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Factors affecting maize production among registered small scale farmers in Trans-Nzoia County, Kenya

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DECLARATION

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Crispus Wangombe Njogu

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Approval

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ABSTRACT

The agricultural dynamics are changing. Today, food security is a top priority among under-developed and developing countries, especially and particularly in Africa and Sub-Sahara region. The fight against hunger is a topic that has been in line of discussion since time immemorial. Early scholars like Malthus and Smith tried to explain the relationship among food security, food production and the involved production factors, in their 'Malthusian Theory' and 'Theory of Production,' but still no substantive solution is feasible to date. Studies by various scholars and entities including FAO shows that among the various agricultural products entrusted with the fight against hunger, maize production has the largest share segment and contributes to 30% of world's food calories. In Kenya, maize production accounts to 65% of 18% formal employment, and it is the stable food year round. Despite of such utility precedence, maize production among these maize-dependent countries, Kenya included, remains to be low and the respective economies dependent on maize importation. This clearly undermines their inherent food security strategies, calling for holistic evaluations on the maize production situation. Among the key areas upon which the evaluation is highly and likely to be based on is the maize production factors. In Kenya, these factors are critical to maize production and require attention. This study therefore sought to undertake on this evaluation, narrowing the focus down to registered small-scale maize farmer in Trans-Nzoia County. Guided by the general objective of establishing the production and institutional factor that affect maize production, a survey was carried out in the five sub-counties of Trans-Nzoia County. The study equally intended to establish the effect that the factors have on the number of maize bags produced. Using stratified sample size of 196 respondents, the study used self-administered questionnaire to collect data. Data was collected from 195 respondents and analysed using descriptive and inferential statistics and findings presented accordingly. From analysis, it was established that land size, use of machinery in ploughing and use of chemicals had a positive influence on maize production. Land size was the most significant of factors. Extension services was also found to influence maize production but with a negative coefficient. Seed application and fertilizer application were found to have no influence on maize production. The study successfully obtained its objective. However, limitation on the pool of factors was identified as other insightful factors were missing. The ecological and climatic conditions were also found to limit the relevancy of the study to other regions due to disparity on maize production potential. The study therefore suggest for a further study that will seek to harmonise these limitations.

Key words: Maize Production, Registered Small Scale, Farmer, Optimum

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ABREVIATIONS AND ACRONYMS

U&D	-	Under-Developed and Developing Countries
FAO	-	Food and Agricultural Organization of the United Nations
ADSA	-	Agricultural Department of South Africa
OECD	-	Organization for Economic Co-operation and Development
IMWC	-	International Maize and Wheat Improvement Centre
SSA	-	Sub-Sahara Africa
HHSC	-	Hystra Hybrid Strategies
NCPB	-	National Cereals and Produce Board
CGIAR	-	Consultative Group for International Agricultural Research
MT	-	Malthusian Theory
KEPHIS	-	Kenya Plant Health Inspectorate Service

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Special thanks to all maize farmers in Trans-Nzoia County.

Sincere thanks to all my friends.

DEDICATION

I dedicate to my parents who have supported me through the entire journey of pursuing this level of education.

To my wife for providing all-round support.

God Bless You All

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The drive towards food security in the 21^{st} century has seen the global rise of commissions of inquiry in various agricultural sub-sectors. In under-developed and developing (U&D) countries, this tendency is highly experienced to the extent that food security forms part of most governments' top agenda (FAO, 2014). Although from a global perspective indicating that food security is meant to outline the sustainability position of all consumables and in respect to health productions (Blanca, 2017), in developing countries it is highly stretched towards sufficiency and distribution. These U&D countries face numerous challenges spanning along the whole food value chain; from production to marketing and consuming dynamics. On top of the U&D countries food chart, we have the maize crop which according to the Agricultural Department of South Africa (ADSA) (2003) serves as cash crop and staple diet and consumed directly by many as first meal option. ADSA further argue that to these consumers, challenges to maize production pronounce adverse effects not only on their nutritional and social wellbeing but also on their economic soundness as well. In furtherance towards food security, it is therefore prudent to ascertain the possible factors that affect maize production.

The World Food Programme (2007) indicates that the first step to analysing maize production as a food security determinant is to understand the inherent relationship with the involved factors. To provide this understanding, Jhingan (2007) advocates for a production function approach in which the involved factors are combined and compared to the final result. This result is modelled as output or production as depicted in this study. In an integrated farming system the output includes the total physical product (Gaspard, 2017), whereby foliage is fed to the livestock as food. In maize farming, the system allows complete utilization of the entire maize plant; the foliage which includes the maize trunk is used as animal feed and or as green manure as the maize grains are taken as the primary product direct for human consumption. This study however focuses only on maize grain production.

Maize is the most important crop (Abate, Mugo, De Groote & Regassa, 2015) and the main staple food crop (Ojala, Nyangweso, Mudaki, Evusa, Kiano, Kisinyo & Chachar, 2014) in Kenya. A study carried out by FAO between 2011 and 2013 shows that out of the 5.3 million hectares of crops in Kenya, a 2.1 million coverage area that represented 40 percent was occupied by maize. In spite of this dominance, trends indicate a declining production capacity. For example, Abate et al. (2015) asserts that Kenya's average yield reduces by a significant 1 kilogram per hectare per year (kg/ha/yr). The rate is extremely high compared to South Africa's growth of 146 kg/ha/yr, Ethiopia's 120 kg/ha/yr and the continent's average of positive 31 kg/ha/yr. Accordingly, resulting adverse effects have further categorized Kenya among maize importers whose net imports keep increasing from time to time since 1960s, to notable figure of 1.5 million tons in 2009. The poor performance perennial trend is also justified by the formation of a commission of inquiry into the maize shortage and misappropriation back in 1965 by the then first president of the Republic of Kenya.

Maize production involves the process of regenerating maize grains (OECD-FAO, 2014) through the interaction of various factors and natural plant reproduction science (Gaspard, 2017). Maize grain is cereal produce crop that is grown in warm weather with temperatures of not less than 19 degrees Celsius (^{0}C) and that average at not less than 23^{0}C. The higher side is supposed to be 32 ^{0}C. According to ADSA (2003), the maize plant requires frost-free temperatures for a period of 120 days to 140 days so as to prevent damage. In terms of water consumption, per hectare yield of 3152kg requires 350 to 450 mm per annum. These conditions are based on averages as variation from place to place and from times is a major incontrollable. In addition to climatic and weather conditions, the International Maize and Wheat Improvement Centre (IMWC) (2008) enlists the interaction of human, technological, legal and political factors as major determinant of the maize production levels.

Together with wheat and rice, maize production contributes to 30% of the world's food calories. Ignaciuk and Mason-D'Croz (2014) argues that the 30% calories is based on over 94 developing countries and a population of over 4.5 billion people. Maize alone contributes to 20% of calories. Early studies by Shiferaw, Hellen and Muricho (2011) and Prasanna (2014) indicate that maize production is highly concentrated in Sub-Sahara Africa (SSA) and Central America. In these regions, maize production is not only based on a food security approach but also a large source of employment in rural areas. In Kenya, maize production activity(s) accounts for 65% of 18% formal employment in the agri-business and almost 30% of informal employment (Olwande, 2012). Together with other agricultural practices, maize production is a major income earner to many rural households.

Maize production in normally evaluated using productivity index (FAO, 2014) and behaviour trend mapping that is normally used in Mexico (Blanca, 2017). The outcome can be either low production or high production. On national level, high production means that the country's produce is high enough to sustain household consumption and local trade. However, on international level, high production further provides for surplus produce that can be exported to earn foreign exchange. This variation on production levels is responsible for creating the low and high production and is influenced by a number of factors. Gaspard (2017) categorizes this factors into socio-economic (experience, education and demographics), production (land, labour and technology) and institutional factors (government support and funds). In addition to these factors we also have influence from health (Kilonzi, 2011), other economic activities and culture (Chumo, 2013) and extension services (Simiyu, 2014). Specific combination of the factors vary from place to place based on awareness, readiness and production measure already put in place.

From a global perspective, maize production is categorized in three units: Yellow maize and white maize production; small scale and large scale maize production; registered and unregistered maize farming. According to Chumo (2013), yellow maize is genetically and biologically similar to white maize and the only difference is the yellow pigment in the yellow maize. The pigment is caused by carotin oil which is not present in the white maize. All other factors like cultivation technology and production conditions are constant in this two maize categories, as argued by Martinez (2000) and Meyer (2006). In terms of scale or cultivation squares, maize production is based on either large or small scale. The distinction between the two varies from one region and country to another due to land availability factor. Another important category is the registration factor. Every country with significant dependence on maize registers farmers, especially those whose cultivating intentions go beyond personal consumption.

The motive behind the registration is to facilitate cereal boards feeding and strategizing towards food security. This study utilizes the scale and registration categories.

1.1.1 Registered Small Scale Maize Farmers in Trans-Nzoia County

Maize farming scales in Trans-Nzoia County are unevenly distributed across sub-counties, with some regions having more intense maize farming than other regions. Equally, as Hystra Hybrid Strategies Consulting (HHSC) (2015) points out, as there exists regions in Kenya that do not cultivate maize at all, some areas of Trans-Nzoia County either produce low units or do not produce at all. However, the low and non-producing areas are small and insignificantly distributed. A report by Nyoro, Kirimi and Jayne (2015) indicates that the determinant of whether the maize farmers take a small-scale or large-scale aligns to the region in which they are undertaking their cultivation. Their argument was that most of the regions that seem to practice large scale farming are equally characterized by low and sparsely distributed population that translate to large and continuous tracks of land. OECD-FAO (2014) refers to these farming distribution as agro-ecological zones. Using availability of land and the population factors, the agro-ecological zoning determine the scale of maize production to be termed as small-scale or large scale.

In Trans-Nzoia County and Kenya in general, small scale maize farming is based on a group of 0-10 acres of land while large and medium scale involves the use of more than 10 acres of land. This scale definition is provided by the Tegemeo Institute of Agricultural Policy and Development, and the Regional Agricultural and Expansion Support (2003). However, this study will take a further step to include single farming done by an individual or group of individuals on pieces of land located in different geographical locations but whose total land-track sums to not more than 10 acres. Nyoro et al. (2015) post that a high mix of small and large scale maize farming in Kenya is mostly experienced in high-potential maize zone which includes Uasin Gishu, Bomet, Kericho, Trans-Nzoia, Nakuru and upper Kakamega. These regions are also termed as the National Cereals and Produce Board (NCPB) of Kenya anchor base. Farmers in these regions not only produce for barter and sale as well as household use, but equally supply to the NCPB as registered maize farmers.

Maize farmers in Trans-Nzoia County are registered by the National Cereal and Produce Board (NCPB) of Kenya. NCPB is a national state corporation that was established in 1985 by the Parliamentary Act, Cap 338 (Government of Kenya, 2012). According to the Act, the corporation is mandated to effect strategic grain reserve, commercialize the grains and implement the famine relief through facilitating the buying, storing, maintaining and distribution of relief food under the national relief programme. NCPB tracks and maintains cereals production and consumption capacity in Kenya. The corporation also distributes subsidized fertilizer to registered farmers (NCPB, 2018). Registration of maize farmers is restricted to farmer only and not traders. According to Business Daily Africa (2016) and Citizen Digital (2018), the corporation receives maize from registered farmers and corporations only. High-potential maize zone form the majority of NCPB registered farmers. This study focuses on Trans-Nzoia County as high-potential maize zone.

