

**AN INVESTIGATION OF THE FACTORS THAT INFLUENCE SUSTAINABLE
FOOD PRODUCTION IN NYERI CENTRAL DISTRICT**

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THE REQUIREMENT OF THE AWARD OF THE DEGREE OF MASTER OF ARTS IN
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DECLARATION

I declare that this is my original work and has not been presented in any other university or any institution of higher learning for examination/academic purposes.

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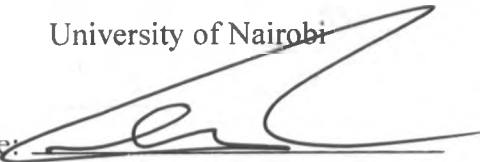
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DEDICATION

This project proposal is dedicated to my lovely family, especially my understanding sons, Maurice Githaiga and Lewis Njagi for their patience, my late Father-in-law, Joseph Githaiga for his continuous Counseling, to my mother Mary Wambui for her support and above all to my late father Peter Njagi, for seeing me through education despite the financial challenges from his severely fragmented parcel of land and to all other parents who invest in their children's education.

ABSTRACT

The current global food crisis has caused great concern and attention the world over, giving rise to a growing trend towards more sustainable agricultural practices. Researches about the sustainability of food production have so far not isolated key factors as obstacles to the issue. The major objective of the study was to investigate the factors that influence sustainable food production in Nyeri Central District, a major agricultural region in Kenya. The reviewed literature from related researchers assisted the researcher to identify the gaps in knowledge and to sharpen and deepen the conceptual framework of this study.

The target population was a sample size of 357. Data was collected through structured questionnaires, observations and interview methods. The data was analyzed using Microsoft Excel and the Statistical Package for Social Sciences (SPSS), from which bar charts and frequency tables were generated. The study findings showed that besides natural factors such as climatic conditions and population growth that hinder food sustenance, lack of access to farm inputs and credit, lack of technological innovations and above all, failure to set the minimum acreage for farming were the multitude of factors leading to unsustainability of food production in the district. However, lack of government policy was identified as the major setback towards a successful program design and implementation towards this worthy course. The result has been hunger and poverty in a district that is climatically well situated in matters of farming activities. This study recommended a greater harmonization between government agricultural policies, the agricultural extension officers and the farmers. It was also the researcher's conviction that arable land can be sustained by voluntary consolidation of household of heirs or neighbours' farms, and an immediate halt of extension of towns towards the agriculturally viable lands.

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ABBREVIATIONS AND ACRONYMS

CORDOBA DECLARATION: Venue of the World Food Summit June 2008

ECOSOC: Economic and Social Council on Global Food Crisis May 2008

FAO: Food Agricultural Organization

GDP: Gross Domestic Product

GMO: Genetically Modified Organic crops

GOK: Government of Kenya

IFAD: International Fund for Agricultural Development

IFIC: International Food Information Council

IFPRI: International Food Policy Research Institute

ILO: International Labour Office

MDGs: Millennium Development Goals

NASA: National Astronomical Space Agency.

NCPD: National Council for Population and Development

UN: United Nations

USAID: United States Agency for International Development

WB: World Bank

WFP: World Food Production

Vision 2020: An IFPRI Focus into global Food, Agriculture, and the Environment

Vision 2030: A blueprint to make Kenya globally competitive in development

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This section looked into the background of the study, the statement of the problem, purpose, objectives, research questions, significance, scope, limitations, assumptions of the study definitions of operational terms and the summary. It examined briefly the concept of sustainable food production in developing economies.

1.2 Background of the Study

Food is traditionally obtained through farming, ranching, and fishing, with hunting, foraging and other methods of subsistence locally important. More recently, there has been a growing trend towards more sustainable agricultural practices. This approach, which is partly fueled by consumer demand, encourages biodiversity, local self-reliance and organic farming methods. The world potential in attaining sustainable food production is determined primarily by soil and climatic conditions, and a complex interaction of socio-economic, cultural and technological factors such as farm sizes, level of farming inputs. It is further argued that management practices including soil conservation and enhancement, veterinary services, economic factors like market prices and access, credit availability, education and extension services also affect the food security.

According to Ahmed (2006), the current financial crisis has led many developing countries to cut their spending on agricultural research and extension. This has led to low activities in the usage of modern farming technology thus impacting on food production in the country. The other aspect is the socio-cultural conflicts that exist in the country. It is common knowledge that the size of the land in most arable areas has continued to decrease, making food production activities to suffer. The population explosion in developing economies coupled with social inclination that each member of the family must get a share of the ancestral land, has led to unviable land fragments which cannot support meaningful farming.

Kenya can learn a lot from other countries with similar problems, on what they are doing to address the issues. In investigating these factors, the information already available is of great help in shaping the direction of this research. The Kenya government is committed to attaining the Millennium Development Goals (MDGs) by the year 2015. This will to a large extent be pegged on how well the agricultural productivity could be enhanced.

The current world food crisis and the biting famine have made the country to formulate temporary measures to mitigate the problems. It is evident that the Kenyan government is finding it difficult to feed its population. The current soaring of prices of basic commodities is evident to this scenario. Most regions that were hitherto able to produce enough food have not been able to do so. Consequently, the developing economies face similar problems in their quest to have sustainable food production. Might be, with adequate funding and access to better farming methods, these countries can reverse the situation and gain sustainable food production. To meet food needs for world growing populations, development of land resources therefore should be based on integral assessment and consideration of ecological, social and economic factors (Migiros 2004).

While focusing on ecological and social considerations, development policies in the past have largely ignored the economic issues and their effects on food production. Food Agricultural Organization (FAO) has assisted member countries in finding rational solutions to various problems of land resources appraisal for planning sustainable agricultural development. This linking involves land use options with other development goals in such areas as food production, food self-sufficiency, cash crop requirements, population supporting capacity, and issues of soil fertility constraints, soil erosion risks and land degradation. In rural developing regions, farmers who have limited resources to support a large proportion of the population, dominate agricultural production. Thus, the availability of education to family farmers of agricultural research and technologies is crucial to ensuring sustainable food supply.

This research project investigated the salient factors that influence sustainable food production in Nyeri Central District of the Central province, Kenya. It was expected to shed more light on the factors that contribute to the inadequate food production in the area and that it would also guide the policy makers in formulating policies that will address sustainable food production in this region.

1.3 Statement of the Problem

Maximum world food production studies are not new, but there is an urgency to address the current global food crisis. "Clearly, global food issues are on consumer's minds," said IFIC Senior Vice President, Danielle Schor. "This year's survey shows feeding the global population is a high priority and people are thinking of long lasting solutions." (IFIC website, 2008). Inadequate food production in developing economies poses a specific problem of policy and program design. Over the last two decades, the levels of poverty and food security have decreased dramatically, resulting in a general deterioration in the standard of living of

the population. According to Malthus theory of population, since 1800, global food production has generally kept pace with population growth, but increasing numbers of humans call for new ways "to increase crop yields while preserving natural habitats and biodiversity. (Wikipedia: 15 December 2008, at 15:28). The rural poor efforts to produce food are pathetically characterized by a problem, which means that they can barely produce enough food to feed themselves. The dwindling land size as results of uncontrollable human activities spells doom to the developing economies. Given the difficult position they find themselves in, it is paramount that those governments work very hard to reverse the current situation. Past experiences, of for example over-reliance on donors to fund the rural endeavors as far as sustainable food production is concerned, clearly shows that developing economies will take time to achieve sustainable food production.

Many researches have been done on land issues especially on deforestation, but the obstacles to sustainable food production have not been adequately identified. The researches undertaken in Kenya (Omosa 1998, Ovuka 2000, Okuro 2000, Mwaniki 2004, Hermunen, 2004) have well documented reasons for widely perceived failure towards food production. Despite these well-documented concerns, the concept of sustainable food production continues to be poorly defined and therefore the research gaps. While the role of new farming technology, rural infrastructure and the agricultural product marketing chain is being better understood to the extent that clear policies are emanating from research, the same is not true regarding food production and how it can be sustained. Among the most important gaps, are lack of emphasis on food security, the roles of subsidized credit to the farmers, the social cultural dimension, land fragmentation and government policy, all of which would mitigate inadequacy of food production. All this has necessitated for a research on factors affecting sustainable food production in Nyeri Central District

Often overlooked in Kenya, is the food production in favor of cash crops. This study was conceptualized on the factors influencing sustainable food production in Nyeri Central District. The study addressed the problem of sustainability of food production, which is still eminent in Nyeri Central District, even as the country strives to achieve the MDG I and the Vision 2030 of halving hunger.

1.4 Purpose of the Study

The purpose of this study was to investigate the factors that influence sustainable food production in Nyeri Central District. It was expected to shed more light on the factors that contribute to the inadequate food production and also to guide the policy makers in formulating a policy that will address the sustainable food production in the area.

1.5 Objectives of the Study

The specific objectives of this study were:

- a) To establish the effects of land fragmentation on sustainable food production in Nyeri Central District.
- b) To evaluate how soil fertility impacts on sustainable food production in the District.
- c) To determine the effects of the access to farm inputs on the sustainability of food production in Nyeri Central District.
- d) To establish the technology in use in the production of food in the District.
- e) To assess the role of government policy towards sustainable food production in Nyeri Central District.

1.6 Research Questions.

The research questions that were addressed are:

- a) How does land fragmentation affect the sustainability of food production in Nyeri, Central District?
- b) How does soil fertility impact on sustainable food production in the District?
- c) How does the availability of farm inputs impact on the sustainability of food production in Nyeri Central District?
- d) Has the technology in use led to sustainable food production in the District?
- e) What is the role of the government towards sustainable food production in Nyeri Central District?

