsilon_j) = \sigma^2$) for all j, a situation known as homoscedasticity. According to Park, (2008), regression analysis methods are based on the assumption of constant variance. Therefore, heteroscedasticity complicates analysis. The researcher used a Modified Wald test to check for the existence of heteroscedasticity. This is done by checking on the existence of consistent standard errors (Halbert White 1980). If the probability value is greater than 0.05, the null hypothesis is constant variance of the error term is accepted.

3.3.4 Auto correlation Test

Auto correlation refers to a situation where time series data relates with its own past and future values (Box & Jenkins 1976). Auto correlation ranges between -1 and +1, a value of between -1 and 0 means no auto correlation, and a value between 0 and +1 means the presence of auto correlation. The auto correlation function is used to check and eliminate any random variables. Auto correlation is a correlation coefficient where correlation should only exist between two different variables, but not two values of the same variable at different times X_i and X_{i+k}. To test for the first order auto correlation, the Wooldridge test for autocorrelation in panel data was used.

3.4 Data Type and Source

The researcher obtained secondary Panel data for five sugar factories including; Chemelil, Muhoroni, Trans Mara, Kibos Sugar and Allied together with West Kenya sugar factory. The five sugar factories selected contribute more than 70% of the total sugar produced, therefore a study of the selected factories provide good guidance for the sugar industry. The researcher obtained data from the Kenya Sugar Board's annual reports. Data collected was for the period 2008 to 2020.

3.5 Data Analysis and Presentation

Panel data was analyzed using descriptive and inferential statistics. Panel data was settled on since it improves the efficiency of econometric estimates by having greater degrees of freedom. Equally, samples have more variability than time series data (Hsiao, 2002). The researcher used descriptive statistics and further use a Cobb Douglas production function to analyse the factors affecting factory level sugar production in Kenya. STATA software was used for analysis. Findings from the analysis were presented using tables.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.0 Introduction

This chapter presents research findings and discussion. The study sought to determine the factory level determinants of sugar production in Kenya. Results include descriptive statistics, diagnostic tests, correlation analysis and regression analysis.

4.1 Descriptive Statistics

This section presents summary statistics of research constructs: Sugar production, capital input, labor input, R&E, technology, firm age, firm size, governance and cost income ratio as shown.

Table 4.1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Sugar production	70	107,894	42,250	37,611	195,000
Capital input	70	421,000,000	64,900,000	310,000,000	526,000,000
Labor input	70	296,000,000	29,700,000	250,000,000	350,000,000
R&E	70	42,300,000	6,694,032	30,000,000	52,400,000
Technology	70	56,300,000	14,000,000	30,900,000	78,400,000
Firm age	70	35	19	11	56
Firm size	70	1,376	1,132	292	4,686
Governance	70	11	2	9	13
Cost income ratio	70	11	8	3	36

Table 4.1 shows that the mean of sugar production was 107,894 MT. This implied that the annual average sugar production by selected sugar processing firms in Kenya was 107,894 MT over the study period 2008 to 2021. Results revealed that selected sugar processing firms spend around Kshs.421, 000,000 on capital, and Kshs. 296,000,000 on labor annually.

In terms of R&E and technology; selected sugar processing firms spend around Kshs. 42,300,000 and Kshs. 56,300,000 respectively annually. The average age of the selected sugar processing firms is 35 years, with the youngest being 11 years and oldest being 56 years. On firm size, the average number of employees is 1376. Results also showed that the average number of board members was 11. In addition, the cost income ratio was 11 indicating that the cost to income ratio was higher in the sugar industry.

4.2 Diagnostic tests

This section presents diagnostic test results including multicollinearity, heteroscedasticity, and autocorrelation tests.

4.2.1 Multicollinearity test

VIF was used to examine multicollinearity. When the VIF value is 1, there is no correlation between the independent and dependent variables, a value ranging from 1 to 5 indicates a moderate link, while anything more than 5 indicates a substantial correlation.

Table 4.2: Multicollinearity test

Variable	**VIF**	**1/VIF**
capital input	7.92	0.126298
labor input	7.44	0.134444
Firm Age	4.64	0.215373
Governance	4.19	0.238751
Firm size	3.19	0.313891
Technology	1.11	0.899037
Cost income ratio	1.11	0.904048
R&E	1.07	0.935077
Mean VIF	3.83	

Table 4.2 indicates an overall VIF of 3.83 which is less than 5. This implies that the variables were not highly correlated. Values exceeding 0.1 in the tolerance range also support the outcome. The results therefore, reveal that there was no multicollinearity between the variables.