1.1.3 Overview of Trans-Nzoia County

Trans-Nzoia County is a devolved functional government jurisdiction forming part of the 47 Counties of the Republic of Kenya (Constitution of Kenya, 2010). Trans-Nzoia County is located in the Great Rift Valley and borders five (5) counties and an international boundary. The county borders Kakamega and Bungoma Counties to the South, Uasin Gishu and Elgeyo Marakwet Counties to the South East, West Pokot County to the East, and Uganda border to the West (Trans-Nzoia County Integrated Development Plan, 2013-2017). Trans-Nzoia County 2018-2022 Integrated Development Plan ranks the County at position 37 out of 47 in terms of size; with squire coverage of 2495.6 kilometres. The County headquarter is situated in Kitale Municipality. The Kenya Bureau of Statistics (2018) projects a current population of 1,111,686 and 1,265,797 by end of year 2022. The County's boundaries are provided and maintained by the Independent Electoral and Boundaries Commission of Kenya and protected by the Constitution of Kenya (2010) and Devolution Act (Cap. 11).

Guided by the vision "to be an outstanding agro-industrialised county with high quality of life for residents," the county considers maize production as the backbone of its economy. This is evident in the 2013-2017 integrated development plan which contains a picture of maize and maize farming portrait and a phrase reading *–Kenya's bread basket*. Apart from the maize philosophy, the county is also interested in tourism, trade, education and literacy, employment, natural and nature conservation, industrial development and health and nutrition. The climatic, land topology and ecological conditions of Trans-Nzoia County fit within the provisions provided by ADSA (2003) as sustainable conditions for a maize plant to be productive. The experienced ecological dispersion segments the county into three zones: Upper highland, upper midland and lower highland zones. Rainfall receives by the County ranges from 1000mm to 1700mm and distributed as shown in appendix IIIc.

The upper highland representing 16% of the total county land is occupied by Mt. Elgon National Park and limited to dairy and sheep farming. The upper midland represents 50% and full supports cultivation farming. The upper midland is the County's major maize zone. The lower highland on the other hand contains a fair mix of livestock and agricultural activities. It is notable that the lower highland has the poorest road network –a factor highly contributing to the area's economic activity approach. The County Integrated Strategic plan (2018-2022) indicates that out of a total food crop area of 157,068 hectares, 68.12% at 107,000 hectares is covered by Maize. The other significant food crop is beans with a coverage of 45,600 hectares. In spite of the existing natural conditions supporting maize cultivation in Trans-Nzoia County, a number of factor are equally factored in when analysis production and productivity levels. Some of the factors that are derived from the two integrated strategic development plans (2013-2017; 2018-2022) include road network, land size, input economics and access, marketing and market forces, legal frameworks and people and farming culture.

1.2 Problem Statement

Maize production is a major concern to under-developed and developing countries, especially the SSA and the Central America countries. These countries, Kenya included, highly depended on maize as a staple food and maize production as a source of employment (Muthaura, 2015; CGIAR, 2016; Gaspard, 2017). The cereal is indicated by FAO (2013) and CGIAR (2016) as the world's leading in terms of production. Most of these countries that depend on it experience climatic and weather conditions that fit within the inherent production requirements, perhaps dictating such dependence. As a result, a large spectrum of food security is aligned to maize production. Ironically, statistics show that most of these maize-dependent countries are also the leading in maize importation as blames weigh towards maize production and diverse pool of influential factors (Prasanna, 2014; HHSC, 2015; Nyoro et al., 2015).

In Kenya, the trend is rather worrying as statistics from the ever first commission of inquiry into the maize shortage was formed in 1966 providing a comprehensive and sufficient but unproductive report. Measures have been put in place, including streamlining the sector and introducing the NCPB which is mandated to track and help maintain cereals production in Kenya. The high-potential maize zone areas that include Uasin Gishu County have also expanded exponentially over the past decades but still production per hectare keeps deteriorating. As a drive towards solution finding, it is prudent that all influential factors that affect maize production be analysed.

Various scholars have undertaken substantial research on maize farming and production. Internationally, Blanca (2017) on preferences of farmers and the factors that influence their maize crop improvement decisions, sought to analyse the attitude and opinion of farmers towards the adoption of improved seeds. Findings indicated that young farmers had high regards for innovation and technology. Gaspard (2017) enlists improved seeds, land size and labour as major factors influencing efficiency and productivity of maize. Issa, Kagbu and Abdulkadir (2016) established that land preparation, manual weeding and seed dressing include the major factors that influence the adoption of improved maize production practices. Other relevant studied include FAO (2012; 2013); Idrisa, Shehu, Ngamdu (2012); Joshi, Singh, Singh, Gerpacio and Pingali (2005).

In Kenya, Muthaura (2015) on maize growth and yield variability and selected limited nutrients conclude that land conversion rate and use of manure highly influence the variability of potassium and nitrogen nutrients. Ojala et al. (2014) sought to establish how small-scale maize farmers are affected by socio-economic factors. Simiyu (2014) established that poor and inadequate land preparation and costly fertilizer are the main factor affecting small scale farmers. Kamoni et al. (2013) used former Kandara District as a case study while analysing on food security. Their findings indicated that enhancing productivity per unit area through the use of recommended fertilizers and seedling is the only way to boost the district's food security. Other studies include Kilonzi (2011), Adijah et al. (2011) and Olwande (2012).

As analysed, it is evident that substantial evaluation on maize farming and production has been carried out locally and internationally. However there exists limited research on Trans-Nzoia County, or those that link Trans-Nzoia County as part of a wider sample context. Simiyu (2014) whose study contains a conceptual link lacks on contextual base, but provides for this study the basis upon inferencing and conclusions. It is also important to note that farmers are sensitive to the context within which production is recommended as approaches and priorities vary from one region to another due to ecological and farming conditions. Trans-Nzoia County is then subject to having its own experiences that are unique from those exhibited by other counties and regions. This study sought to bridge this research gap.

1.3 Research Objectives

This study intended to fulfil the following objectives

1.3.1 General Objective

The general objective of this study was to establish the factors affecting maize production among registered small scale farmers in Trans-Nzoia County.

1.3.2 Specific Objectives

i. To establish the production factors and their effects on maize production among registered small scale maize farmers in Trans-Nzoia County.
ii. To establish the institutional factors and their effect on maize production among registered small scale maize farmers in Trans-Nzoia County.

1.4 Research Questions

i. Which production factors are involved in maize production and what effect do they have among registered small scale maize farmers in Trans-Nzoia County?
ii. Which institutional factors are involved in maize production and what effect do they have among registered small scale maize farmers in Trans-Nzoia County?

1.5 Significance of the Study

Researchers and academicians in the line of crop production will draw benefit from this study as they will find it a useful instrument in providing information that will provide great contribution to reviews on literature. The study will also further enhance their academic reporting and research approach and writing skills which in turn they can use to further the field of academic research and solution findings.

The research will be useful to the registered small scale farmers and all other farmers in Trans-Nzoia County as it will provide them with information on the specific factors affecting maize production in the county. Possible solutions to these factors will also be recommended by this study, providing an opportunity for the farmers to be aware of their options and correctly implement preventive and corrective action plans. The farmers will also be able to correctly relate their registration to the production factors they experience.

The study will also be of great importance to the ministry of agriculture, the National Cereals and Produce Board and the government in general as it will inform them effectively on the factors affecting maize production in Trans-Nzoia County. Thorough such, these bodies can then obtain insight on diagnostic requirements and regulations towards ensuring that maize production in Trans-Nzoia County is secured and approached objectively. The study will boost the food security agenda and go an extra mile towards providing substantial solution on maize importation problem.

1.6 Scope of the Study

This study contains two dimensions of scope. The first one is the conceptual scope and the second one is the contextual scope. The conceptual scope confines this study into maize production and the involved factors. This means that the study will only conduct research within the dynamics of maize production and the involved factors. Any other crops that might find their way into the study will only be so if findings express a perception that the so said crops act as a factor affecting maize production. As far as contextual scope is concerned, the study will confine itself to Trans-Nzoia County and the registered small scale maize farmers. No unregistered, medium and large scale and non-maize producing farmer will make to the population target of this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review from previous studies on factors affecting maize production. The chapter involves a review on the foundational theories, factors affecting maize production, knowledge gap and chapter Summary, and the conceptual framework.

2.2 Theoretical Background

This study is based on Malthusian Theory and the Theory of Production. The theories are discussed with an aim of illustrating the existence of influential factors and establishing the importance attached to maize production.

2.2.1 Malthusian Theory

Malthusian Theory (MT) was developed by Malthus (1798) in the first essay on *An Essay on the Principle of Population*. The second essay version combining of four editions ranging from 1806, 1817, 1826 and 1830 refined the first edition to produce what is today known as Malthusianism philosophy. The theory argues that the power of population growth is higher than the one responsible for food production. The theory further add that food insecurity will always be an issue as long as population growth rate exceeds the rate of food production and technology. Although the theory is applicable in various scenarios pertaining population and resource distribution as indicated by Quamrul and Oded (2008) and Weisdorf (2007), MT's originality is based on food security and population factor. The Malthusianism philosophy spreads over two centuries spanning from 1798-to date, but still relevant and even more applicable in contemporary perspective as illustrated by Khalil and Amjad (2016).

In the first edition of the second version created in 1806, Malthus argue that human population increases in geometric progression while food production increases by means of arithmetic progression. Leufstedt (2012) defines the geometric progression as a sequence in which the each term is established by multiplying the previous one by a constant number that is not zero and called a common ratio. Meaning, if the current population is 50 units and the common ratio is 5, then the second and third population generation will be 250 and 1250 respectively. On the hand, Agarwal (2018) defines the arithmetic progression as a sequence whereby the variance within a series is constant. This means that if the current produce is 50 and the variance is 5, then production will increase to 55 and 60 respectively. MT theory then asserts that the 55 to 60 increment in food production in relation to the 250 to 1250 increment in population automatically creates a food insecurity situation.

Malthus insists in the third edition of 1817 that there exists no immediate solution to this growth gaps and further predicts that the principle will finally spread to every useful resource to human. Elhrich and Elhrich (2009) supports Malthus' assertion, adding that the battle against hunger is bound to fail. In the subsequent editions of *An Essay on the Principle of Population*, Malthus refines the population control aspect as a control measure. His argument is that the situation will get better after attaining the apex of its worse. The Malthusian catastrophe, as he calls it, which includes feminine, wars and natural disasters will express natural and positive checks on the gap. Most importantly, MT suggests the use of preventive measure which include population growth controls and relooking on means and technology to enhance crop and general food production.

Quinn (1997) argued against MT, suggesting that the increasing world population is instigated by food production and supply. This argument against MT is also supported by Hopfenberg (2003) who demonstrates that through measuring future agricultural and food dynamics, the world's population can be projected and estimated correctly. This kind of measure indicator is used by FAO in estimating population. Odds against MT include the Western Europe population that grows much slower than food production. However, the situation in SSA, including Kenya, and Central America countries directly aligns to Malthusianism. It is therefore important for this study to consider maize production to be as a result of various factors that include population. The MT then anchored to the first specific objective which looks at production factors that affect maize production. The theory is based on the effect of demographics as a production factor, essentially the influence brought about by household size.