1.7 Justification of the study

As food prices soar and the need to feed more people with fewer resources becomes increasingly challenging, more and more people are thinking about the concept of sustainable food production and its role in feeding the world. There would be little cause to research on factors that influence sustainable food production had there been adequate food in the district. Despite its geographical position in the agriculturally rich highlands, Nyeri Central District does not experience food sustenance.

This research would therefore be important to the government of Kenya, so that the problem of food inadequacy can seriously be addressed. The findings of the study will highly sensitize the academia in this field of food security, to open up room for further research. The study would also create awareness to the farmers in the district to attempt to come up with a meaningful solution to sustainable food production. Back in 1969, Hendricks had put it, “currently there is a demand for twice as much more food than is now available in the world.” Today, 40 years down the line, the problem of food sustenance still persists, which justifies

this study to investigate those factors that influence sustainable food production in Nyeri Central District.

1.8 Significance of the Study

This study would be important to the farmers of Nyeri Central District, the government and the academia for further research. The findings would create awareness to all the stakeholders, but most significantly to the government, which would be expected to come up with a food policy towards sustainable food production. The findings of the study would be applicable Nationally, but mostly to Mount Kenya region, in which the area of study is geographically located. Most of the aspects in terms of soils, climate, land size and culture are similar.

1.9 Scope of the Study

The study was carried out in Nyeri Central District. It considered the farmers, the agricultural officers as well as the opinion leaders of the district.

1.10 Assumptions of the Study

The study assumed that the sample would be representative of the population, the data collection

Instruments would be valid in measuring the desired findings, the respondents would be available and willing to give information necessary in this research and that there would be adequate and accessible resources to carry out the research conclusively.

1.11 Limitations of the Study

Cost and time resources were the main constraints. As such, the study was limited to the eight locations of Nyeri Central District, with little differences in cultural, geographical and economic systems. . The study was conducted in a district heavily dominated by a single community and this may introduce some degree of bias. Some respondents might not have co-operated while others probably gave incorrect information. The issue of land was treated sensitively and suspiciously and might have tempted farmers to withhold the actual parcel sizes and crop yields. A sample of 349 farms was visited in the one month of research.

1.12 Delimitations of the Study

In order to reduce the limitations, the researcher worked over time and utilized the available resources in a more elaborate way. The researcher also explained clearly to the respondents why the research was being carried out in order to enhance cooperation and avoid vagueness. This reduced incorrect information. The independent variables studied were land size, soil fertility, farm inputs and technology.

1.13 Definition of the Operational Terms.

Word	Meaning
Arable land:	An area suitable for growing crops in terms of weather conditions and soils.
Biotechnology:	Is a recent method in agriculture, which is considered to increase food productivity through disease-free germ plasma. It is a tool that may bring advances that were considered impossible through conventional plant breeding,
Crop yield:	The amount of food crop produced in a given parcel of land
Per capita production:	The average harvest of crops from each plot.
Food:	Is any substance, usually composed of carbohydrates, fats, proteins and water, that can be eaten or drunk for nutrition and life sustainance. Items considered food in this study is that which is sourced from plants, mainly maize, beans and potatoes.
Food security:	Is the availability of food and one's access to it. A household is considered food-secure when its occupants do not live in fear of starvation.
Land consolidation:	Is concentration of parcels from formally scattered ones.
Land fragmentation:	Is the increasing subdivision of individually owned pieces of land into small plots.
Land size:	It simply means land area in which crop production activity is carried out.
Land suitability:	Refers to sustained land use, that is, the envisaged use of land must take into account all the degradation processes.
Population pressure:	Is a situation whereby an increase in the number of people strains the resources. Population increases, but land is always static.
Poverty:	Is the state of being unable to satisfy the basic needs of a person such as food, shelter and health services.
Soil degradation:	Is the removal of the fertile top layer through erosion causing poor crop yields.

Sustainability: Is the capacity to use what there is as at now, without compromising the needs of the same for the future- to keep an effort going continuously.

Sustainable food production: Is the ability of food systems to keep production and distribution going continuously without any marked interruption.

Sustainable food production

system: May be defined as an agric-food sector, which over the long term can produce a sufficient food supply and provide adequate rewards to primary producers

Nyeri Central District: Is a newly created administrative area (December 2008), hived from the larger Nyeri District. It is at the heart of Central Province, whose headquarters are in Nyeri town.

1.14 Summary

In this chapter, the study sought to establish the factors that influence sustainable food production. The background of the study showed that the desire for sustainable food production in Nyeri Central District couldn't be underestimated. The stated problem indicated that though many researches have been done on land issues, hardly have key factors been identified as obstacles to sustainable food production. The assumptions and the scope of the study were justified by the objectives and the questions of the research. It was expected that the study would be of significance to the farmers in the region to know how they can grow food sustainably.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter reviews the necessary literature about the concept of the study. It has reviewed the theories and the empirical review about sustainable food production. By reviewing the works of other researchers, research gaps were identified. The section therefore aimed at reviewing and presenting studies done by other researchers in the area of sustainable food production, which forms the basis of this study.

2.2 Food Crisis

The Current global food crisis has caused great concern and attention the world over. In the last two years, there have been widespread riots especially in the developing economies in Asia, Africa, Latin America and the Caribbean. The aggravation of the food crisis shows that there is chronic hunger that goes against The 1948 United Nations' Declaration, (UN) which maintains that everyone has a right to be free from hunger and to adequate food. There is a similar commitment to halve the world population who go hungry, by 2015, which was made at the UN Millennium Summit in 2000. It is also included in Millennium Development Goals (MDG 1) and also reiterated by the 2005 Summit document (Cordoba Declaration, December 2008). Globally, there are more than 900 million people throughout the world, and particularly in developing countries, who do not have enough food to meet their basic nutritional needs.

In Kenya, the food challenges facing our country has left many people with inadequate or no provision of food to eat on a regular basis due to scarcity and exorbitant prices. One only needs to look at the accelerated, and widespread increasing prices of food and agricultural products. World prices of basic food commodities have risen steeply in the last two years. The Food Agricultural Organization (FAO) food price index rose by 23 percent in 2007, and in 2008 wheat and maize prices were 130 and 30 percent higher than a year earlier. (NASA Report on Sustainable Food Production, March 2009). The poor – especially the urban poor, but also the rural landless and small-scale farmers who are not food buyers – have been most vulnerable to food price hikes, spending as they do, a high proportion of household income on food. The rise of cereals' prices, which in most cases are the staple foods of most countries, have an impact on household income by reducing the consumption of other foods

such as fruits, vegetables, eggs and fish which are rich in proteins and micronutrients (ECOSOC Report, 2008).

The problem of sustaining food production has stubbornly refused to fade away despite the many researches and recommendations that have been highlighted. The bad news is that the way we grow our food now cannot attain food security unless the main factors affecting its sustainability is addressed. There is need to stabilize food prices in order to help farmers in production planning and ensure the availability of food supplies to consumers at stable prices. Population increase and human activity cause soil degradation and might have greatly contributed to aggravation of food crisis (Mwaniki, 2004).

Amidst the growing debate and concern of the current food crisis in the country and in other developing economies, there is an obvious need to address the situation. In Kenya, the cost of maize, which is our main staple food, has been on the high due to low yields. For example, in December 2007, a packet of maize flour cost 48 shillings that shot to 120 shillings one year later. This caused cabinet crisis meetings to appease the hungry crowds especially in Nairobi slums. Prime Minister Hon. Raila Odinga in his address to the Nation warned that food prices had become a serious crisis that “has all the makings of a catastrophe”. (Daily Nation, December 1st 2008). This is in line with the sharp rise of the cost of maize flour from more than one and half times in four months, which has been occasioned by shortage of maize in the country. A clip of The New York Times, (Sunday Nation, September 7th 2008) reported that, the soaring global food prices has seen the price of wheat in Russia rise by 77 percent more between 2007 and 2008. In this respect, the attention shifts to the rural areas where land use has profound implications for food production for its people.

There is need for new research, to be geared towards more thinking about the concept of sustainable food production and its role in feeding the world. As food prices soar and the need to feed more people with fewer resources becomes increasingly challenging. The problem of hunger is evident. This contemporary global issue of food insecurity is a wake up call into more studies and policies.

2.3 Effects of Population Increase on Food Production

Since the early 1980s, per capita agricultural production has been declining steadily in the developing economies. The problem has further been aggravated by the rising population rates. Over three-fourths of the countries in sub-Saharan Africa produce less food today than in 1980s. Thus, the challenge facing the region's agriculture is to feed a population that is increasing at an annual rate of about 3 percent and yet 50 to 80 percent of sub-Saharan Africans earn their living from the land. It has been estimated that to meet this challenge, sub-

Saharan African agriculture must grow at a minimum average annual growth rate of about 4% during the next 20 to 25 years (Abalu, 1997).

A country such as Nigeria, where the population is projected to double to 244 million people by 2050, means the per capita farmland will shrink from 0.15 hectares to 0.07 hectares. According to Osei (2000), Nigeria's current prospects in food production will be far more difficult. Such practices that are prevalent in Africa will complicate the effects to expand food production. Bizimunane (2000), in his study of agricultural practice in Eastern Africa, noted that Rwanda and Uganda, once thought to have no problem with food production, have recently felt the heat of fragmentation practice now prevalent in the region. In his view, this led to food shortage in some regions, which can be attributed to population pressure. Over the last two decades, the levels of poverty and food security have decreased dramatically, resulting in a general deterioration in the standard of living of the population especially in Sub-Saharan Africa (IFAD, 2006). Per capita food and agricultural production has been inadequate in the region, and because the food and agricultural sector dominates most of her economies in terms of contribution to Gross Domestic Product (GDP), employment and incomes, its growth and development are also affected. It will therefore become quite difficult to feed a population that is increasing, and which might double in about 20 years.