4.2.2 Normality Test

According to Paul and Zhang (2009), conducting a normality test helps to determine the shape of the distribution and predict the scores of the dependent variables. Skewness and Kurtosis coefficients were employed. Results are shown in Table 4.3.

Table 4.3: Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj	chi2(2)	Prob>chi2
my residuals	70	0.3728	0.4699		1.36	0.5067

Table 4.3 shows a probability value of 0.5067 > 0.05, leading to acceptance of the null hypothesis of normal distribution. This means that the study data was normally distributed.

4.2.3 Heteroscedasticity Test

Heteroscedasticity is a situation where the variance of the dependent variable keeps changing across the data. According to Park (2008), regression analysis methods are based on the assumption of constant variance. Heteroscedasticity therefore complicates analysis.

Table 4.4: Modified Wald test for Groupwise heteroskedasticity

Modified Wald test for groupwise heteroscedasticity H0: sigma(i)^2 = sigma^2 for all i	
chi2 (5)	1.58
Prob>chi2	0.9034

Table 4.4 indicates a probability value of 0.9034>0.05. This leads to acceptance of the null hypothesis that assumes a constant variance. As such, the research data did not have heteroscedasticity problem.

4.2.4 Auto correlation Test

Auto correlation refers to a situation where time series data relates with its own past and future values (Box & Jenkins 1976). Wooldridge test for autocorrelation in panel data was used and results are shown in Table 4.5.

Table 4.5: Wooldridge test for autocorrelation in panel data

Wooldridge test for autocorrelation in panel data H0: no first order autocorrelation	
F(1, 4) =	5.842
Prob > F =	0.0730

Table 4.5 indicates a probability value of 0.073>0.05, hence the null hypothesis that the data does not suffer from autocorrelation was accepted denoting that there was no autocorrelation in the research data.

4.3 Correlation Analysis

This section presents correlation analysis results on the relationship between the study variables. Table 4.6 shows the correlation matrix.

Table 4.6: Correlation Matrix

	Sugar production	Capital input	Labor input	R&E	Technology	Firm Age	Firm size	Governance	Cost income ratio
Sugar production	1								
Capital input	0.320*	1							
Labor input	0.449*	0.896*	1						
R&E	0.042	-0.179	-0.156	1					
Technology	0.089	-0.015	0.039	0.039	1				
Firm Age	-0.249*	-0.709*	-0.660*	0.076	-0.1187	1			
Firm size	0.652*	0.096	0.331*	0.0312	0.1675	-0.062	1		
Governance	0.440*	0.259*	0.419*	0.0852	0.1468	-0.553	0.656*	1	
Cost income ratio	-0.219	-0.061	-0.060	0.0903	-0.2086	0.171	-0.068	-0.0767	1

*Significant at the 5 percent level.

Table 4.6 shows a positive and significant relationship between capital input [0.320*], labor input [0.449*], firm size [0.652*], governance [0.440*], and sugar production among selected sugar processing firms in Kenya. This means that improvement in capital input, labor input, firm size, and governance is significantly associated with improvement in sugar production.

Results reveal a positive but insignificant relationship between R&E [0.042], technology [0.089], and sugar production among selected sugar processing firms in Kenya. This means that increase in R&E and technology is not significantly associated with an increase in sugar production.

Results indicate a negative and significant relationship between firm age [-0.249*] and sugar production. This means that increase in firm age is significantly associated with a decrease in sugar production. Finally, results show a negative but insignificant relationship between the cost-income ratio [-0.219] and sugar production. This means that increase in the cost-income ratio is not significantly associated with a decrease in sugar production.

4.4 Regression Analysis

Regression analysis was conducted to determine the effect of factory level determinants on sugar production in Kenya. Results are depicted in Table 4.7.