2.2.2 Theory of Production

The Theory of Production originates from the classical work of Smith (1776). The first classical illustrative writing depicting the theory was developed in the article *The Wealth of Nations*. The classical approach of the theory looks at the physical resources that are directly involved in production and on which value and cost can then be appropriated. The contemporary approach goes beyond physical resources to include technological progress, and intellectual and social capital (Daly & Ferley, 2011). The theory of production argues that all outcomes depend on a choice of involved factors, their perceived and exhibited optimal combination.

According to Darshan Institute (n.d), Battese and Coelli (2005) and Ojala et al. (2014), the theory drives the profit notion in terms of maximum production levels. They argue that with complete understanding of all involved factors and their individual contribution and group dynamics, correct combinations can be executed at a balanced costing system. The decision making is aided by modelling factor behaviour under a production function approach as $Y = (X_1, X_2, X_3..., Xn)$. From the model, Y represents the outcome or output while X_1 to Xn represents the individual inputs. Sometimes, depending on the objectives behind the modelling, X_1 to Xn may include all involved factor; whether direct or indirect and whether controllable or not.

In maize production, the output of the model represents high or low maize production which is denoted by 'Y' (Ojala, 2014) while the factors include access to land (X_1), seeds (X_2) and fertilizer (X_3), demographics (X_4) use of extension services (X_5), use of machines (X_6) and use of chemicals (X_7). Use of machines and chemicals are grouped under use of technology. The choice on the best and optimal scenario option varies from region to region. This is because some of the factors might happen to be naturally optimized in some regions known as zone belts, requiring focus only on those factors that are not and that are necessary for improving output. For high maize production, the most competitive factor combination scenario must be selected and focus based on how to effectively exploit each factor. In this study, the theory of production outlines the foundation of maize production. It provides an understanding that high production/yields are realized at the expense of many factors which include access to land, seedlings and fertilizer; climatic changes; demographics; extension services; and technology. The theory provides an understanding of the relationship between maize production and the involved factors.

2.3 Empirical Review

This section reviews existing information on maize production practices and how the practices influence the real production levels. It focuses on the studies that have directly and indirectly dealt with the production factors. In these reviews, this study applies multidimensional context approach. As indicated by the theoretical background, maize production is a function of various factors. According to Kilonzi (2011), Chumo (2013), Simiyu (2014) and Gaspard (2017), these factors include access to land, access to seeds and fertilizer, human demographics, extension services and Technology. These factors are categorized into production factors as well as institutional factors.

2.3.1 Production Factors

The involved maize production factors include access to land, technology and demographics. Together with the influence of other categories of factors, production factors determine the outcome of maize production through yields levels.

2.3.1.1 Access to Land

Access to land is a major factor affecting maize production. CGIAR (2016) argue that land distribution especially in the productive areas of the SSA countries is a problem. In Kenya, high-potential maize zones are distributed along densely populated areas (Ministry of Agriculture, Livestock and Fisheries, 2018). The high population translates to small pieces of land which in most cases end up within the real estate docket as housing projects are elevated to meet the shelter demand. As a result productive land, including lands that are outside residential zones, becomes expensive to acquire. On the other hand, Ahmed, Suleiman and Aminu (2013) indicate that sometimes the sizes of land can be influenced by the inherent economic and social foundations. They add that in a social and economically stable environment, the land utilization patterns favour farming of continuous pieces of land. However, that is not the case in most areas.

Ojala et al (2014) looks at this problem as the creation of poor government planning and settlement culture. Their argument is that with proper planning, human settlement is expected to happen in less productive regions and areas so as to free high-potential zones and allow easy access to agri-productive land. The study agrees with the argument of Mignouma, Mutabakazi, Senkondo and Manyong (2010) who insist that large land size is associated with operational efficiency due to increased economies of scale. They also indicate that land tracks encourage mechanization which normally aligns with optimized costs. Population distribution figures produced by the Trans-Nzoia County Integrated Development Plan, 2018-2022 (2018) indicates that the upper midland region which is highly productive has the highest population count. This kind of settlement translates to poor access on productive land therefore exposing farming to lands that have poor soil content and insufficient and unreliable maize production conditions.

2.3.1.2 Human Demographics

Human demographics are based in the social-economic category and include gender, age, household size, level of education, general wealth and other farming activities involved by the farmers. Together, all demographics influence maize production. An early study by Nkonya et al. (1997) indicate that weak sets of demographic factors highly affect the uptake on institutional factors and competitive information that can lead to high yields, and the ability to seek for credit. The level of education for example is very important as it enables farmers to exhibit a critical and an alert mind. Education enhances the ability of the farmers to allocate decisions effectively and in an optimal manner. The farmers' ability to analyse on the most feasible seed variety was also found by Fufa and Hassan (2006) to be resting on their level of education.

The adoption of maize production and general farming technology is also determined by the level of education and age. Un-educated farmers normally fall short of information on farming technology. This is so especially because they are not aware of where to look for the information and at the same time even if they get the information, they cannot interpret and comprehend accordingly. From Roger (2003) and CGIAR (2016) we can deduce that young farmers are likely to absorb new maize production technology more than older farmer due to the schooling they underwent and to the fact that their attitude to change is much softer. In Kenya, a large number of farmers belong to the older category whose level of education is minimal and farming decision are not flexible to change and new technology. The average household size in those high-potential maize zones is also on the higher end, making maize production to focus on household consumption.

2.3.1.3 Technology

In a study carried by CGIAR (2017), the top significant difference that was found to exist between maize production in Mexico and that of SSA countries was production technology. To realize the extent of this difference, a comparison of seed technology used in Kenya and illustrated by Abate (2015) to that used in Mexico as illustrated by CGIAR (2017) reveals that Kenya used hybrid and free pollinated seeds only as opposed to Mexico's rapid deployment of synthetic varieties. An in-depth performance analysis of the synthetic varieties by Blanca (2017) indicate that due to the foreign gene introduced, these varieties have a capability of excelling beyond the normal ecological and conditions necessary for maize crop production. The varieties require less monitoring as they resist effect from normal deceases and weeds. Vallejo et al. (2008) argued that synthetic varieties represent the future of maize production as their development takes less time and many types can be developed at a go. This variation of variety of seed technology has also been noticed by The United Nations' World Food Programme, who state in Challinor et al. (2016) that only around 50% of the total maize fields represent modern varieties in developing countries as opposed to an average of 100% in developed countries.

This trend in the use of seed varieties is also reflected in other maize production technology that include land preparation, crop support practices and harvesting mechanisms. In developing countries that include those in SSA, the process of land preparation, crop support practices and harvesting processes are high depended on human labour while in most of developed countries these processes are mechanized (Araus & Cairns, 2014). The obvious downfall for using human labour is that it lacks uniformity in standardization of quality. Quality in land preparation, crop planting process, crop support practices and to some extent in harvesting. Mechanization of these processes equally ensures that the cost of maize production is minimized in the long run. Timing and time utilization is also major functional factor that is optimizable with farm mechanization (CGIAR, 2016). For Kenya to realize high yields, mechanization in maize production must be considered and factored. This study looks technology from the perspective of using machines in ploughing and use of chemicals in maize plant treatment.

2.3.2 Institutional Factors

Institutional factors include access to seeds, extension services and access to fertilizer. Together with production factors and other dynamics, the involvement of institutional factors influence the number of bags in yield per specified size of land. These factors are important and highly influential.

2.3.2.1 Extension Services

An extension service is identified by Kilonzi (2011) as a programme organized by the farmers' management unit at the ministry of agriculture level or a group of farmers. The service is meant to enable farmers get updated practices in form of assistance from experts. He further argues that the experts are meant to advice on the relevant type of fertilizer to use and the most feasible intercropping system as well as the quality of seeds meant for specific regions and conditions in subject. Ojala (2014) post that extension service are important to maize production especially now that the changes in climatic conditions are unpredictable. Early, Yaron et al. (1992) posted that extension services play a major role in the adoption of maize production technology, especially in regions where majority of farmers lack formal education.

In Kenya, extension service is not a technical term, many farmer are aware of such services but the problem is that the services are not offered to maize farmer. This knowledge on extension service is only based on the assistance platforms established in the tea planting sector and the early assistance accorded to the coffee farmer way before the fall of the coffee sector. As indicated by Olubandwa, Kathuri and Wesonga (2011), extension services are supposed to be a drive directly under the country's ministry of agriculture, livestock and fisheries. Judging by the current position of the government of Kenya and maize security; specifically on the big 4 agenda and the fact that maize is the country's stable food, it is apparent that extension services can enhance maize production. An example of where extension services have directly resulted in better yield is given by Minten and Barrett (2008) who carried out a study on The Green Revolution in Asia. Their argument is that, the revolution is a success due to involvement of the relevant ministries majorly through extension services. We expect the same results if Kenya can adopt the same approach.

2.3.2.2 Access to Seeds and Fertilizers

Access to seeds and fertilizer in Kenya is a major factor determining maize production (Kilonzi, 2011). The Government of Kenya through the Ministry of Agriculture, Livestock and Fisheries has provided for this factor but still challenges are experienced. The provision entails the creation of the National Cereals and Produce Board (NCPB) and Kenya Plant Health Inspectorate Service (KEPHIS). The two bodies are mandated with the task of ensuring that services to farmers are paramount. KEPHIS is expected to ensure no counterfeit seeds get to the farmers through enforcing certification and quality on seed producers and distributors. According to the National Cereals and Produce Board Act, chapter 338 (Government of Kenya, 2012), NCPB is expected to distribute certified seeds and fertilizer alongside other certified bodies. Lack of access to certified hybrid seed by most farmers have resulted to rampant use of recycled seeds. A study by Crowley and Carter (2000) indicates that maize farmers in Kenya are still using basic varieties (recycled seeds) as their main seedling. Those farmers that access and strictly use the hybrid ones are few and observation indicate that most of them are registered ones.

Abate et al. (2015) indicate that out of the 14 new and subsequent improved hybrids released between 2007 and 2014, most maize farmers are only familiar with those released in 2007 to 2012. Compared to Mexico, Kenya is still far behind in terms of ensuring the production through the support of seedling. According to Blanca (2017), Mexico's main seedling combination is made of hybrid varieties, free pollinated and synthetic varieties. Their use of free basic breeds is somewhat limited to small scale farmers who constitute less than 20 percent. These farmers are also said to use free pollinated breeds. The dynamics involved in the distribution of fertilizer is also similar to that involving improved seeds. Nyoro et al. (2015) indicate that maize supporting soil contents is highly depleted when crop rotation is not adequate, a practice (crop rotation) not common to most of the Kenya Maize farmers.

2.4 Knowledge Gap

The empirical literature reviewed reveals extensive coverage on maize production and the inherent influential factors. The review, based on the causative theoretical foundation, focuses on local and international research and brings into perspective the involvement of various maize production factors. Various dimensions have been explored, but specific knowledge on factors affecting maize production among registered small-scale farmers has not been directly been addressed: Especially in areas that exhibit similar characteristics to those in Trans-Nzoia County. However, the much done provide leeway to effective positioning of the prospective factors.