Kenya has also been hit by a wave of serious land fragmentation. Food production has fallen greatly since the 1990s, due to population growth, inheritance, lack of employment and poverty. This has resulted in land ownership changing hands more frequently to a younger generation that unfortunately is disinterested in farming activities. It is predicted that at one time, sixty per cent of Kenya's population will be too young to contribute to the national economy through food production (The Republic of Kenya, 1998) Due to the limited sizes of the plots, most of the youths prefer building rental structures to make quick money to alleviate poverty.

The official incidence of rural absolute poverty is around 47 per cent and this may worsen if the current population trend continues without sufficient technological progress and other measures to counter the effects of population growth. Mwaniki (2000), reiterates that available good land in Embu is scarce, population pressures on the land are already intense in some areas and the potential for further developments in the rural areas is constrained by a number of complex factors. A similar situation is seen in Nyeri Central District where extraordinary densities of cultivation in the tightly spaced *shambas* are dominated by cash crop production. Maize, beans and bananas, which are the staple foods, take a smaller portion of the farms.

Land fragmentation in this area has made the average land parcel economically unviable, which leads to idleness and unproductivity of the farmers. Due to poverty, some people near the urban centers are even selling their pieces of land for residential plots, causing expansion of the town into more arable land. This has reduced farming space.

2.4 Effects of Education on Food Production

There is a multitude of factors leading to food insecurity, including limited availability of arable land; inadequate water supply and other environmental disasters; diseases, conflicts; and insufficient tools and infrastructure for successful agricultural production and transportation. In rural developing regions, farmers, who have limited resources to support a large proportion of the population, dominate agricultural production. Thus, the availability of education to these farmers of agricultural research and technologies is crucial to ensuring sustainable food supply.

The acquisition of education allows people to address societal issues, such as hunger, through innovation and the creation of technology. Technological and economic developments stimulate growth in countries, helping reduce the threat of hunger amongst populations. Before delineating solutions of alleviating widespread poverty in East Africa and strengthening food security, it is important to examine the peoples' way of life. In East African countries, there is a cultural emphasis on large families. According to the United States Agency for International Development (USAID, 2007) the average family size in Kenya are about six children. Women generally marry early, around the age of sixteen, and thus they begin to have children at an earlier age, leading to large family size (Kiriti, 2004). Therefore, population increase means more demands for food supply.

While education of youths is valuable, the most important factor in increasing food production in East African countries is emphasis upon farmers. Rural farmers comprise the majority of East African populations and agriculture is a main source of livelihood for eight out of ten Kenyans. (IFAD, 2006). Arable land therefore is necessary for increased agricultural production, and thus, limited availability of fertile land is a major hindrance in guaranteeing adequate food production.

Joseph Kinyua, Permanent Secretary of the Ministry of Agriculture in Kenya, explains in his April 1, 2004 report, "Towards Achieving Food Security in Kenya," that small-scale farmers account for 75% of total agricultural production, allowing them to dominate Kenya's agriculture. (Daily Nation, 2004 April 2,). Kinyua states that "small-scale farmers produce over 70% of maize, 65% of coffee, 50% of tea, 90% of sugar, 80% of milk, 85% of fish, and 70% of beef and related products" on small land holdings of two to three hectares.

Small-scale farmers highly contribute to food production in Kenya and other East African countries; thus, ensuring their access to markets and ability to export products is vital in increasing agricultural productivity. Peter Hazell, Director of the Development Strategy and Governance Division of the International Food Policy Research Institute (IFPRI, 2007) asserts the importance of this claim, "that farmers need access to land and labor, appropriate technology, and key inputs like seed and fertilizer, credit, and knowledge" to increase farm production, the first part of a marketing chain. While Kinyua explains that small-scale farmers account for 70% of agricultural output, Hazell states that market chains for Africa's domestic and interregional trade are struggling because small-scale farmers do not have access to the mentioned resources to be able to compete with subsidized imports from foreign countries. However, farmers require education so as to gain farming knowledge and marketing strategies (Kasryno, 1995).

Therefore, when farmers are educated on agricultural research, they can apply the knowledge to implement the effective farming methods to increase food production. Most farmers in the largely rural East African countries have little financial support to implement new farming methods and technologies,

2.5 The Impact of Land Fragmentation on Sustainable Food Production.

Land is man's most valuable resource, in which his existence and progress depend. In the words of Maddox (1996), "it is what people divide, occupy and assert rights to, socially and politically in order to exploit it economically" Land can be acquired through buying, inheritance, renting or as a gift. Since land is a limited resource and societies are dynamic, a farmland passes from one generation to another where it is subdivided into more or less equal parcels among the inheritors. The new demands for land and space continue to create stiff competition for the remaining stock of this resource. Land fragmentation is a common phenomenon in different parts of the world, whose patterns differ from country to country.

A few countries practice fragmentation of land use, where a household operates on separate parcels of land on a single farm, but majority, especially from the developing economies, practice fragmentation ownership where a single farm has been subdivided into plots, each with its rightful ownership. FAO recognizes the challenges given to agriculture and the food production by the diminishing sizes of farmland. During an International Federation of Surveyors Conference at Prague in 2000, Rembold argued that, the processes could arise as a result of cultural and legal traditions in form of inheritance and gifts or due to land scarcity. Violeta (2000), in her presentation at the 94th EAAE Seminar observed, "Land fragmentation is an effect of transformation from one system into another and has adverse effects on food

production” J Ridell et al (2000) affirmed that land fragmentation is a sign problem, which seriously affects rural development in terms of productivity, efficiency and competitiveness for farmers. Fragmentation of land is as a result of different factors.

In most developing economies, population growth is the major cause of land fragmentation, which shrinks the available arable lands. This impacts on food production, making it a nightmare for many households to produce adequate food to feed their families from the tiny plots. Most households are known to eat all the food from the farm before it is ready for harvest, thereby subjecting themselves to a long wait until the next season. This is due to the fact that they heavily rely on agricultural lands to feed themselves, and in the absence of enough food, they tend to suffer a lot.

In his FAO's Corporate Repository presentation, Riddell et al (2000) noted, “land fragmentation has emerged as a side effect with detrimental implications for sustainable economic growth and social development.” This was affirmed by Raghbendra (2005), who reported that generational succession in India had played a key role in perpetuating the caste system, which in the process reduced the size of land holdings. This greatly affected agricultural productivity Osei (2000) affirms that Ghana is expected to increase by 45 million people and her average farm size will reduce from 0.25 hectares to 0.09 hectares per capita. This translates to more fragmentation of land. Agricultural productivity in Nepal has been quite low and decreasing. Both production and productivity were found stagnating. The low returns for the poor yields from agriculture are mainly due to factors such as small size of holdings. (Singhadubar ,2002) . Niroula (2007) also notes,” that there is an increasing trend in the number of land parcels and a decreasing trend in the size of land parcels primarily due to hereditary tradition of equal division of land among the inheritors.

Africa has considerable arable land but highly fragmented due to the growing population size and the customary inheritance practices. In Kenya, the pressure for farming space aggravates the high rate of land fragmentation. Land fragmentation in the country's arable land areas is closely tied to cultural values and practices associated with land ownership as well as territorialism practiced by ethnic groups The other stems from the colonial period when some land was alienated for large scale expatriates and government land The practice of land subdivision between generations has contributed to extreme land fragmentation and increasing landlessness in a country where there is no clearly defined or codified National Land Policy on the minimum acreage.

Pressure on land in areas of high density such as Kisii, Meru, Vihiga, Kiambu and now Nyeri, has made the average land parcels economically and socially unviable. According to

Kenyatta, J. (1962), land in Central Province of Kenya was mainly inherited and that every inch of the Gikuyu territory had its owner, with the boundary properly fixed and fragments passed on to the sons, who were the heirs as custom demanded. Mary Omosa (1998) argues, "The subdivision of farms means that many of them are too small to provide the minimum subsistence to feed the large population."

The tightly spaced shambas constrains sustainable food production at local and National levels where a smaller area of cropland results in less food per person on average. It is unfortunate that the growth of food to feed the increasing rural and urban populations in the area of study has largely been left to the smallholder farmers. They cultivate a hectare or less of land, and produce inadequate food due to various factors that the study sought to investigate.

2.6 Impact of Soil Fertility on Sustainable Food Production.

While the question of food security is central to the creation of wealth and improvement of the livelihoods of the people globally, Africa is instead confronted with many development challenges, which require interventions in areas such as tackling poverty, hunger, malnutrition and sustainable environmental management. These four development challenges directly relate to essential wealth creation, food security, food for health and sustainable use of natural resources. The continent needs a sustainable food production system, which over the long term can simultaneously maintain environmental quality, produce a sufficient food supply and provide adequate rewards to primary producers

One of the most important ingredients of sustainable agriculture is an adequate soil resource base to provide the nutrients and moisture essential to plant growth. The increases in population density have necessitated a shortening of the fallow period, resulting in incomplete natural regeneration of the fertility of cultivated soils. For instance, Niroula (2007) maintains that over vast areas of Thailand, population pressure has forced farmers to cultivate marginal land, exposing this fragile resource to degradation. In 1981 the area of arable and permanently cropped land was 20 million ha (approximately 39% of Thailand's total land), the amount of degraded land was 17.2 million ha (33.7%)

Research therefore has a major role to play in meeting the challenge of increasing food and agricultural productivity in sub-Saharan Africa at an annual rate of about 4% over the next 20 to 25 years. Mangoa, (2007) puts it more clearly that there is rarely any harvest done to sustain the family for a season and the smallholdings are hardly left fallow to regain fertility so as to support food productivity. This leads to exhaustion and therefore quicker degradation of the soil nutrients. Sustainable agriculture is a pre-requisite for sustainable food production.