Table 4.7: Determinants of Sugar Production

Sugar production	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Capital input	0.276	0.659	0.420	0.676	-1.041	1.593
Labor input	0.402	0.994	0.400	0.687	-1.585	2.389
R&E	0.263	0.230	1.140	0.257	-0.197	0.722
Technology	-0.099	0.142	-0.700	0.489	-0.383	0.185
Firm Age	-0.002	0.002	-0.960	0.343	-0.005	0.002
Firm size	0.00012	0.000	4.800	0.000	0.000	0.000
Governance	-0.027	0.022	-1.270	0.209	-0.070	0.016
Cost income ratio	-0.100	0.055	-1.810	0.075	-0.210	0.010
_cons	-1.728	5.704	-0.300	0.763	-13.133	9.677
R-squared	0.540					
F-statistic	8.96					
Prob	0.000					

Results indicate that capital input increased sugar production by 0.276. However, the effect of capital input on sugar production was not significant (p>0.05). Labor input increased sugar production by 0.402. However, the effect of labor input on sugar production insignificant (p>0.05). The findings concur with Odhiambo (1978) who established that performance of sugar factories was unsatisfactory because of lack of efficiency in resource utilization such as capital and labor.

R&E increased sugar production by 0.263. However, the effect of R&E on sugar production insignificant (p>0.05). The findings corroborate with Teodoro et al. (2014) who argued that research & development was still inadequate in the sugar industry.

Technology decreased sugar production by 0.099. However, the effect of technology on sugar production was not significant (p>0.05). The study findings agree with Irungu, Wambugu and Githuku (2008) observation that sugar production firms experienced negative growth in technological efficiency leading to poor production levels

Firm age decreased sugar production by 0.002. However, the effect of firm age on sugar production was not significant (p>0.05).

Firm size increased sugar production by 0.00012. The effect of firm size on sugar production was significant ($p<0.05$). The study findings support Wanjere and Egessa (2015) who concluded on a positive relationship existing between employee training and the firm's performance.

Governance decreased sugar production by 0.027. The effect of governance on sugar production was not significant ($p>0.05$). The study findings support Raheman, Qayyum and Afza (2009) conclusion that sugar factories experience a lot of management inefficiencies.

Cost-income ratio decreased sugar production by 0.100. The effect of the cost-income ratio on sugar production was not significant ($p>0.05$).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.0 Introduction

This chapter presents a summary of the findings, conclusion, and policy recommendations.

5.1 Summary of Findings

The study intended to determine factory-level determinants of sugar production in Kenya, using panel secondary data from 2008 to 2021. Findings indicated that capital input, labor input, and R&E had a positive though insignificant effect on sugar production. Results showed that the size of the firm had a positive and significant effect on sugar production. Results revealed that technology, firm age, governance, and cost-income ratio had a negative insignificant effect on sugar production.

5.2 Conclusions

Based on the findings, the study concluded that capital input, labor input, and R&E positively affect sugar production levels for the selected sugar processing firms in Kenya. The implication is that increasing capital input, labor input, and R&E increases the likelihood of an increase in sugar production. The study also concluded that firm size positively and significantly affects sugar production. The implication is that increasing firm size increases the likelihood of increases in sugar production. Finally, the study concluded that technology, firm age, governance, and cost-income ratio negatively affect sugar production. The implication is that technology, firm age, governance, and cost-income ratio reduce sugar production.

5.3 Policy Recommendations

The study established that capital input, labor input, and R&E had a positive insignificant effect on sugar production. The study recommended that sugar processing firms should review their capital input, labor input, and R&E policies to enhance increases in in production. The study recommends on government to provide subsidies for various inputs needed in the production process. Equally, a consideration of reduction of taxes levied for both the inputs used in the production process and on the final product as a measure to reduce on the cost of sugar production in Kenya.

The study established that firm size had a positive significant effect on sugar production, and recommended that sugar processing firms should strengthen the capacity of their employees through training to enhance efficiency in production. The firms should also hire enough employees, which is likely to enhance sugar production.

It also established that technology, firm age, governance, and cost-income ratio have negative insignificant effect on sugar production and recommended that sugar processing firms should adopt appropriate modern technology in the production process. The governance structure of the firms should also be reviewed to ensure competence. The management of the firms should further review the cost-income ratio, and find ways of reducing the overall costs while at the same time generate more income.

5.4 Further study areas

The current study focused on factory-level determinants of sugar production. Future studies could focus on macro-level determinants of sugar production such as inflation, foreign exchange rate, and competition.