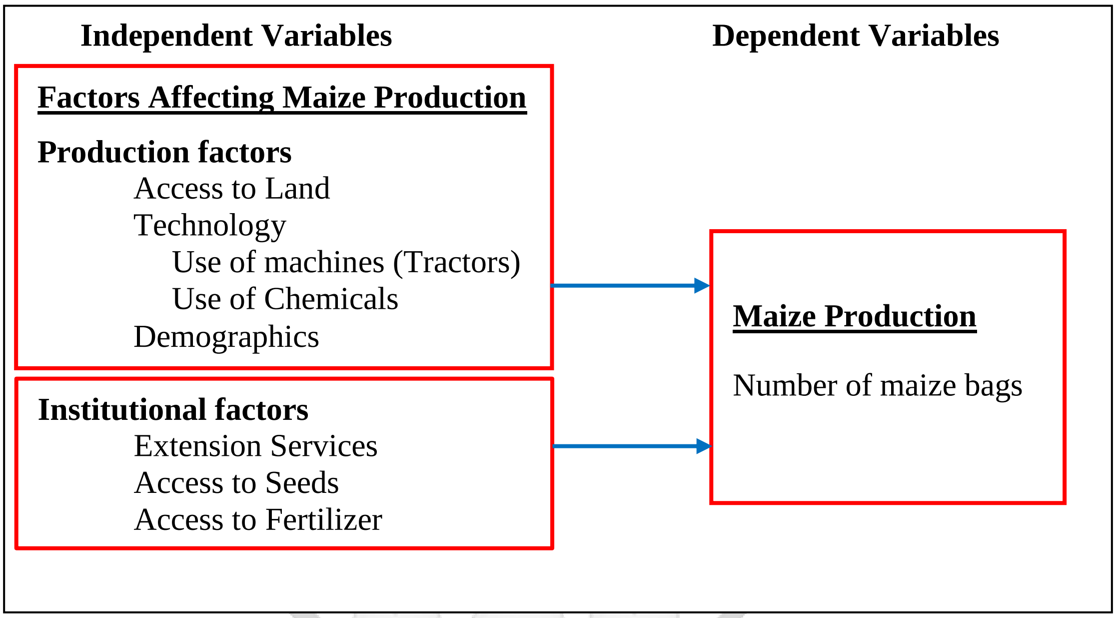
Many studies have grouped the factors into bundles of related aspects, coming up with socio-economic, political and legal, climatic and technological and even ecological. Such studies include Nkonya (1997), Michele (2001) and Ojala et al. (2014)). The review also reveals studies on variant outputs including Gaspard (2017) that focus on productivity and Blanca (2017) that focus on improved decision making among farmers rather than production level. Other studies include Issa et al. (2014) that focus on improved maize production practice and Muthaura (2015) that looks at soil nutrients and how they affect maize production. The review also establishes a study by Simiyu (2014) for partial knowledge gap due to its focus on factors affecting maize production among small-scale farmers. Simiyu's study exploits a significant stretch as per this proposed study but fails to incorporate the registration of farmers' aspect as well as a contextual alignment. Another factor validating a knowledge gap include argument that different zones and regions experience different factors and their extents: A factor that all reviewed studies including Simiyu's fail to address.

Unlike the reviewed literature, this study will focus on multi-dimensional factors that include extension services and technology factors, which have been extensively ignored, among others. In summary therefore it is apparent that many studies have looked at the factors that influence maize production. However, neither is based on Trans-Nzoia County as a high maize yield potential area nor evaluated among others the use of technology and extension services. It is thus prudent that this study analyses upon this knowledge gap.

2.5 Conceptual Framework

According to Mugenda and Mugenda (2003), a conceptual framework is a construct model representing the interaction between various attributes. Independent and dependent variables form the major categories of the model and they exhibit a causative relationship. Figure 2.1 illustrates the variable involved in this study.

Figure 2.1: Conceptual Framework



Source: Researcher (2019)

Based on the objectives of this study, figure 2.1 shows that the independent variables directly determine the outcome of the dependent variable. This means that if farmers can find a way of optimizing the use of technology and extension services, access hybrid seeds and sustainable amount of fertilizer, align demographics and access reasonable sizes of land at a reasonable cost, then high maize production in terms of maximum number of bags will be realized. The figure shows that when both production and institutional factors are fully instituted and operationalized, maize production increases: more maize bags are realized.

2.6 Chapter Summary

Using Malthusian Theory and Theory of Production to analyse on factors affecting maize production, diverse literature shows the positioning of the relationship in various regions around the world. Evidence shows that that there already exists statistical base for high maize production if most the factors are optimized. The literature also brings out the difference in levels of production vis-à-vis the approach to the considered factors in two different regions: The Sub-Sahara Africa against Mexico. With the support provided by the Government of Kenya via The Big Four Agenda, it is worth singling-out these factor based on the various regions to enable optimized approaches.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research methodology that will be used in conducting this study. It comprises of research design, sampling technique and sample size, data collection methods, data analysis, research quality and ethical issues.

3.2 Research Design

This study used a survey research design. A research design is defines by Kothari (2004) as a specified procedural approach to data collection and analysis. He further add that the main aim of a research design is to ensure data collected is procedurally economical and relevant, and that analysis is done as per objectives and expectation. Survey design is deemed appropriate for this study as it enable in-depth analysis and understanding of the factors affecting maize production. The survey design-related circumstances as involved in this study are justified by McLeod (2014) who post that survey design approach is effective in establishing status of a large social or economic process.

3.3 Population Size and Sampling Technique

The area of study includes the entire Trans-Nzoia County. The target population comprise all registered small scale maize farmers in the County. Stratified sampling technique was used to determine the sampling size. Stratified sampling technique divides the entire population into strata also known as subgroups (Molenberghs, n.d.; Alvi, 2016). The subdivision was based on Trans-Nzoia Sub-County boundaries as exhibited by the Independent Electoral and Boundaries Commission of Kenya and expressed by Trans-Nzioa County's Integrated Development Plan 2018-2022 (Appendix, IIIb). The five sub-counties exhibited heterogeneous characteristics.

To obtain the right sample size, the study used Cochran (1977) sample size formula. The Cochran formula enables the determination of the sample size given the desired confidence level, a desired level of precision and an estimate of the population (Lani, 2009). Due to the maize growing culture expressed by the Trans-Nzioa County, the infinite population was expected to be large therefore informing an estimated proportion of 30%.

The Cochran formula is represented as;

$$SS = \frac{Z^2 * (P) * (1 - P)}{C^2}$$

Where;

SS=Sample Size

Z = Z-Value

P = Estimated proportion making the sample size

C = Confidence interval (expressed in decimal)

Therefore;

$$SS = \frac{1.96^2 * (0.3) * (0.7)}{0.0025}$$

$$SS = 322$$

The sample size is based on the assumption that the number of small scale farmers in Trans-Nzoia County is infinite.

Modification of the Cochran (SSn)

$$SSn = \frac{SS}{1 + (\frac{SS - 1}{N})}$$

$$\mathbf{SSn} = \frac{322}{\mathbf{1} + (\frac{322 - 1}{500})}$$

$\mathbf{SSn}$ = 196 (modified sample size)

N = 500 is based on the number of NCPB registered small scale maize farmers.

3.4 Data Collection Method

This study used primary data. Collection of the data was done through the use of questionnaires. The questionnaire contained an optimal mix of closed and open-ended questions so as to allow the respondents to express more opinions on the factors that affect maize production in Trans-Nzoia County. This means that the data collected exhibited both quantitative and qualitative aspects. The researcher used research assistants who in turn expressed and explained the requirements of each question to each respondent in order to assure on objectivity and relevancy of responses. This prompted the method of administration to be self-administration. The questionnaire were divided into five so that each of the five sub-counties got 39 questionnaires. One questionnaire was used to re-capture on re-test scenario to ensure reliability of the tool.

3.5 Data Analysis

Obtained data was coded and analysed accordingly. Descriptive statistics and inferential analysis was be engaged. A non-parametric F-test at 0.05 significance level was performed on the analysis tools. Preliminaries were analysed accordingly. To obtain the first objective and second objective, obtained data in support of both questions were analysed using descriptive statistics and inferential analysis. Descriptive statistics was based on mean and standard deviations and presented in a table while inferential statistics was based of regression. The following regression model was used.

$$Y=W0+\beta_1X_1+\beta_2X_2+\ldots+\varepsilon$$

Key:
Y = Maize Production (Number of Maize Bags)

X_1 = Access to Land

X_2 = Access to Hybrid Seeds

X_3 = Access of Fertilizer

X_4 = Demographics

X_5 = Extension Services

X_6 = ploughing using machines

X_7 = chemical treatment

W0 = Coefficient of intercept (Constant)

$\beta_{1\ldots}\ \beta_6$ = Coefficient of variable $X_{1\ldots}\ X_7$

3.6 Research Quality

Research quality pertains the originality of the field research undertakings as opposed to the proposed guidelines that inform such undertakings. To ascertain research quality, the researcher ensured that objectivity and validity were observed as suggested by Kothari (2004). According to Sekaran and Bougie (2013), objectivity includes the interpretation of findings relative to personal interpretation while validity and reliability represent the degree in which tools and process used measure the intended aspects.

To ensure objectivity of the results, the researcher took reflexive approach upon the interpretations and further detached from the bias of owning constructs by accepting self-perceived impossible responses.

To ensure validity and reliability of the research tool, partial triangulation was carried out on one of the farmers. The process was carried out through the use of one of the questionnaires. As evidence for involving skills, data collection was appropriated by the preparedness of the researcher and the well trained research assistants.

3.7 Ethical Considerations

The study observed two ethical considerations: The research only and only conducted the questionnaire administration if the respondent(s) voluntarily allowed their participation, and that personal identification of the respondents were kept anonymous and confidential. In this case, any respondent who was approached and did not want to respond to the questionnaire was duly briefed on the intention of the study and assured of secure data and anonymity of his/her participation. If s/he/they insisted not to participate, then s/he/they was excluded and replaced by another respondent. An identity number was assigned to each questionnaire with sub-county prefix to ensure anonymity.

CHAPTER FOUR

PRESENTATION OF RESEARCH FINDINGS

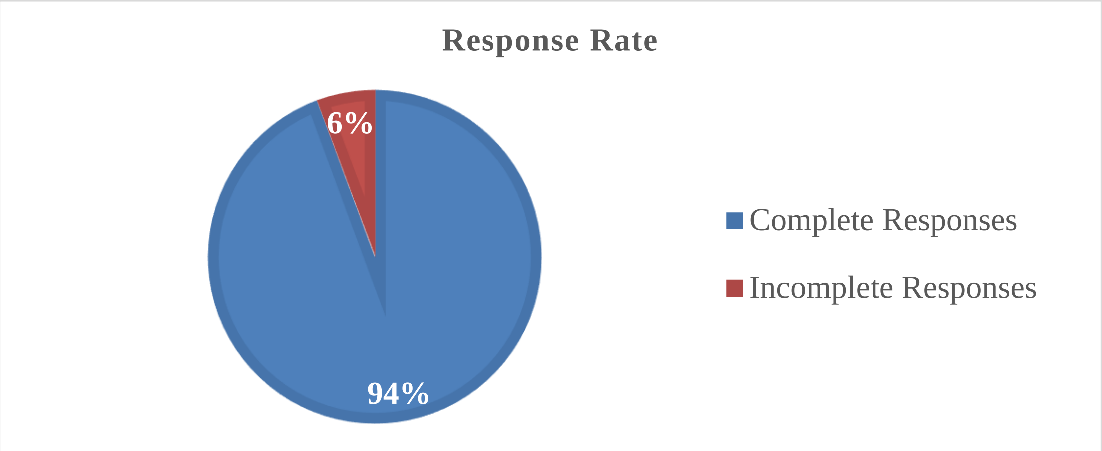
4.1 Introduction

This chapter contains findings from the field. It presents research findings. The collected data exhibits both qualitative and quantitative aspects. The collected data was categorised into three sections which include preliminary; production and institutional factors; factors and maize production. Section one exposes the capabilities and general exposure of the respondents to maize farming. Section two looks at the characterization of the factors under consideration. Section three looks at the relationship between the factors and maize production. Data was collected from registered small-scale famers in Trans-Nzoia County.