It is generally admitted that future agricultural systems in the region must be sustainable, with greater resource use efficiency, less negative impact on the environment, and improved food safety and quality. Contributions to sustainable food production in sub-Saharan Africa in the 21st century through crop improvement require envisioning the nature of future agricultural systems, as well as new technologies that are likely to enhance the efficiency of crop improvement programs in the region. Thailand has begun a strong program to restore and replenish soil. The use of leguminous cash crops in a rice-based cropping system is emphasized, providing nitrogen for the subsequent crop. Green manure crops such as sesbania are being grown before rice in areas such as the Northeast where soil organic matter is particularly low.

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Kenya is a country with an expansive contrasting landscape of about 575,000 square kilometers of land surface. However, only about 20 percent of this limited asset is arable despite the highly increasing rate of family sizes annually (GOK, 1988). Physical factors such as soil fertility and climate and a complex interaction of socio-economic, cultural and technological factors such as farm sizes, management practices, conservation enhancement and economic factors determine the potential for sustainable food production. Programmes such as restoration of soil fertility are crucial to replenish soil fertility (.FAO, 1995).

Therefore, there is need to grow adequate food, get benefits from the produce and at the same time, conserve the environment for the needs of the current and future generations.

2.7 Agricultural Productivity

Global food production, so far, has increased continuously because cropped area has expanded and productivity per unit area has increased. In the developing economies however, there is little scope for further spatial expansion of agriculture. The crop yields are instead stagnating. While there is an upper limit to food production, results of recent analysis indicate that global agriculture is still far from it (WFP, 2005). Agricultural production and related industries already are and will continue to be the backbone of economic growth and food security in most of the developing economies for the next coming decades. However, the upper limits of production of food and feed vary greatly from one region to another. The production structure of Kenya's agriculture is characterized by a dichotomy between small-scale and large-scale farms. Small-scale farms comprise the bulk of the farming population and produce mainly staple subsistence crops, with some surplus for marketing (Dutto, 1975). The crops are mainly cereals, of which maize is the staple food.

For the developing economies to be able to support increasing rural and urban populations, agricultural production needs to intensify and become more market oriented, both

domestically and internationally. To accomplish this, there is an urgent need to identify promising “bottom-up” pathways of intensification and agribusiness development. Agricultural productivity would also stimulate a growth of jobs in industries related to food, which would further develop agriculture and increase food production (Buttel 1998). . Policies for Food Security and Self-Sufficiency According to an FAO study in 37 developing economies (FAO, 1985), food security has had a major influence on agricultural policies in developing countries. In addition to ensuring stable prices, some governments have raised producer prices above market equilibrium in order to increase production for food security stocks or to achieve food self-sufficiency.

Growth in agricultural productivity would further lead to the growth of the countries' economies, since farmers could also invest and become income-generated through increased agricultural productivity in other goods and services. Not only would agricultural productivity stimulate economic development, but also improve living standards of the people many economists have recommended that developing economies should implement policies that increase food security. (Tesi 2000) emphasize that food security policies are concerned with stabilizing available food supplies from a variety of sources, rather than from increased domestic production alone, as a means of reducing the effect of import supply disruptions on prices and food consumption. Food security policies also recognize that shortfalls in domestic food production can result in increased volumes of imports and thus higher import costs.

Therefore, in the wake of the projected land reforms stipulated in the Vision 2030 document, “the transformation is expected to be dependent on a national land use policy, which therefore must be completed as a matter of urgency.”(Vision 2030 Document, 2008) The minimum acreage of land could be passed and reinforced to enhance agricultural productivity because most farmers will feel secure and supported.

2.8 Technology and Improvement of Food Productivity.

According to the International Fund for Agricultural Development (IFAD, 2006), every 3.6 seconds, a person dies of starvation. This finding illustrates the alarming state of malnutrition in the world today, and the frightening truths of poverty and hunger. This is most evident in the developing economies of Africa, where more than forty percent of the people are unable to obtain sufficient food on a daily basis (IFAD, 2007). The answer to the country's food security crisis is not the importation of food but sustainable food production. A better understanding of the driving factors and how they impact on food production is urgently needed. This will minimize the government's anxieties and announcement such as was made

by the President on Jamhuri day, (12th December 2008), that the government will release 700,000 bags to maize millers in the country to bridge the shortfall or even the World Bank, giving the country an emergency fund of Ksh.1.9 billion to reduce its food crisis. (News Media: Tuesday, 16th December 2008).

Currently, Kenya has no government policy on food security, but the proposed land reform programme might increase security of tenure, and end the ambitious and contradictory land reform programme full of presidential dictates. This was in continuation of the colonial period under the Swynnerton Plan of 1954 that envisaged the elimination of indigenous land tenure and imposition of private property rights along the lines of English Law (Morgan, 1972). During the pre-colonial period, communities owned their own land, and as Okigbo et al (1999) mentions, "in scattered homesteads among their crops and herds" From 1954, pieces of land per household were consolidated into unitary shambas. This turned people among the farming communities who had held traditional rights, into deed – holding property owners. The independent government continued with similar land reforms and today, those farms have reduced in size due to fragmentation as the inheritors have increased. The results have been among other things, disputes among the local people over the demarcation stage that delineates people's rights over land before they are registered. Where land registration has been going on in Kenya, most disputes have been noticed concerning boundaries and ownership of land occasioned by disagreements between and among family members, renegeing on previous "informal" and customary land agreements and deaths. (Hamunnen, 2004).

Jeffrey Sachs, Director of the UN Millennium Project, states that African farmers would be able use 50 kg/ha of fertilizer every four planting seasons in high potential areas, 75 kg/ha every two planting seasons in ~~me~~ medium potential areas, and 125 kg/ha every planting season in low potential areas. This is less than the levels recommended by her Ministry of Agriculture, which recommends 50-75 kg/ha, 75-125 to triple their crop yields if they add soil nutrients through fertilizers and agro-forestry. For instance, Indonesian farmers kg/ha and > 125 kg/ha for each planting season respectively. It is much less than the actual application rates in most of Java, which are often well over 100 kg/ha/ per season.

The Kenyan situation is worse for the small-scale farmers due to the poverty levels. Recent studies have shown that irrigated agriculture provides forty percent of the world's food production from seventeen percent of the cultivated area, and yields on irrigated land are often two to three times those of lands that are not irrigated (Migiro 2006). Sub-Saharan African agriculture is mainly rain fed, with irrigated agriculture accounting for only 3% of

the total cultivated area. At independence, low population densities characterized most of the region. Today the situation is changing in such a way that in many countries, it is becoming increasingly difficult to expand local food production horizontally to keep pace with the population growth (Malthus theory). Norman Borlaug, President of the Sasakawa Africa Association and a Nobel Peace Prize Laureate, states that farmers should use technologies, such as drip irrigation and the capture of water in ponds, to collect water to grow enough food in areas with little rainfall (IFIC).

There are many methods for improving environment and increasing agricultural productivity. Borlaug recommends the establishment of food-for-work types of operations that would employ food-insecure farmers in operations to improve the environment, such as the “planting of trees and grass, forest technology, and agro-forestry” to prevent erosion (FAO 2005).

Agricultural researches carried out in other developing economies also provide a variety of methods of increasing food production where farmers use these techniques to augment agricultural productivity. The governments of Ghana, Thailand and India have invested in programs to financially support the farmers and provide the technologies and infrastructure to enact efficient agricultural methods. (Kouame' 2003) This will enable the farmers to apply the methods found from agricultural research, to ultimately increase food production. Income, generated from increased agricultural productivity would therefore stimulate growth, because farmers would have the financial resources to invest in technologies, hired labor, and more efficient farming practices that would increase agricultural productivity. Researches done in Africa show that though men own the land; African farmers are mainly women. Smallholder farmers who dominate the agricultural sector (Namanga, 2009: Daily Nation, Aug 6,pg 11).

Farming technologies such as biotechnology are also important in the production of disease-free germ plasma and for disease diagnosis of crops. Innovative approaches through biotechnology and farmers' participation should be used as appropriate additional tools for plant breeders to improve the efficiency of the breeding process for sustainable agricultural systems. (John,2002) Countries such as Ghana have succeeded in Genetically Modified Organic crops (GMO) crop production measure against hunger whereas mixed cropping systems and agro forestry are some of the ways used by various countries to improve food productivity. However, a huge amount of technology generated by research has not been accepted by farmers, simply because farmers feel that it is impractical.

FAO maintains that it is important that technology should be tested under farm conditions, and recommendations should be made only in consultation with farmers. Technology that

sustains productivity at a lower cost and does not harm the environment needs to be developed. (FAO, 1995) For example, plant breeding in Thailand aims at selecting crops adapted to environmental constraints. These are crops that are adapted to local conditions, including climatic factors, mineral stress and soil toxicity, and should have durable resistance to most important pests.

The only way for countries to survive in this more competitive world market situation is to improve their competitiveness, by acquiring better technology to increase their efficiency (ILO, 1985) To survive in the more competitive world market, each country must improve its competitiveness by acquiring better technology to increase efficiency.