Further research can also be conducted on the role of cartels and the effect of dumping of cheap sugar on the efficiency of Kenya's sugar industry.

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Appendix I: Raw Data

	Period	Sugar production (MT)	Capital input (Kshs)	Labor input (Kshs)	R&E (Kshs)	Technology (Kshs)	Firm Age (Years)	Firm size (No. of employees)	Governance (No. of board members)	Cost income ratio (Cost/income)
Firm 1	2008	51767	515,173,387	280,895,716	50,917,289	41,129,095	54	962	11	36.37
	2009	54821	347,867,788	284,543,348	47,839,263	49,572,692	54	631	11	20.06131
	2010	52365.2	481,554,805	349,853,271	44,282,204	38,569,379	54	515	11	19.01333
	2011	49021	381,376,474	262,634,520	44,379,397	60,816,166	54	671	11	6.010895
	2012	49393.7	525,029,949	304,760,105	50,475,362	53,644,217	54	872	11	27.50949
	2013	60017.9	422,937,539	282,666,122	42,197,365	58,001,524	54	588	11	9.393627
	2014	59266.8	356,602,689	296,558,018	38,465,228	51,004,207	54	822	11	15.61601
	2015	63567.4	441,938,449	329,961,630	42,760,988	54,250,050	54	536	11	5.341523
	2016	63974.1	418,532,705	315,316,034	40,781,149	30,903,744	54	897	11	4.678823
	2017	37611.1	413,805,111	329,496,002	42,222,548	76,846,500	54	637	11	4.306843
	2018	49109.7	429,560,296	271,915,718	42,791,645	64,103,824	54	581	11	7.361643
	2019	44093.5	517,894,999	302,752,373	46,649,238	63,213,636	54	914	11	5.925721
	2020	54546.75	397,892,511	258,027,406	32,115,730	76,830,989	54	723	11	5.706186
	2021	65000	359,593,760	309,488,669	35,428,398	37,603,443	54	992	11	9.431161
Firm 2	2008	109641	440,134,462	320,610,113	32,459,726	63,008,167	56	634	9	16.62103
	2009	104730	418,081,567	345,815,245	46,945,509	75,641,894	56	407	9	3.853857
	2010	98042	495,219,853	267,465,060	33,749,619	39,330,58	56	830	9	30.52137

	2011	98787.4	371,639,414	252,909,769	32,857,889	35,275,899	56	895	9	3.336278
	2012	120035.8	327,770,820	260,315,359	40,776,146	33,665,737	56	443	9	3.250647
	2013	118533.6	525,501,580	259,508,616	45,695,582	52,396,660	56	983	9	19.78572
	2014	127134.8	497,970,413	266,791,456	47,191,299	64,416,225	56	984	9	6.747993
	2015	127948.2	472,416,000	297,778,023	45,700,091	58,149,037	56	546	9	30.65458
	2016	75222.2	323,848,153	256,402,533	42,435,144	77,125,732	56	605	9	10.33499
	2017	98219.4	310,938,447	262,117,277	35,925,495	71,673,329	56	635	9	3.772799
	2018	88187	524,825,773	305,880,517	47,673,357	44,394,228	56	423	9	14.3546
	2019	109093.5	383,144,842	316,326,540	35,983,892	62,170,395	56	996	9	4.555292
	2020	109093.5	441,961,937	320,163,727	47,668,821	49,006,204	56	440	9	6.323345
	2021	130000	389,282,662	320,821,601	45,157,272	36,781,539	56	787	9	8.572231
Firm 3	2008	130913	365,727,278	296,694,709	39,012,755	58,896,883	11	1847	13	9.639226
	2009	122553	472,319,072	264,520,199	52,392,847	47,105,888	11	1615	13	5.64961
	2010	123484.3	497,536,533	319,334,332	45,253,341	74,690,928	11	1845	13	16.9759
	2011	150044.8	395,676,777	293,376,210	30,040,481	55,015,973	11	1779	13	8.587268
	2012	148167	415,755,690	275,955,385	45,107,448	67,176,890	11	1582	13	3.574298
	2013	158918.5	479,257,359	288,060,396	51,915,332	73,899,309	11	1720	13	4.166046
	2014	159935.3	422,282,036	331,191,115	44,255,520	33,139,953	11	1790	13	5.435565
	2015	94027.75	344,790,027	313,069,012	37,248,018	69,225,808	11	1295	13	31.84952
	2016	122774.3	383,638,143	316,480,414	51,945,017	78,365,401	11	1892	13	7.064099