4.2 Response Rate

The study was subjected to a sample size of 196 respondents within Trans-Nzoia County. A total of 196 questionnaires were presented to the field, 195 subjected to respondents while one was used to validate the responses provided. The data recapture for validity was done by a different research assistant and an accuracy of 94% established. Out of the 195 questionnaires administered and regained, 184 fully were found to be compliant with the set acceptance level. This translate to a response rate of 94% as indicated in figure 4.1 below.

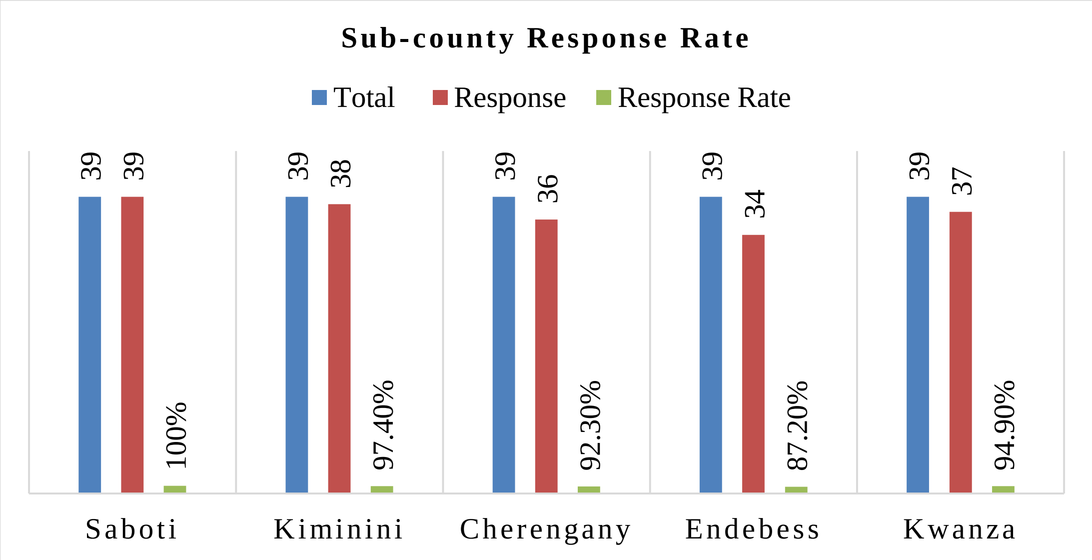
Figure 4.1: Total Response Rate



Source: Researcher (2019)

Based on Mugenda and Mugenda (2003) who indicate that a response rate of more than 70% is excellent while one at 50% and above is adequate, it can be concluded that a response rate of 94% is excellent.

Figure 4.2: Sub-County Response Rate



Source: Researcher (2019)

As per sub-counties, response rates of 100%, 97.4%, 92.3%, 87.2% and 94.9% for Saboti. Kiminini, Cherengany, Endebess and Kwanza Sub-Counties respectively. All the five sub-counties provided excellent response rates. The responses from the four sub-counties with less than 100% response rate is based on the fact that some respondents did not fulfil the minimum accepted response quality. The high response rate shows the readiness of the farmers to provide accurate and substantive information.

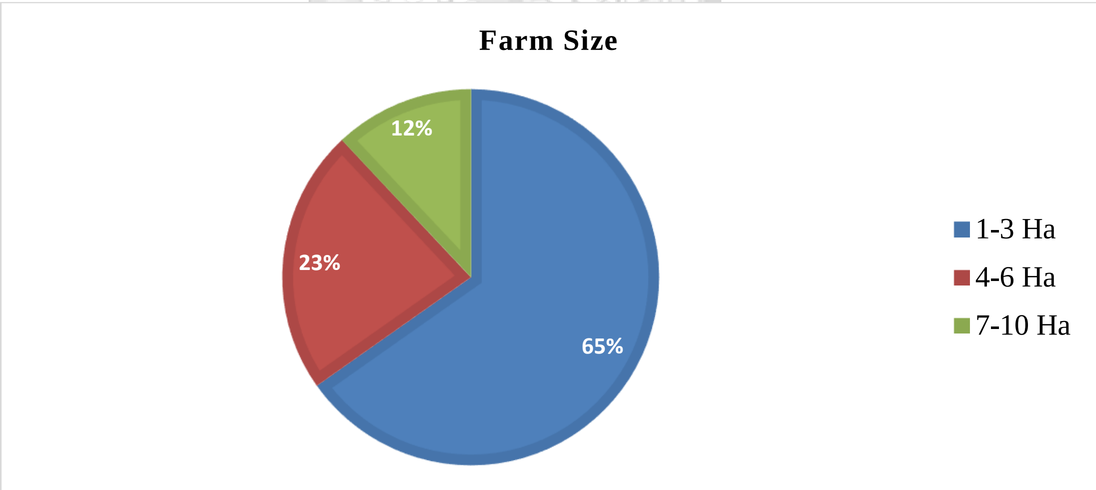
4.3 Respondents Profile

The provisions for the respondents profile is based on section one of the questionnaire. A spread sheet statistic for every response was generated and subjected to relevant computations. Statistical mode, mean, maximum and minimum was executed in order to provide the dominating characteristics. To establish the dominant characteristics and those that rank next, the countif formula was used appropriately. The outcome of the statistical analysis is depicted herein.

The respondents were asked to provide the accurate age in the preliminary section. The information intendent to provide the average position on whether those involved in maize farming are the youth or the old members of the society. Supported by an average of 40.5, a statistical mode of 40 years was established meaning that most of the respondents are classified as old (mature) members of the society. The highest age for the respondents was established to be 89 years old while the youngest respondent was 20 years old. This skewed spread in age indicates that maize farming the prioritized by the older members of the Trans-Nzoia County society.

The respondents were asked to indicate the size ranges within which their maize farms belong. Three categories were provided: 1 for 1 to 3 ha; 2 for 4-6 ha; 3 for 7-10 ha. Out of 184 respondents, a response mode of 1 was provided by 65% (120) respondents, 2 was provided by 23% (42) respondents, and 3 was provided by 12% (22) respondents. This means that 120 registered farmer own land measuring 1 to 3 hectares and 42 of them own land that measures 4 to 6 hectares while the rest (22) own farms that measure between 7 and 10 hectares of land.

Figure 4.3: Distribution of Farm Size



Source: Researcher (2019)

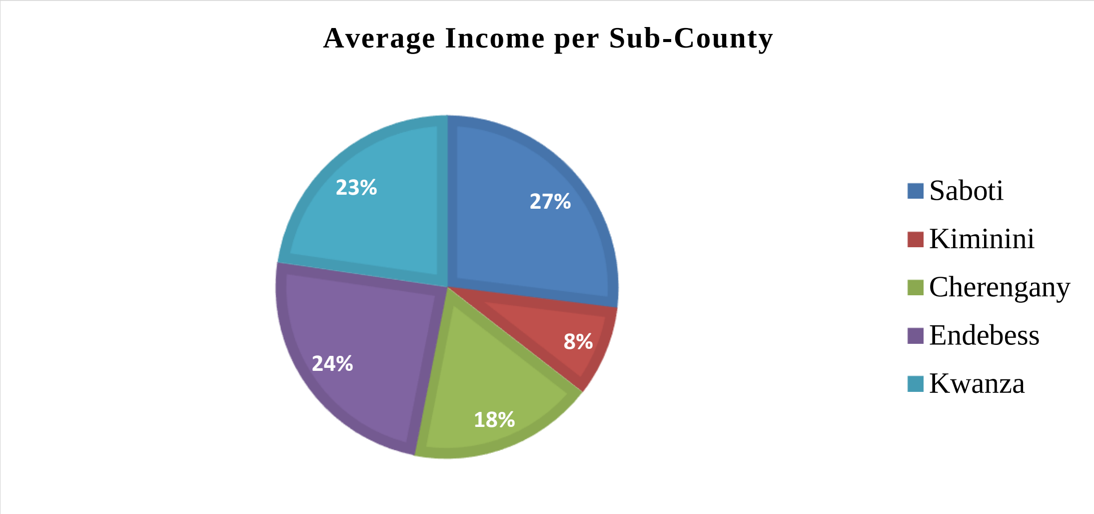
In terms of marital status and number of dependants, the study intended to establish the support status and the motivational drive within the family level. Out of the 184, 141 respondents indicated that they were married, 29 indicated that they were single while 14 indicated that they were divorced. Another measure on the number of dependants indicate that 30 farmers have dependants, 82 have between 1 and 4 dependants, 53 have between 5 and 7, while 19 have 8-10 dependants. These statistics indicate that most of the respondents are married and have high chances of receiving both psychological and physical support from their family members in terms of effecting maize farming.

The respondents were also asked to name any other crop they planted a part from maize and if they carried out any other economic activity other than crop farming. More than 8 crops were named, whereby bananas took the highest share at 100 respondents, followed by vegetables, beans, a combination of beans and bananas and potatoes at 29, 15, 11 and 10 respondents respectively. Other crops noted therein include coffee planting, sorghum and millet, sugarcane and peas. In response to other economic activity(s), most of the respondents indicated that they conducted assorted business, kept animals and did poultry farming, while others did nothing at all and others are employed elsewhere at 76, 48, 28, 16 and 11 respondents respectively.

The last provision for section A of the questionnaire required the respondents to provide their consolidated monthly income: including income from all other sources that may exist. Provision for this section intended to establish the level of financial support that maize farming receives, whether by taking maize farming as the core activity in the farmer’s family or as a supportive activity. From the statistical analysis, Ksh.900000 was established to be the highest income and recorded by one farmer who had category 3 farm size and conducted multiple businesses. Five (5) farmer with the lowest income received Ksh.15000 each. It was further established that these five farmers belong to the least farm size category and had either no any other source of income or had many dependants.

It is also important to note that most of the low income farmers with small sizes of land were youths. As provided by the mode.mult in excel, most of the farmers earn an average of Ksh.70000, with county average of about Ksh.117000. The distribution shows that Saboti Sub-County had an income average of Ksh.158000, Kiminini had the least at Ksh.50000, Cherengany had Ksh.103000, Endebess had Ksh.142000 and Kwanza had Ksh.133000 as figure 4.4 shows. This shows that Saboti Sub-County has the highest income among registered small scale maize farmers, consequently followed by Endebess, Kwanza, Cherengany and Kiminini Sub-Counties respectively.