Kenya is behind in adapting to new technologies of food production especially in the growth of G M O crops, whose fear is their side effects, though yet to be manifested. Economists such as Borlaug suggest that each country should focus on the production of commodities in which it has a comparative advantage. In the wake of change of attitude to embrace biotechnology in the rural areas, sustainable food production might just be a reality, whereby the farmers will grow for both domestic and commercial purposes.

2.9 Government Policy towards Sustainable Food Production

Kenya has no clearly defined national land policy, which leaves the land issue very complex and sensitive – a key reason for the struggle for independence in the 1950s, and as James Orendo, the Minister for land and settlement rightly observed, “Regular ethnic clashes every 5 years in some parts of the country is partly due to this”. (Daily Nation May 23rd 2008). In 1999, the Population Reference Bureau (2002) gave the population of Kenya as 29.8 million, a birth rate of 34 per 1,000 populations and a death rate of 14 per 1,000 populations. This translated to a population growth of 2.9 per cent. per annum. A high fertility rate means, demand for more food and which may also translate into low per capita income. It has further been projected that by the year 2020, 300 million people in sub-Saharan Africa will be living in poverty, and that by the end of this decade, almost one-third of the developing world’s poor will be found in sub-Saharan Africa Abalu (1997) Poverty in our country is generally high where most of the people live below the poverty line.

The average family size for Kenya was 4.4 compared with the average for less developed countries of 2.17. With the current preparations under way for 2009 National census, the population figures are projected to be quite high. The World Bank (2005) ranked Kenya as the 19th poorest nation in the world with a per capita income of US \$250. Even with the current average fertility rates, the population in Kenya will at least double in 34 years. With a declining GDP, as has been the Kenyan trend over the last couple of years, and declining

contributions of the agricultural sector to Gross Domestic Product, this may translate into much lower standards of living for the future generations (Kiriti, 2004, pg 4). High population levels will lead to resource-depleting effects, at the expense of future generations, and food sustainability will obviously be an issue.

Our National objectives of the 1965's Sessional Paper No 10, which aimed at fighting poverty, hunger and disease, have been elusive mainly due to lack of government policy and population pressure. The Millennium Development Goals (MDGs) are currently the global strategies whose aims among other things, is to halve hunger and poverty by 2015. The goals are supposed to be realized through Vision 2030, which targets increasing productivity of crops and livestock. According to Omosa (1998), there is an assumption within Kenya's policy goals that sustainable food production at national level will automatically translate into food security at the household level. The assumption is that by both engaging in food cultivation and investing their land in related resources in those farm activities, households could meet their food needs with a surplus for sale. Where they enjoy a comparative advantage, households could work towards generating a cash income with which they can then acquire their food needs on the market. National food policy that aims at avoidance of food imports has not translated into food security for all, especially in the rural areas of the country. The aforementioned assumption ignores the fact that food security at the household level is a combination of many things. It is a function of accessibility, affordability, availability and adequate supply of nutritionally balanced food at all times. Discontinuities in the food supply impose severe costs at several levels. At the household level, especially in production systems where many families live by a subsistence economy, discontinuities in production threaten the nutritional status of both rural people and the poor among the urban population, and tend to increase inequality in the distribution of wealth and income.

If the government could come up with a working policy on food security through sustainable food production, farmers would embrace it, especially when subsidized support and direction is given.

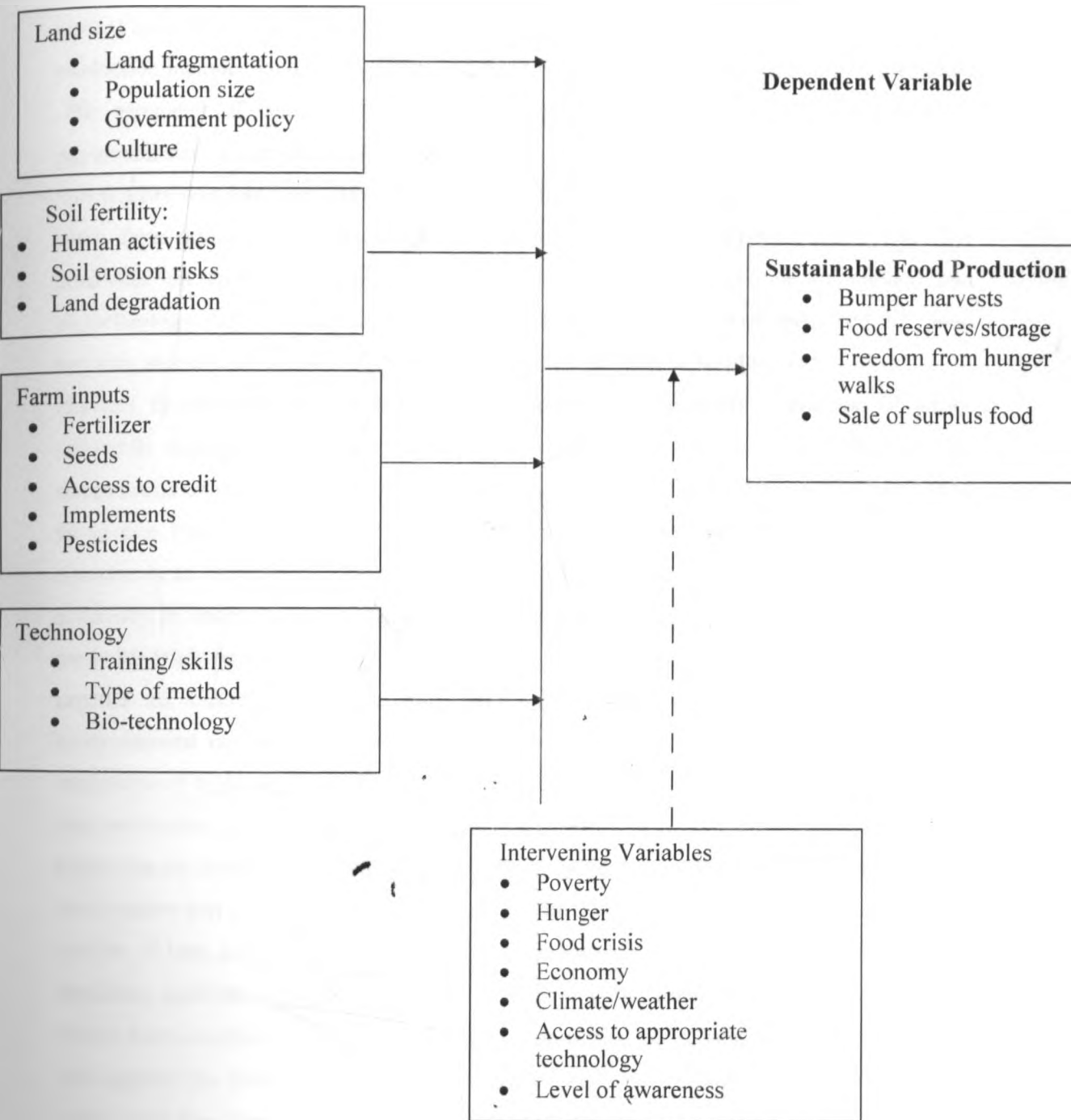
2.10 The Conceptual Framework

The Conceptual Framework Model represents the relationship between the dependent variable and the independent variables. In this case, there are various major variables and their possible patterns of influence on sustainability of food production. This structural model further indicates that the land size, the soil fertility, farm inputs and the use of technology in farming, mostly affect the sustainability of food production in Kenya. In the context of the conceptual framework, the theoretical underpinning of the study is that the sustainability of food production in Kenya is a complex multi-faceted process that involves the interplay of various issues. When sustainable food production is held constant, the independent variables influence it in terms of land size, human activities, and access to credit to purchase certified seeds, implements, chemicals and fertilizers. However, without the necessary technological skills such as simple irrigation, sustainable food production is hard to be achieved. The problem is aggravated by the intervening factors such as poverty, hunger and level of awareness, which to a great extent causes food crisis. High population levels will lead to resource-depleting effects may be, at the expense of future generations.

The variables identified in the study are expected to prove that natural phenomena such as climatic conditions are not the entire causes of unsustainability of food production. The blame is mostly on other human factors that can be avoided. If all stakeholders introduced working mitigating interplays, sustainable food production in the country can be achieved, hence guaranteeing food security. (Figure 2.1).

Figure 2.1: The Conceptual Framework

Independent Variables



2.11 Operational Definition of Variables

The purpose of operationalization of the variables was to develop measurements that would be used to measure parameters that had the best indicators that sought to answer the research topic.(Figure 2.2) The parameters that the researcher used to measure sustainable food production included land size, soil fertility, farm inputs, technology and access to information .The parameter of land size was measured by using statistics on land fragmentation, population size, government policy and culture.

Soil fertility was measured through human activities, soil erosion risks and land degradation, while farm inputs were measured by use of fertilizers, seeds and access to credit. The parameter on technology was measured through training skills, type of method and biotechnology. The parameter of sustainable food production was measured by good harvests, stored food, freedom from hunger walks and selling the surplus food.

Physical factors such as soil fertility and climate and a complex interaction of socio-economic, cultural and technological factors such as farm sizes, management practices, conservation enhancement and economic factors determine the potential for sustainable food production The only way for a country to survive in this more competitive world economic situation is to improve its competitiveness, by acquiring better technology to increase its efficiency in order to sustain agricultural development in general and food production in particular.High population levels will lead to resource-depleting effects, may be, at the expense of future generations, and food sustainability will obviously be an issue Environmental degradation, competition for resources, increasing food demands, and the integration of agriculture into the international economy threaten the sustainability of many food production systems (Table 2.1).