	2017	110233.8	441,654,116	258,060,454	32,050,283	57,000,313	11	1480	13	5.718437
	2018	136366.9	317,397,180	281,539,729	48,925,130	49,273,239	11	1308	13	6.16826
	2019	110233.8	506,547,679	250,949,442	45,192,072	60,858,101	11	1416	13	4.809572
	2020	136366.9	310,153,926	298,372,231	33,837,778	68,976,000	11	1586	13	3.053527
	2021	162500	356,983,468	284,409,283	34,420,293	64,414,085	11	1526	13	3.631235
Firm 4	2008	73532	516,984,268	325,574,972	34,393,651	60,277,765	15	337	11	5.140649
	2009	74091	335,862,787	250,493,843	49,705,952	74,437,434	15	775	11	10.65256
	2010	90026.85	438,089,173	273,664,651	40,804,003	35,494,800	15	959	11	5.240321
	2011	88900.2	433,864,549	321,052,480	35,745,500	71,290,958	15	935	11	4.191854
	2012	95351.1	342,236,949	314,544,396	39,492,279	32,655,910	15	445	11	3.633435
	2013	95961.15	526,299,249	330,133,530	52,045,896	71,744,453	15	487	11	5.091409
	2014	56416.65	347,853,975	285,714,617	49,230,350	67,582,912	15	956	11	17.89725
	2015	73664.55	471,717,397	256,303,958	41,798,209	49,185,371	15	346	11	4.246558
	2016	66140.25	376,314,442	340,946,528	49,012,616	34,402,111	15	292	11	17.36637
	2017	81820.13	355,659,095	256,069,053	31,975,977	66,186,150	15	331	11	3.917553
	2018	97500	404,418,168	300,507,982	49,823,509	59,556,797	15	735	11	13.97428
	2019	66140.25	318,432,100	253,502,069	32,305,070	32,694,811	15	359	11	21.49685
	2020	81820.13	447,371,757	278,509,268	31,717,206	63,537,981	15	895	11	20.48924
	2021	97500	520,743,053	259,943,351	32,750,068	48,748,616	15	996	11	4.709803
Firm 5	2008	148181	417,968,734	307,719,525	38,050,490	57,928,000	41	2378	13	19.90234

	2009	180054	394,150,368	279,690,616	51,537,362	39,940,118	41	2294	13	14.41859
	2010	177800.4	408,826,721	273,288,240	50,215,167	67,936,685	41	4584	13	4.279727
	2011	190702.2	343,093,387	304,108,139	35,431,510	70,244,442	41	4686	13	6.015146
	2012	191922.3	441,035,558	333,373,254	50,028,210	53,887,479	41	4038	13	6.419042
	2013	112833.3	483,478,397	341,181,761	47,341,932	34,296,492	41	2262	13	13.89564
	2014	147329.1	512,341,897	314,227,634	30,205,995	53,335,529	41	4327	13	9.391739
	2015	132280.5	428,101,993	296,184,245	45,024,141	44,557,525	41	2001	13	25.29868
	2016	163640.3	366,651,921	347,188,848	37,843,324	60,767,001	41	4487	13	5.228734
	2017	195000	444,978,115	340,365,653	49,067,801	71,388,076	41	2726	13	4.505385
	2018	147329.1	460,445,877	343,103,772	42,757,369	76,215,714	41	3552	13	12.52753
	2019	132280.5	525,247,120	350,030,032	38,208,486	37,720,096	41	2342	13	22.48874
	2020	163640.3	392,902,494	281,734,046	48,619,676	60,475,453	41	4134	13	5.182463
	2021	195000	340,168,369	267,772,926	50,245,990	67,012,605	41	1040	13	3.603461

Firm 1: Chemelil Sugar Factory.

Firm 2: Muhoroni Sugar Factory

Firm 3: Trans Mara Sugar Factory

Firm 4: Kibos Sugar and Allied Industries

Firm 5: West Kenya Sugar Factory