Figure 4.4: Average Income per Sub-County



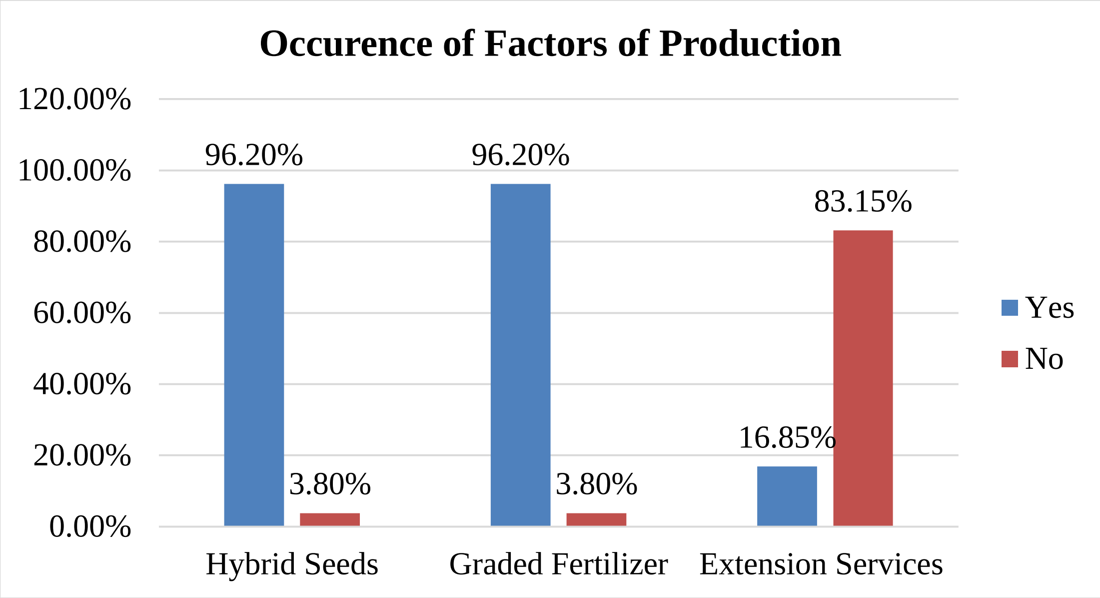
Source: Researcher (2019)

From the statistic above, it is apparent that more financial support towards maize is highly likely to be possible in Kiminini Sub-County, followed by Endebess, Kwanza, Cherengany and Kiminini Sub-Counties respectively. The high income is likely to support the mitigation of the negative maize farming trends that are exhibited within the factors that affect maize production. To be specific, high income boosts the propensity to use improved maize seeds, graded fertilizer and use of extension services. Theoretically, it is therefore anticipated that Saboti Sub-County be the leading Sub-County in maize production. It is equally important to note that sometimes high income means less dependency on farming, meaning reduced that maize production.

4.4 Production and Institutional Factors

The study sought to establish the occurrence of the individual factor affecting maize production in Trans-Nzoia County. The investigation was anchored in section B of the questionnaire which dealt with production and institutional factors. The respondents were asked to state yes or no on the characterization of the factors and further asked to provide the extents if their answers pertaining rainfall and service extension were yes. The technology factor was given more concern by widening its scope. The responses provided on access to hybrid seeds, access to graded fertilizer, change of rainfall pattern and extension services are represented in figure 4.5

Figure 4.5: Occurrence of Factors of Production



Source: Researcher (2019)

From table 4.5 above, (96.2%) 177 respondents indicated that they used improved/hybrid maize seeds in the previous maize planting season while the remaining 3.8% (7) respondents indicated otherwise. The same number of respondents with partial difference in individualism also indicated that they used graded fertilizer during the same planting season. The responses shows that access to hybrid maize seeds is not an impermeable challenge, and so is the access to graded fertilizers. It is then expected that the contribution of these two factors, access to hybrid maize seeds and graded fertilizer, will be paramount. The questionnaire further required those farmers who used graded fertilizer to indicate whether they acquired the fertilizers in full or in subsidized prices. 141 of the 177 farmers indicated that the fertilizer they used was acquired under full prices while the rest indicated otherwise.

In the next question the respondents were asked to indicate if they had received extension services in the last maize planting season. 83.15% (153) of the respondents indicated that they did not received any extension service during the last maize season while 16.85% (31) of them indicated otherwise. To further understand the extent at which the factor was practiced, the respondents were further provided the option to indicate how many times they did get extension services in that very same season. 16 respondents indicated that they received extension services once in that particular season, 12 respondents indicated that they received extension services twice while 3 respondents indicated that they received the services thrice.

Concerning technology, the questionnaire focused on the use of tractor, direct human labour and use of chemicals in ploughing, planting and tilling. For irrigation, it was assumed that there only exists the option of either irrigating or not. Those irrigating were then bound to using an irrigation pump. Table 4.1 represents the findings.

Table 4.1: Type of Technology Used in Maize Farming

Technology	Ploughing	Planting	Tilling	Irrigation
Tractor/ use of Pump for Irrigation	69.02%	15.76%	22.83%	1.63%
Manpower	30.98%	84.24%	73.37%	0.00%
Chemicals	0.00%	0.00%	3.80%	0.00%
Totals	100.00%	100.00%	100.00%	1.63%

Source: Researcher (2019)

As indicated in table 4.1, 69.02% of the respondents use tractor while 30.98% of them use manpower in ploughing. 15.76% of the respondents use tractors while 84.24% of them use manpower in planting. While tilling for the maize crops, the responses indicate that 22.83% of them use tractors and any other form of machinery, 73.37% use manpower and 3.8% use chemicals. Irrigation is one factor that nearly all farmers were found not to practice, only 1.63% of the respondents did. The three farmers indicated that they use a pump for do the irrigation. However, as they further argued, the irrigation was only done for the period when the maize was planted to the germination.

The respondents were also required to declare if the land they used in maize farming was owned by them or it was leased to them. They were then asked to tick between owned and leased. Out of the 184 respondents, 123 indicated that the land they planted maize was their own while the rest indicated that the land was leased to them. The assumption behind this question was that leased land tend to be effectively utilized compared to lands that are fully owned by the farmers. The perspective also determines if the farmer performs soil testing, a factor that was equally in question. In the responses concerning the factor, 18 respondents indicated that they performed soil testing. Of the

18 respondents, 5 indicated that they performed soil testing once in the last five years, as 11 respondents indicated performing the testing twice and 2 respondents having performed the testing three times. From the findings, it can be noted that the act of performing regular soil testing is not common but at least it is a practice considered among a few farmers.

4.5 Descriptive Statistics

Section C of the questionnaire intended to establish the exact relation of the dependent variables (land size, amount of seeds, applied fertilizer, household size, extension services, use of machines in ploughing and chemical treatment) to the independent variable (number of maize bags produced). Unlike section A of the questionnaire which categorized the characteristics of the factors, in Section C, the respondents were asked to provide the exact size of land in hectares, seeds used in kilograms, number of household dependants, cost in shillings of chemicals used, cost in shillings that went to use of machinery in ploughing and the exact number of bags of maize harvested. The statistics was pulled from the year 2017 and 2018, and an average provided. The findings were coded and analysed according. The results were as follows.

The SPSS output on descriptive statistics included all the independent variable. The output is presented in table 4.2 which includes the mean (Mean) of all the factor variables, the standard deviation (Std. Deviation) and total data set (N).

Table 4.2: Descriptive Statistics

	Mean	Std. Deviation	N
Maize Production (No. of Bags)	84.1848	63.00042	184
Land Size (Ha)	3.2935	2.43119	184
Seeds (Kg)	33.5788	25.03147	184
Applied Fertilizer (Kg)	160.7255	122.08969	184
Household Size	4.2582	2.56072	184
Extension Services (No. of Times)	.3750	.94991	184
Ploughing using Machines	6745.3804	7214.51882	184
Chemical Treatment	3177.1467	4678.88387	184

Source: Researcher (2019)

Maize production, which is the dependent variable had a mean of 84 bags of maize and a standard deviation of 63 bags. Such a higher spread of standard deviation means that most of the farmers produce far less or more than 84 bags of maize. In terms of land size, a mean of 3.3 ha and a standard deviation to 2.4 indicates that most farmers have land that measure around 3 and 4 hectares with a disparity of about 2 hectares. Having the same characteristics the use of seeds, household size, fertilizer application and chemical treatment.

However, the use of chemicals indicated herein is different from that explained in section A due to the fact that in this section respondents included chemicals used in plant treatment as opposed to the responses in section A that included only those chemicals used in tilling. It can also be noted that the use extension service is very rare in that it records a mean of 0.38 and a standard deviation of 0.95. Similarly, the use of machinery in ploughing records a mean of 6745 with a higher standard deviation of 7214; showing that the practice is not uniformly distributed but skewed towards extreme ends.

4.6 Inferential Analysis

The following regression model was applied to measure the relationship between the involved factors and maize production among registered small scale maize farmers in Trans-Nzoia County.

The Regression model was as follows:

$Y=W0+\beta_1X_1+\beta_2X_2+\ldots+\varepsilon$

Key:

Y = Maize Production (Number of Maize Bags)

X_1 = Access to Land

X_2 = Access to Hybrid Seeds

X_3 = Access of Fertilizer

X_4 = Demographics

X_5 = Extension Services

X_6 = ploughing using machines

X_7 = chemical treatment

W0 = Coefficient of intercept (Constant)

$\beta_{1\ldots}\ \beta_6$ = Coefficient of variable $X_{1\ldots}\ X_7$

Regression was carried out between the independent variables and dependent variable. The independent variables that represent land size, amount of applied seeds and fertilizers, household size, extension services, use of machinery and chemical treatment while dependent variable represent operational performance. Average rainfall which represented climate change was excluded from the entry variables as the respondents were not able to adequately provide its measure. The study therefore relies on section B for the interpretation of the rainfall variable.

The model summary indicate a correlation value of 0.996 which shows a high relationship between independent and dependent variables. This characteristic relationship is also shown by the determination coefficient reading at 0.991. The coefficient of determination indicates that the regression line holds explanation for 99.1% of the total observation.

Table 4.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.996[a]	.991	.991	6.07229	.991	2788.932	7	176	.000

a. Predictors: (Constant), Chemical Treatment, Extension Services (No. of Times), Household Size, Ploughing using Machines, Applied Fertilizer (Kg), Seeds (Kg), Land Size (Ha)

Source: Researcher (2019)

The significance of the regression model was established using ANOVA. An f-significance value (p-value) of 0.000 was established. This shows that the regression model has a less than 0.000 likelihood of giving an erroneous prediction: P=0.000<0.05. The regression model is therefore termed to be sufficient in establishing and explaining for the study's findings and objectives. Table 4.5 shows the ANOVA Analysis.

Table 4.4: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	719847.131	7	102835.304	2788.932	.000[b]
	Residual	6489.587	176	36.873		
	Total	726336.717	183			

a. Dependent Variable: Maize Production (No. of Bags)

b. Predictors: (Constant), Chemical Treatment, Extension Services (No. of Times), Household Size, Ploughing using Machines, Applied Fertilizer (Kg), Seeds (Kg), Land Size (Ha)

Source: Researcher (2019)

Table 4.5: Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.601	.994		-1.610	.109
	Land Size (Ha)	26.155	2.675	1.009	9.777	.000
	Seeds (Kg)	-.166	.213	-.066	-.782	.435
	Applied Fertilizer (Kg)	.034	.027	.067	1.280	.202
	Household Size	.276	.190	.011	1.451	.148
	Extension Services (No. of Times)	-1.095	.477	-.017	-2.297	.023
	Ploughing using Machines	-0.00036	.00014	-.041	-2.623	.009
	Chemical Treatment	.00042	.00013	.031	3.206	.002

a. Dependent Variable: Maize Production (No. of Bags)

Source: Researcher (2019)

The regression model in table 4.3 shows significance of four factors that include land size, chemical treatment, ploughing using machinery, and extension services. Seed and fertilizer rate, and household number were found to be statistically insignificant at 95% confidence level with 0.435, 0.202 and 0.148 respectively. The following regression model was obtained.

$$Y = -1.601 + 26.2X_1 - 0.166X_2 + 0.34X_3 + 0.276X_4 - 1.095X_3 - 0.00036X_4 + 0.0042 + 0.824$$

From the resulting model, it can be deduced that if land as a variable is held at a constant of 1 ha and other factors kept constant, the value of maize production would be at 26.2 bags. In this regard, the study shows a significant relationship between maize production and size of land (p=0.000), chemical treatment (p=0.002), ploughing using machinery (p=0.009) and use of extension services (p=0.023).