Kenya has no clearly defined National land policy, which leaves the land issue very complex and sensitive and a mark off sustainable food production. There is an increasing trend in the number of land parcels and a decreasing trend in the size of land parcels primarily due to hereditary tradition of equal division of land among the inheritors. The aforementioned factors have contributed to the current aggravation of the food crisis, whose chronic hunger goes against The 1948 United Nations' declaration, (UN) which maintains that everyone has a right to be free from hunger and to adequate food.

Table 2.1: Operational Definition of Variables

Variables	Operationalization indicators	Measure
Land size	<ul style="list-style-type: none"> • Land fragmentation • Population size • Government policy • Culture 	<ul style="list-style-type: none"> • Nominal scale • Interval scale • Nominal scale • Nominal scale
Soil fertility:	<ul style="list-style-type: none"> • Human activities • Soil erosion risks • Land degradation 	<ul style="list-style-type: none"> • Nominal scale • Nominal scale • Nominal scale
Farm inputs	<ul style="list-style-type: none"> • Fertilizer • Seeds • Access to credit 	<ul style="list-style-type: none"> • Nominal scale • Nominal scale • Nominal scale
Technology	<ul style="list-style-type: none"> • Training/ skills • Type of method • Bio-technology 	<ul style="list-style-type: none"> • Nominal scale • Nominal scale • Nominal scale
Sustainable Food Production	<ul style="list-style-type: none"> • Bumper harvests • Food reserves/storage • Freedom from hunger walks • Sale of Surplus, food 	<ul style="list-style-type: none"> • Nominal scale • Nominal scale • Ordinal scale • Nominal scale

2.12 Summary

The literature was reviewed to identify the gaps in knowledge towards sustainable food production, in terms of food crisis, land fragmentation, population and food production, agricultural productivity, sustainable food production systems, improving food productivity, use of technology and government policy. The research gaps showed that though many research studies have been done on land issues, in areas such as deforestation, subsidized credit to the farmers and agricultural product marketing chain, the findings do not adequately tackle the obstacles to sustainable food production. Thus, the concept of sustainable food production continues to be poorly defined and therefore the research gaps. This has necessitated for a research on factors affecting sustainable food production in Nyeri Central District.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section introduces how the study was conducted with the aim of obtaining the required information. It contains a detailed explanation of how the study was implemented. It also gives insight into the research design, study population, source of data, data collection methods and techniques, data analysis techniques and the report.

3.2 Research Design

The study adopted a descriptive research design aimed at explaining the relationship between the research questions and the various independent variables identified. This approach was considered to be valuable in assessing and collecting data for this particular study because it is suitable for an in-depth study of the target population. According to Gay (1990), descriptive research involves collecting data in order to test hypotheses or to answer questions concerning the current status of the subject of the study. A descriptive study determines and reports the way the variables appeared to be.

3.3 Target Population

The target population of the study was all the farmers within the district. Nyeri central district is made of two divisions namely Tetu and Municipality. There are two locations in Nyeri town and six in Tetu division that form the Nyeri central district. These are Kiganjo and Mukaro in Nyeri Town and Aguthi, Gaaki, Karundu, Muhoya, Tetu and Thegenge in Tetu Division. This study considered a farmer to have come from each household; therefore it used households as the basis of getting the population of the study. The number of households in the division according to 1999 census was 5000. According to Gay (1990), population is the group of interest to the study, the group to which the results of the study will be generalizable. The population has at least one characteristic, which differentiates it from others. The total population included all the farmers in Nyeri Central District and since it wasn't possible to visit every farm, a sample size was determined from the total population. The researcher interviewed 349 farmers in the district and 8 agricultural officers, making a total sample of 357. (Table 3.1)

Table 3.1: Target Population.

Location	No. of households
Kiganjo	600
Mukaro	500
Karundu,	350
Muhoya	800
Aguthi	900
Thegenge	750
Gaaki,	600
Tetu	560
Total	5000

3.4 Sampling Design and Procedure

This study used probability-sampling method. According to Kathuri ed. (1993), a sampling procedure should be used to determine the needed size of a randomly chosen sample. In this method, every item in the universe has a known chance or probability of being chosen for the sample. This method implies that the selection of sample items is independent of the person making the study and that the sampling operation is controlled objectively. As table 3.1.shows, the number of households in the district was 5000.The matrix table, 3.3 was used to identify the sample size, as is shown on page 30.

The sample size that corresponded to 5000 was 357. Since there were 8 agricultural officers who were directly identified from the targeted locations, the remaining 349 respondents came from the farmers. A sample of 349 households were chosen at a random, as follows; first the households in the district were stratified into eight (8) locations and then by the use of cluster sampling, identified sections where simple random sampling generated about 44 households from every location. This was intended to give a wide range of farmers in the district. At the same time, the eight (8) Zonal Agricultural Officers were directly identified as part of the sample. Table 3.2 shows the sampling procedure.

Table 3.2 Sampling Design

Location	No. of households	Sample size
Kiganjo	600	42
Mukaro	500	36
Karundu,	350	25
Muhoya	800	56
Aguthi	900	63
Thegenge	750	53
Gaaki,	600	42
Tetu	560	40
Total	5000	357

Due to the population size, it wasn't possible to study the whole population. Instead, a sample was selected from the universal population. In order to facilitate generalization, a lot of attention was given to selecting a sample that was as representative of the population as possible. The sample size was determined by the use of the following formula.

$$n = \frac{Z^2 pq}{d^2}$$

n= the sample size

Z = the standard normal deviation

P=the proportion of the target population

q= 1-p

d=the level of statistical significance

The following table shows the required size for the randomly chosen samples.

It determines the needed size of a randomly chosen sample from a given finite population of N cases such that the sample proportion P will be within plus or minus .05 of the population proportion P with a 95 percent level of confidence.

Table 3.3 Sampling Procedure Matrix

N	S	N	S	N	S
10	10	320	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302

25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	241	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	100000	384

N= population size; S= sample size

Adapted from: Kathuri N.J and Pals D.A (1993) *Introduction to Educational Research*.
Agricultural Education and Extension, Pg 55.

3.5 Data Collection Methods

Data was collected through questionnaires, interviews and observations. In addition, archival information in the form of previous surveys information was obtained. Questionnaires were first pretested in fewer numbers in each location before the main fieldwork. Most of the structured and non-structured interviews were carried out during the main project. The study also employed observations especially in the farms to find out the type of crops and farming practices that the farmers carried out. This secondary data was acquired from the Library, the Provincial, District and Zonal Ministry of Agriculture Offices and the District Lands Office.

3.6 Data Collection Procedures

Questionnaires, which had both open ended and closed ended questions, were used to collect data from the respondents, through an interview guide. Questionnaires were administered in two ways. The dominant one was the individual interview, where most farmers were taken through. A few others were left to the busy literate respondents, to be picked after 3 days. Both the farmers and the agricultural officers were involved in this drop and pick method. As Kathuri, (1993) stated, it helped to establish rapport with the respondents. The method enabled the study to collect data that would otherwise have been difficult to get.

3.7 Validity and reliability

A few questionnaires, which were similar to the actual sample of this study, were first pre-tested to a selected sample. The procedure of pre-testing was also similar to the one of the actual data collection. Pre-testing the questionnaire enabled the researcher to note aspects that had not been addressed adequately in the questionnaire. Once aspects such as the role of cultural inheritance and that of soil fertility were identified, changes were made in the main measuring tool.

3.8 Data Analysis Methods.

In the proposed study, both qualitative and quantitative data was collected. Mugenda and Mugenda (1999) say that in order to save time and to increase the accuracy of the results, a computer should be used. The data was organized as per the response of each question, after which it was edited, coded and entered into the Microsoft Excel and the Statistical Package for Social Sciences (SPSS) computer program for data analysis. The data was interpreted and an inference made, which was then presented descriptively using tables.

3.9 Ethical Issues

Confidentiality was paramount in the undertaking of the study. As such, a letter assuring the respondents that their responses would be treated in total confidence was issued. The researcher ensured that she kept time as far as appointments were concerned and the research conducted at the convenience of the respondents. The researcher is now under moral obligation to utilize the information obtained for the purposes of this study only.

3.10 Summary.

This research used descriptive research design. The target population consisted of all the farmers in the district. This study used probability-sampling method. A sample of 349 households was chosen at a random, first the households were stratified into eight locations and then through cluster sampling, generated 44 households from every location. Data was collected through questionnaires, interviews and observations and was later analyzed by use of Microsoft Excel and the Statistical Package for Social Sciences (SPSS). It was then interpreted, inferences made and findings presented in frequency tables.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents the findings of the data collected from the sampled farmers and agricultural officers in Nyeri Central District on factors that influence sustainable food production. The section also provides results and discussions of the findings and data analysis of the study. The discussion is linked to the questions of the study and research objectives to determine the factors that influence sustainable food production in Nyeri Central District.

The data was interpreted according to the research questions. The analysis was done through descriptive statistics and findings of the study were presented in form of frequency tables. The discussion of the outcomes is based on the outputs from Microsoft Excel and the Statistical Packages for Social Science (SPSS).

4.2 Background Information of the Farmers in Nyeri Central District

The study sought to find the background information of the farmers so as to form a basis of the expected responses. Their gender, age and level of education were asked. The correlation between the age and education of the farmers was also calculated.

4.2.1 Respondents by Gender

The study revealed that majority of the respondents was males. The male response accounted for 58.2% by the farmers and 62.5% by the agricultural officers. Meanwhile, the female response accounted for 41.8% and 37.5% by the farmers and agricultural officer's respectively.

This shows that there were more men involved in farming than the females. However, the study found out that in Nyeri Central District, majority of the farmers were men who mainly own the farms but are not necessarily the ones who till the land. The expectations were that equal and number of gender would be involved in the growth of food in the households.