However the increment indicated on chemical treatment and reduction by ploughing using machinery might be significantly low to the relevance of the involved cost which are associated with increasing and reducing the number of bags produced. Extension services factor equally record a negative coefficient that is a bit higher: at -1.095. This coefficient means that for every one unit of involved extension service, production reduces by 1.095. Therefore, it is appropriate to state that the most important factor is size of land.

4.7 Enhancing Production and Institutional Factors

The last part of Section C required the respondents to critically think and suggest to their ability the best ways to improve the maize production factors. The questionnaire sub-section provided six (6) factors with space for suggestions. The factors included access to land, seeds and fertilizer, extension services and technology. All 184 respondents attempted to provide for the respective responses. To improve access to land, most of the respondents suggested that both national and county governments facilitate credit facility specifically for land acquisition and lease. The credit be channelled specifically to registered maize farmers. Another substantive pool of respondents suggested provision maize farming-loan products by banks, through the influence of the Ministry of Agriculture.

The suggestion provided for access to seeds factor include educating farmers on the best yield-based hybrid varieties for the five (5) sub-counties, and full subsidizing of the seed prices by the government through NCPB and any other authorized distributor. The same suggestions were also provided for the access to fertilizer factor. Concerning extension services, most of the respondents suggested that all the extension services be attached to the NCPB as the body in-charge. In this criteria, they further added that the NCPB offices be distributed to every administrative ward to facilitate access. Lastly, the suggestions provided on improving access to technology include providing special loan and credit facilities for acquisition of heavy machinery and facilitating cheap acquisition of quality chemical spraying pumps.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMENDATIONS

5.1 Introduction

This chapter contains discussions, conclusions and recommendation. The chapter is based on the analysis of the findings and the underlying objectives of the study. The objectives include; establishing the factors involved in maize production among registered small scale farmer in Trans-Nzoia County, and establishing the effect of the identified factors on maize production in Trans-Nzoia County.

5.2 Discussion

The following is the discussion of the research findings upon which conclusions and recommendation are drawn. The undertaking of the research was guided by two specific objectives. Collection of data was done through the guide of two main research questions that were directly obtained from the research objectives. From the analysis of the first objective, the study indicates that all variables are important. However, Trans-Nzoia County being a high-potential area, some variable are natural aspirated to occur thereby consequently overshowing the occurrence of others. A good example include the insignificance of fertilizer usage. The factor is overshadowed by the fact that the area is a high potential maize production area with conducive soils and ecological base. There exists a difference in the way each factor influence maize production, but this phenomenon is only explained by the statistical and inferential analysis on both objectives.

On preliminaries, the analysed response rate indicate the success of the study in the data collection method as well as the ethical standards involved during data correction period. It also shows that most of the respondents were ready to provide information on request. The same response criteria was replicated throughout the questionnaire. It was noted early enough that the farmers/respondents had an anticipation on rainfall as a factor, with many seemingly suggesting that the stability in climatic conditions contribute greatly to the zoning of Trans-Nzoia as a maize belt.

It was also established that most of the respondents indicated that they acquired fertilizer on full selling price against the maize production strategy by the Ministry of Agriculture

(TIAPD & RAES, 2003) which suggest on subsidized fertilizer. This means that the fertilizer subsidy policy by the GoK through Ministry of Agriculture has not been successful. The respondents, 80 percent, equally showed that used hybrid seeds. The findings contradict the findings of Crowley and Carter (200) who post that a significant number of maize farmers in Kenya use basic varieties/recycled seeds. This equally aligns to the objectives of Government of Kenya and the Ministry of Agriculture in the objective of instituting NCPB and KEPHIS. NCPB and KEPHIS are mandated to ensure distribution and use high quality seedlings by farmers in Kenya. In supporting maize production, the seedling and fertilizer factors resolves or mitigates the soil content problem indicated by Nyoro et al. (2015). Perhaps the county does not critically require the use of fertilizer due to the fertility of the land, but to those ready to otherwise use them should get the product under subsidized prices a little bit. This will go way far in encouraging the use of fertilizer, especially in those areas experiencing diminishing maize based nutrients. The subsidy programme by the national government should be working.

The analysis on household size was found to be statistically insignificant to maize production, meaning that it had no direct relationship whatsoever to the number of bags produced. However, the use of machinery was found to be significant on a negative though not by tangible margins. Not all respondents indicated that they were using tractors in ploughing. Those that did use tractors indicated total machinery costs that was way far below the expected total ploughing cost. To amalgamate the two perspectives, it can be argued that the use of machinery like tractors stands as a secondary mode of ploughing as opposed to the use of human manpower. This is the same reason why the cost of ploughing using machine expresses a negative effect on number of maize bags harvested: Because manpower was already in operation as the primary factor while use of tractors was a secondary option that is unnecessary. However, on hypothetical position it can argued that if machinery was intensified with little involvement of direct human labour, the total cost will reduce due to reduction in additional and unnecessary secondary machine usage.

Considering the argument of Ojala (2014) that production of maize in the future will depend on the youth in the society and contrasting with the analysis of findings herein which shows that most of the maize farmers are of an average of 40 years of age, it is important to start empowering the young to embrace maize farming. The current statistics places maize farming at the age of 40 years and even further indicates that the distribution is skewed towards the older age. The effect equally translate to the firm size category, with the young cultivating small pieces of land, averaging at 1 to 2 hectares. Those with large size of large include mostly from the older and elderly members of the society who again have higher disposable incomes. This findings conform to the findings of Duvel, Chiche and Steyn (2003) who arguably indicate that maize farming is for the elderly members of the society. These arguments and findings shows how sensitization of farming to the youth has not been effective yet. It is also arguable that compared to the old, the farming potential among the young people is high and that it only requires motivation and consequently exploitation of the ability.

The contribution of access to land factor in maize production is enormous. As indicated by analysis of the findings of this study, an increase in one unit of land significantly leads to more produce. However, with the small land size distribution exhibited in Trans-Nzoia County, farmers will always be producing small units of yields. This occurrence agrees with CGIAR (2016) who post that land distribution in SSA countries and especially in productive regions is a major problem. Taking Trans-Nzoia as an example to explain CGIAR's notion and considering the population distribution (Trans-Nzoia County, 2013), it is the apparent that the large population leads to sub-division of land into small sizes –whose production is limited to the small size. Small sized of land, especially non-merged ones express high operational costs that do interfere with economies of scale that can otherwise be expressed by large and continuous tracks of land. The cost of using machinery will reduce, as well as dynamics of lead timing.

It terms of climatic change, Simiyu (2014) agrees with FAO (2006) that climate change is a very important aspect and variable input to maize production. Part of the climate changes that involve changes in maize production are mentioned by Michele (2001) as change in humidity, temperature and rainfall. This study did not focus on climate change. However, taking into consideration the exposed characterization on fertilizer application which record an insignificance index of 0.202 meaning that its effects are probably by chance, it can be assumed that the occurrence of the maize yields can heavily be explained by the stable climate. In addition, it is worth noting that the County is a high-potential region with adequate and consistent rains. Perhaps, the real observation on the fertilizer could be if the climatic condition in Trans-Nzoia County was not consistently potential.

The assumption that the Trans-Nzoia County is well served with rainfall is not an abstractive idea but a conclusive reading. A reading that is justified by the Trans-Nzoia County Integrative Development Plan 2018-2022 (Trans-Nzoia County, 2018) which indicate that the county receives annual rainfall of about 1000mm to 1700mm. The report equally aligns the long and short rain seasons, adequately matching the maize planting seasons. The report equally indicates that the temperatures in the county are optimal for maize production even when the rains fall short, meaning that humidity is highly supportive. This findings on fertilizer can be aligned to Chumo (2013) who indicate that rainfall pattern and humidity highly influence maize production thereby supressing other major and important factors.

The use of technology in this study was sub-divided into the use of machinery to plough and the use of chemicals. The study found both technologies very important in maize production, though to a very small extent. In spite of its low influence, which has been termed as high by Abate (2015), use of machinery in ploughing contains a positive influence that is statistically acceptable. This findings are in agreement with Challinor et al. (2016) who insists that the effect of technology is largely felt on the costing side and not really on production rates. It is however important to understand the level of production that will prudently be mechanized by technology and become effective and efficient. For example, in large sized lands and as observed in this study, the use of technology enhances might bring about economies of scale -which is a favourable to production when cost is factored.

Extension service was also identified as one of the factors that influenced production, though in a negative manner. Studied by Yaron et al. (1992) and Ojala (2014) indicate otherwise by arguing that extension services are important especially in areas with climatic inconsistencies and farmers who lack formal education in maize production. However, the negative level of significance to maize production experienced in Trans-Nzoia County means that the farmers should prudent in introducing extension services. This is because with other factors held constant, that is, if the maize planting is done accordingly and their happens to be no uncertainties in growth conditions, then introducing extension services will only add to the total cost. It is therefore important that maize farmers introduce extension services only when it is necessary.

5.3 Conclusion

The focus of this study was to establish the factors affecting maize production among registered small scale farmers in Trans-Nzoia County. The study equally sought to establish the effects of the factors on maize production. The objective was analysed according to conclusiveness of the data collected.

All the factors were found to be important in maize production. However, the regression coefficients indicated that only land, chemical treatment, use of machinery in ploughing and extension services had a significant influence on maize production. But, the use of extension services exhibited a negative influence while the other three exhibited a positive influence. The study therefore concludes that land size, chemical treatment, use of machinery and extension services influence maize production. Consequently it is apparent that more focus should be directed to land size and use of machinery. Extension services should only be used in Trans-Nzoia County if the service are provided by the relevant institutions and are cost-free, or unless there exists a necessitating scenario.

On equal measure, chemicals are influential to maize production but should be used only when necessary. It is also important for farmers to consider the prevailing conditions of their given regions: whether the ecological and climatic conditions are sufficient and stable. This is because the preference of most of the conditioning factors are determined by the natural occurrences. For example, it is not prudent to practice irrigation on wet lands and so is the exploitation of other factors. Conclusively, the registered small scale maize farmers should exclusively exploit the factors of production based on the occurrence and the prevailing requirements.

5.4 Recommendations of the Study

Based on the finding, this study recommends that registered small scale maize farmers in Trans-Nzoia County focus on enhancing the land size factor. This can be done probably through making land use trade-off on other crops. The government should also enhance the acquisition of land for maize production through provision of focused credit and loan facilities. In an alternative suggestion, through the involvement of the ministry of land, maize famers in Trans-Nzoia County should find amicable solution to the land sub-division problem, and encourage large farm tracks. The factor of extension services should also be approached prudently to avoid unnecessary expanses that might negatively influence maize production. It is also recommended that farmers use chemical treatments only when necessary. Importantly, to enhance maize production and resolve on the issues involved, the farmer must collaborate with national and county government institutions. It also important to empower the youth to take up the maize farming activity from the elderly and embrace technology. As suggested by the farmers, the local and national governments should also assist farmers in securing loans to finance maize production and fully effect the distribution of subsidized hybrid seeds and fertilizer.