Table 4.1 shows the distribution of the respondents by gender.

Table 4.1 Respondents by Gender

Gender	Farmers	Agricultural officers	Total
Male	203 (58.2)	5 (62.5)	208
Female	146 (41.8)	3(37.5)	149
Total	349 (100.0)	8(100)	357

4.2.2 Age Group of the Farmers

The age group that was mainly involved in farming lay between 36-45 years. This was about 40.1 % with those above 46years accounting for 31.5%. The rest that was partly 20%, were the youths of between 18 yrs and 35 yrs.

From the study, it is concluded that the young and energetic adults have shunned farming, leaving the older people to toil the farms. A change of attitude is needed if sustainable food is to become a reality. Table 4.2 represents the age group of the farmers.

Table 4.2 Age Group of the Farmers

Age	Frequency	Percent
18-25	33	9.4
26-35	66	18.9
36-45	140	40.1
Above 46	110	31.5
Total	349	100.0

4.2.3 Level of Education of the Farmers

The level of education for both the farmers and the agricultural officers, may explain how easy or hard it may be to tackle the problem of food shortage. The study looked into this with the view of establishing their level of education.

The study showed that 51.0% of the farmers in Nyeri Central District have secondary level of education, with 34.8% and 14.2% representing primary and tertiary education level respectively. This information shows that the farmers and the agricultural Officers have adequate levels of education, which could be useful in creating awareness of improved farming activities in the district. Figure 4.3 depicts these findings.

Table 4.3 Education Levels of the Farmers

Education Level	Farmers	Agric. Officer	Total
Primary	119 (34.8%)	0 (0.0%)	119
Secondary	176 (51.0%)	1 (12.5%)	177
Tertiary	54 (14.2%)	7 (87.5%)	61
Total	349 (100.0%)	8	357

The degree of association between the age group and education level of the farmers shows a moderate negative relationship of -0.58 . This means that as the age group increases, the level of education decreases. Table 4.4 shows this correlation.

Table 4.4 Correlation Table of Age Group and Level of Education of the Farmers

Correlation	Age Group	Education Level
Age group	1.000	-0.58
Education level	-0.58	1.000

4.3 The Effects of Land Fragmentation on Sustainable Food Production

Land fragmentation in a given area may explain the degree of the sustainability of food production. The study looked into this by establishing the methods that were used in the acquisition of land by the farmers and their land sizes in terms of acreage. The findings are presented in tables 4.5 and 4.6.

4.3.1 The Method of Land Acquisition

The usage of land may be affected by the manner in which land is acquired. The research sought to establish the way land was acquired and the way it is being used for agricultural purposes in-order to understand the relationship. The findings of the study showed that 89.1% of the farmers inherited their land while only 10.9% bought the land.

From the study, it is concluded that majority of the farmers in the district got their pieces of land through inheritance, and that the still family- owned parcels are awaiting further fragmentation. This may largely explain why some members may not be utilizing the land maximally. A member of the family may feel that there is no point in putting much input into a piece of land that may eventually end up with another family member when inheritance is finally put into effect. The findings of the study are shown in frequency table 4.5

Table 4.5 The Method of Land Acquisition

Land Acquisition Method	Frequency	Percent
Through inheritance	315	89.1%
Through buying	34	10.9%
Total	349	100.0%

4.3.2 Land Acreage

Land fragmentation in this study was viewed as a strong factor that has greatly affected sustainable food production. This, as shown in figure 4.3.1 is evidenced by the land acreage that a farmer uses for farming, Out of 349 respondents, the study targeted the majority who own between one and two acres of land. This accounted for 50.1%, with 39.6% owning between 3-5 acres. This cumulatively accounts for 89.7% of the respondents. The rest, which totals 10% owns above 6 acres.

The study showed that in general, land holdings in Nyeri Central District ranged from a low of 2 acres which leads the study to conclude that majority of the farmers, may not be producing enough food to sustain them. Their tightly spaced shambas constrains sustainable food production where a smaller area of cropland results in less food per person on average. The research findings are shown on table 4.6.

Table 4.6 Size of Land in Acres

Size of Land	Frequency	Percent
Less than 2 Acres	175	50.1
Between 3 & 5 Acres	137	39.6
Between 6 & 8 Acres	28	7.8
Over 8 Acres	9	2.5
Total	349	100.0

4.4 Impacts of Land Fragmentation on Food Production in the District

The farmers were asked to give their opinion on the impact of land fragmentation on food production in the area in the light of reduction of arable land, and the types and amount of food crops grown.

4.4.1 Impact on Arable Land

Most of the respondents who accounted for 54.4% reported that land fragmentation reduced arable land in different ways. One of the responses that featured most was that the plots are demarcated as per the number of heirs, who end up putting up more houses on the otherwise cultivable pieces. On the other hand, 36.3% of the respondents stated that land fragmentation led to poor food production since the acreage size is too small to practice any meaningful

farming. Meanwhile, 5.1% of the respondents reported that land fragmentation had no impact at all, while 4.2% had no idea of the issue. The study identified land fragmentation in the country's arable land areas as a closely tied factor to population pressure and the cultural inheritance practices. Land fragmentation was also identified as a cause of land degradation in the area of study. This means that farmers hardly plant trees because every space was meant for growing food. Figure 4.7 represents the responses to impacts of land fragmentation.

Table 4.7 Impacts of Land Fragmentation

Impacts	Frequency	Percent
Reduced arable land	185	54.4
Led to poor food production	133	36.3
No impact at all	17	5.1
Have no idea	14	4.2
Total	349	100.0

4.4.2 Types of Crops Grown

The farmers were asked to state whether they grew food crops, cash crops or both in their land. The study revealed that most farmers in the area grow both cash and food crops. This accounted for 38.1% of the respondents. However an almost equal percentage of the respondents grow cash crops. All the households cultivated maize as the staple food crop while a few others also grew some beans and potatoes. The study shows that there is a bias in area to grow cash compared to food crops. Table 4.8 represents this information.

Table 4.8 Types of Crops grown

Types of Crops	Frequency	Percent
Cash crops	133	38.1
Food crops	88	25.2
Both cash crops and food crops	125	35.8
None of the above	3	0.8
Total	349	100.0

4.4.3 Amount of Food Crops Grown

When the farmers were asked whether they grow enough food to sustain themselves, 86% of the respondents said they grew inadequate food while 14% said that they grew enough food. Majority of them further said that the main reasons why they do not grow enough food is due to a combination of poor soil, inability to afford proper seeds and small land size. The extension officers confirmed this scenario. They stated that the fragmentation of land has made farmers grow inadequate food to meet their needs. Of the eight extension officers that the study targeted, 79.4% said that land size is the biggest hindrance to achieving sustainable food levels.

The study concludes that most that most farmers in Nyeri Central District do not produce adequate food to feed their families from the tiny plots. Most households are known to eat all the food from the farm before it is ready for harvest, thereby subjecting themselves to a long wait until the next season. Table 4.9 shows the findings of the amount of crops grown.

Table 4.9 Amount of Food Crops Grown

Amount of food Crops	Frequency	Percent
Yes	48	14.0
No	301	86.0
Total	349	100.0

4.5 Impact of Soil Fertility on Sustainable Food Production

Soil fertility determines the type and the amount of crops being grown in an area. This ultimately explains whether a region is able to have sustainable food production or not. The study sought to get answers for the soil fertility by determining whether the farmers apply manure or fertilizers in their lands, the type of farming practice and the common farming methods they used. The following are the findings of the impact of soil on sustainable food production.

4.5.1 Application of Manure

The study revealed that 61.8% apply manure in their farms with only 38.2% responding in the negative. This means that majority of the farms are relatively fertile as a result of the continuous addition of manure that boosts soil fertility. When the same farmers were asked about how often they apply the manure, majority, who accounted for 56.4% replied that they do it very often. The agricultural officers, who often visit the farmers to advise them on application of manures to their farms, affirmed the same.

However, the study found out that the farmers in Nyeri Central District apply fertilizers and manure to a large extent, though they might be underrating or overrating the amounts per acre. The study concludes that the application modes, the type and the amount definitely have an impact on sustainability of food production. Figure 4.10 represents the frequency of the farmers who apply manure in their farms.

Table 4.10 Application of Manure

Application of Manure	Frequency	Percent
Yes	218	61.8
No	132	38.2
Total	349	100.0

4.5.2 Farming Practice

The kind of farming practices adopted in an area explains the fertility of the soil, which in turn translates to productivity of the land. The study sought to establish the practice of farming in the district with the view of finding out whether it has any impact on sustainable food production in terms of soil fertility. Out of the 349 farmers, 203 responded that they practice inter-cropping, 128 practiced mono-cropping while 18 did not practice any of the two forms of farming practices. The study found that most of the agricultural land throughout Nyeri Central District was over cropped. Farmers grow all manner of food crops on a single plot in a mixed form. For example, the study identified maize, beans, sweet potatoes and bananas being grown together. A relatively good number subdivided their plots and grew the food crops separately from the cash crops. For instance, coffee in the lower areas and tea in the higher zones, were mono-cropped away from the cereals and the vegetables. There is need to employ proper farming methods so as to sustain food productivity. Figure 4.11 represents the findings of the farming practices.