5.5 Limitations of Study

This study contains two limitations. There exists a large pool of factors affecting maize production other than those indicated in this study. The ones dealt with in this study might be the most common one, but other factors like maize prices, distribution channels and consumption trends exert substantive impact. The second limitation is based on location and the involved ecological and climatic conditions. Trans-Nzoia County is a high-potential region with fairly stable maize production conditions. Other regions might not be experiencing similar stability, therefore it is essential to understand that the findings and characterization of the factors might highly or slightly differ.

5.6 Suggestion for Further Study

This section is based on the limitations indicated in section 5.5 which underlines the limitations of the study. This study suggest that a further research involving all possible factors be conducted to establish the true position of maize production. If possible, the study should exhibit a cross-county approach involving at least one low potential area.

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APPENDICES

Appendix I: Questionnaire

Identity number. (*Assigned by the researcher*)

…………..........................

Ensure all questions are provided for.

Section A: Preliminaries ***(Kindly indicate or tick where appropriate)***

1. Sub-County Number
(1, 2, 3, 4 &5 for Saboti, Kiminini, Cherengany, Endebess, and Kwanza respectively)

…………………………

2. What is the size of your maize farm? *Kindly provide in Hectares*

A. 1-3 ha ☐ B. 4-6 ha ☐ C. 7-10 ha ☐

3. What is your exact age?

………………………………………..

4. Marital Status.

A. Married ☐ B. Single ☐ D. Divorced ☐

5. Number of dependants: Children and extended family directly under you.

A. 1-4 ☐ B. 5-7 ☐ C. 8-10 ☐ D. 11 and more ☐

6. Indicate any other crop(s) planted other than Maize crop.

……………………………………………………………..

7. Which other economic activity do you practise?

………………………………………………………………

8. What is the total income for the whole family?

KSh…………………

Section B: Production and Institutional Factors *(respond appropriately)*

9. Indicate on the occurrence of each of the factors as follows *(assess each individually)*

(a) Did you use improved maize seeds last season?

Yes ☐ No ☐

(b) Did you use graded fertilizer last season?

Yes ☐ No ☐

(c) Did you g ☐ ension se ☐ last season?

Yes ☐ No ☐

How many times did you get service extension last season?

…………………………………………

(D) Which technology do you use in ploughing, planting, tilling and irrigation?

Ploughing…………………………………………

Planting……………………………………….......

Tilling……………………………………………..

Irrigation…………………………………………..

10. Do you own the land where you plant maize or is it on lease?

☐ ☐

A. Owned B. Leased

11. Do you acquire the fertilizers on a full retail price or are they subsidized?

A. Full price ☐ B. Subsidized ☐

12. Do you perform soil testing?

A. Yes ☐ B. No ☐

If yes, how many times in the last 5 years ………………………

Section C: Factors and Maize Production

This section is based on a 2-year period and each year has two planting seasons

Factors/ Year	**2017**		**2018**		**Average**
	Season 1	**Season 2**	**Season 1**	**Season 2**	**All Seasons**
Land size (Ha)					
Seeds (Kg)					
Applied fertilizer (Kg)					
Average rainfall per season (mm)					
Household size (number of people per house)					
Extension services per season (number of times)					
Use of machines in Ploughing (cost per season)					
Chemical Treatments (cost in total per season)					
Maize Production (no. of bags)					

Note: *Seeds -Hybrid seeds be registered in kilograms as recorded by the farmer.*

-Traditional records be established as a product of 0.75 to level with hybrid ones.

14. How can these factors be improved to enhance maize production?

(*Exclude the household factor due to its natural nature –not a subject to manipulation*)

a) Access to Land

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

b) Access to Seeds

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

c) Access to fertilizer

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

d) Extension Services

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

e) Technology

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

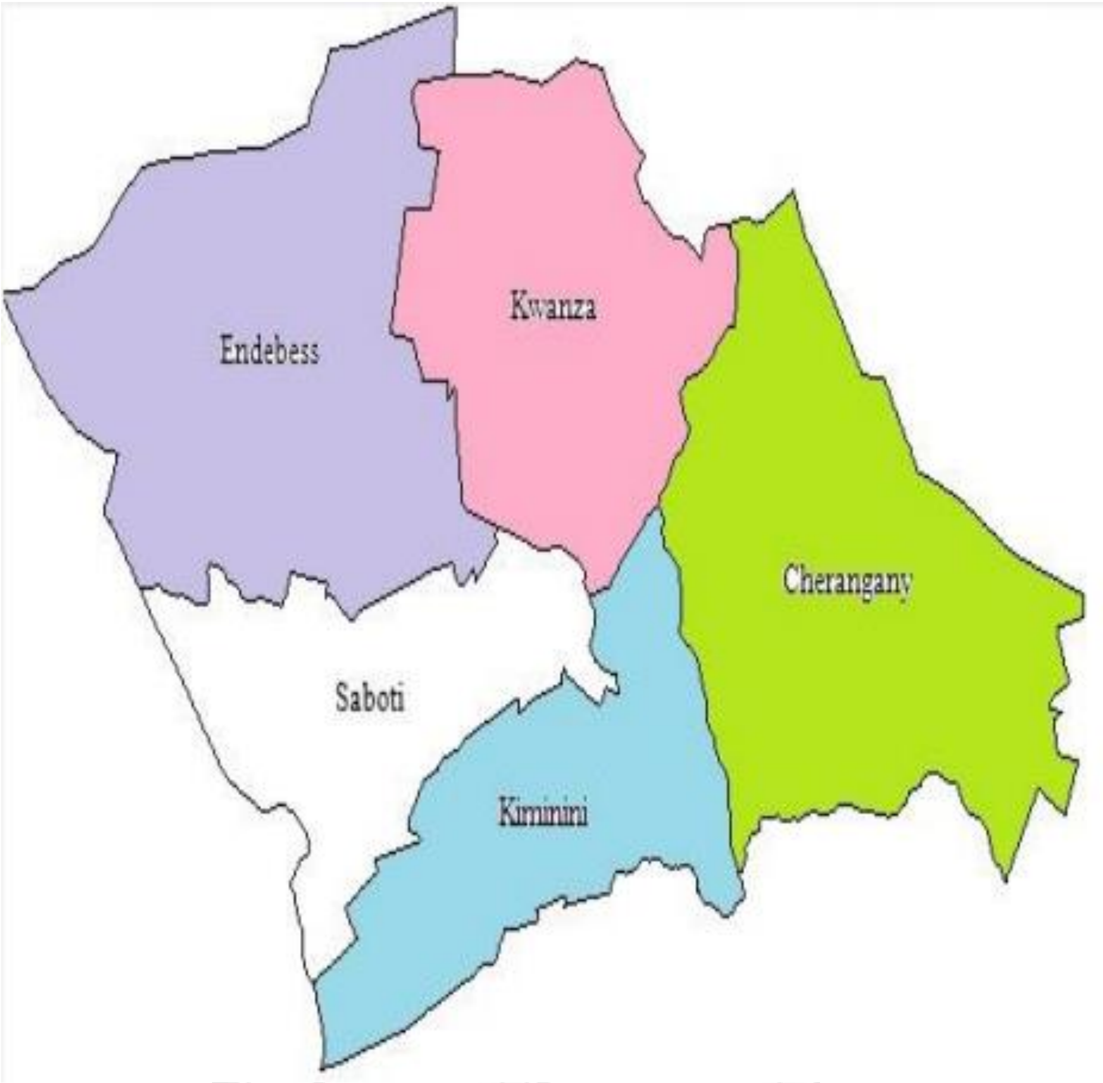
END, THANKS

Appendix II: Trans-Nzoia Sub-Counties

Appendix IIa: Location of Trans-Nzoia County in Kenya

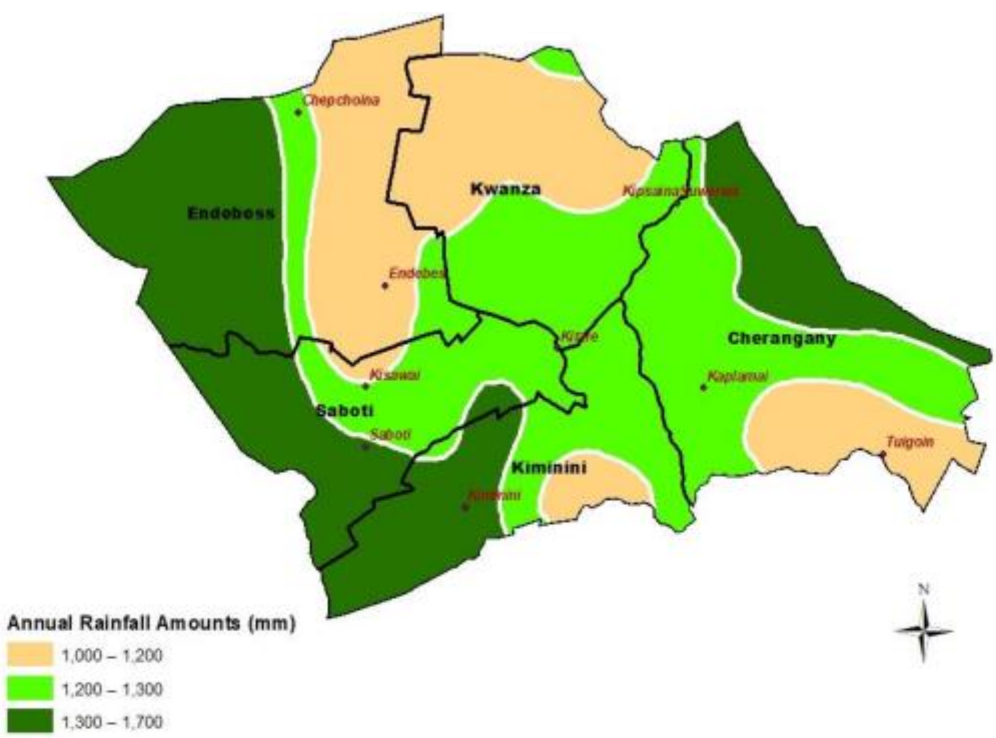
Extracted from Trans-Nzoia County Integrated Development Plan 2018-2022

Appendix IIb: Sub-Counties of Trans-Nzoia County in Kenya



Extracted from Trans-Nzoia County Integrated Development Plan 2018-2022

Appendix IIc: Trans-Nzoia County Annual Mean Rainfall



Extracted from Trans-Nzoia County Integrated Development Plan 2018-2022

Appendix III: SPSS Output

```
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  /DESCRIPTIVES MEAN STDDEV CORR SIG N
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT Q8
  /METHOD=ENTER Q1 Q2 Q3 Q4 Q5 Q6 Q7.
```

Regression

Notes

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	Split File	<none>
	N of Rows in Working Data File	184
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.
Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT Q8 /METHOD=ENTER Q1 Q2 Q3 Q4 Q5 Q6 Q7.
Resources	Processor Time	00:00:00.03
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	Additional Memory Required for Residual Plots	0 bytes