Table 4.11 Practices of farming

Farming Practices	Frequency	Percent
Inter-cropping	203	58.4
Mono-cropping	128	36.3
None	18	5.3
Total	349	100.0

4.5.3 Farming Methods

The farmers were asked the extent to which they agree with the statement. About 37.5% were found to strongly agree with the statement, 22.4% agreed while the rest either disagreed or were indifferent. The study concludes that the agricultural officers in Nyeri Central District need to be more vigilant in their agricultural advisory work. The farmers need to put more efforts in conserving the environment for effective food sustainability. By planting of crop-friendly trees and more terracing, the topsoil in the sloppy areas will be sustained. The findings of the farming methods are shown in table 4.12

Table 4.12 Effects of Farming Methods

Farming Methods	Frequency	Percent
Strongly agree	130	37.5
Agree	77	22.4
Disagree	72	20.5
Strongly Disagree	52	14.3
Indifferent	18	5.6
Total	349	100.0

4.6 Effects of the Access to Farm Inputs on the Sustainability of Food production

Access to farm inputs is viewed in this study as a determinant to attaining sustainable food production in Nyeri Central District. The study measured this variable in terms of the use of certified seeds and access to credit.

4.6.1 Use of Certified Seeds

The farmers were asked whether they use certified seeds. About 69.3% confessed they do not use certified seeds when planting, while 30.7% were found to be using certified seeds. Most farmers expressed interest in their use, but cited poverty levels. They claimed to have no access to credit to buy these seeds.

The study concluded that, with the poverty levels in the rural areas, most of the small-scale farmers do not have access to the most needed resources. As a result, a farmer can hardly afford the required inputs to improve the crop yields. The big number of the farmers that were found in the district not using certified seeds might explain why the region does not sustain itself in food production. The findings are presented in the table 4.13

Table 4.13 Use certified seeds

Use of certified seeds	Frequency	Percentage
YES	106	30.7
NO	243	69.3
TOTAL	349	100

4.7 Effects of Technology on Production of Food in the District

The technology in use in any region mostly determines the level of productivity in the area. The study sought to find out the extent to which the available farming technology is in use since it is known to boost farming practices. The study revealed that majority of the farmers does not use irrigation technology at all. About 64.2% of the respondents were found not to use it at all while 21.7% were found to be using it to some extent. The agricultural officers who accounted for about 56.5% confirmed that irrigation is not widely used. They cited lack of planning by the government as well as lack of creativity by the farmers.

The study concludes that the farmers should take advantage of the different technologies that are available in the region such as drip irrigation and the capture of water in ponds. This will enhance the efficiency of crop improvement programs technologies, in ponds, in which water. Table 4.14 shows the extent on the use of technology.

Table 4.14 Extent on the use of technology by the farmers

Use of Technology	Frequency	Percent
Greatly	15	3.3
Moderately	34	9.8
Some Extent	77	21.7
Not at All	223	64.2
Total	349	100

4.8 Government Policy towards Sustainable Food Production

The government policy on sustainable food production normally gives direction on how and what should be done. The farmers are normally called upon to grow food crops that are best suited by the weather and the soil types. The study sought to know whether there is such a

policy to guide sustainable food production in the district and whether food sustainability can be a reality in the district.

4.8.1 Policy on Minimum Land Size

Being the implementers of the government directives on agricultural issues in the district, the agricultural officers were asked whether there is any policy on land size in the area. The study found out that there is neither any minimum land size policy that has been established in the country, nor is there any on credit accessibility. However majority were of the opinion that sustainable food production in the district is a reality.

4.8.2 Reality of Food Sustainability

On the reality of food sustainability 87.5% of the agricultural officers said that it is very possible in the district. The study found that the farmers were ready to embrace any support by the government especially in terms of access to credit to buy farm inputs.

The study concluded that with the proposed land reform policy by the Ministry of Lands and Settlement (2009), there should be increase in security of land tenure. If the minimum land size is fixed, fragmentation will be minimal and there might be more access to credit for farmers to practice meaningful farming. This means that with concerted efforts among all the stakeholders, food unsustainability will be a thing of the past. Table 4.15 depicts the findings of reality of food sustainability.

Table 4.15 Reality of Food Sustainability

Food sustainability	Frequency	Percent (%)
Very possible	7	87.5
Possible	1	12.5
Total	8	100.0

4.9 Summary

The chapter dealt with data analysis, presentation and interpretation. The data analysis per each variable was done through descriptive statistics by use of Microsoft Excel and the Statistical Package for Social Science (SPSS). The findings of the study were presented in form of frequency tables.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings, conclusion, recommendations and suggestions for further research.

5.2 Summary of the Findings

This study set out to investigate the factors that influence sustainable food production in Nyeri Central District. Five research questions were formulated to guide the study. Research question one sought to establish how land fragmentation affects the sustainability of food production in Nyeri Central District, research while question two sought to assess the role of government towards sustainable food production. Question three sought to evaluate how soil fertility impacts on sustainable food production, question four sought to determine how the availability of farm inputs impact on the sustainability of food production, while question five sought to establish whether the technology in use has led to sustainable food production of food in the district.

The literature review focused on the objectives and research questions of the study. These were presented clearly in the conceptual framework from which the operational framework was developed. The study adopted a descriptive research design aimed at explaining the relationship between the research questions and the various independent variables identified. This approach was considered to be valuable in assessing and collecting data for this particular study because it is suitable for an in-depth study of the target population. The target population of the study was all the farmers within the Nyeri Central District and the study used probability-sampling method to select which farmers would be sampled. There were 349 questionnaires that were sent out to the farmers and 8 to the Zonal Agricultural Offices in the district.

5.2.1 Background Information of the Farmers in Nyeri Central District

The findings of the study revealed that there were more males than females who were found to own most of the farms in Nyeri Central District. The men accounted for 58.2% and the women 41.8%. Majority of the respondent farmers were also aged between 36-45 years. The study also found out that most farmers, who accounted for 51.0% had attained secondary level of education, with 34.8% and 14.2% representing primary and tertiary education level

respectively. This means that the farmers are capable of farming since they are not very old and their level of education is appropriate.

5.2.2 The Effects of Land Fragmentation on Sustainable Food Production

The study sought to investigate the effects of land fragmentation on sustainable food production by finding out the method of land acquisition and the land size. The study revealed that the largest number of farmers inherited land. 89.1% of the farmers responded that they acquired land through inheritance while only 10.9% bought their land. Most of the farmers owned between one and two acres of land. This accounted for 50.1%, with 39.6% owning between 3-5 acres. This cumulatively accounted for 89.7% while the rest of the farmers who accounted for 10% owned above 6 acres of land. This shows that the average land size is small and has an effect on food production.

5.2.3 Impact of Land Fragmentation on Food Production in the District

The farmers were asked to give their opinion on the impact of land fragmentation on food production in the area in terms of its impact on arable land, types of crops grown as well as their adequacy. Most of the respondents who accounted for 54.4% reported that land fragmentation reduced arable land in different ways. One of the responses that featured most was that the plots are demarcated as per the number of heirs, who end up putting up more houses on the otherwise cultivable pieces. On the other hand, 36.3% of the respondents stated that land fragmentation led to poor food production since the acreage size is too small to practice any meaningful farming. Meanwhile, 5.1% of the respondents said that land fragmentation had no impact at all, while 4.2% had no idea of the issue.

The farmers were asked to state whether they grew food crops, cash crops or both. 35.8% of the respondents grow both cash crops while an almost equal percentage of 38.1% grow cash crops. Those who grow food crops accounted for 25.2%. However, all the households cultivated maize as the staple food crop beans and potatoes. When asked whether they grow enough food to sustain themselves, 86% of the respondents were found to grow inadequate food while 14% grew enough food. The extension officers confirmed this scenario. They stated that the fragmentation of land has made farmers grow inadequate food to meet their needs. Of the eight extension officers that the study targeted, 79.4% said that land size is the biggest hindrance to achieving sustainable food levels. The study concludes that inadequate food is due to a combination of factors such as poor soil, inability to afford proper seeds and small land size.

5.2.4 Impact of Soil Fertility on Sustainable Food Production

The study sought to get answers for the impact of soil fertility on sustainable food production by finding out whether the farmers applied any form of manure. The farming practices were also investigated because poor farming methods are known to affect food production if the soil is not properly conserved. Whether farmers apply manure or not to their farms determine the fertility of the farm.

The study revealed that 61.8% apply manure in their farms with only 38.2% responding in the negative. This means that majority of the farms are relatively fertile as a result of the continuous addition of manure that boosts soil fertility. When the same farmers were asked about how often they apply the manure, majority, who accounted for 56.4% replied that they do it very often. The agricultural officers, who often visit the farmers to advise them on application of manures to their farms, affirmed the same.

The kind of farming practices adopted in an area explains the fertility of the soil, which in turn translates to productivity of the land. The study was able to identify 203 farmers who responded to the practice of inter-cropping, 128 for mono-cropping and 18, who did not practice any of the two forms of farming methods.

On farming methods, the farmers were asked the extent to which they agree to the statement that poor methods have an impact on food production. About 37.5% were found to strongly agree with the statement, 22.4% agreed while the rest either disagreed or were indifferent. Poor farming methods may explain why the district has not been able to produce enough food.

5.2.5 Effects of Access to Farm Inputs on Sustainable Food Production

The study sought to establish the access of the farmers to farm inputs in the district with the view of finding out whether it has any impact on sustainable food production. The respondents were asked to state whether they used certified seeds about 69.3% confessed they do not use certified seeds when planting, while 30.7% were found to have been using certified seeds. Most farmers expressed interest in the use of certified seeds, but cited poverty levels. They said that they had no access to credit to buy these seeds. They argued that this problem also had an impact on the access to farming implements and failure to buy farming chemicals such as fungicides and pesticides. The study therefore cites poor access to farm inputs as a drawback to unsustainable food production.

5.2.6 Effects of Technology on the Production of Food in the District

The technology in use in any region mostly determines the level of productivity in the area. The study sought to establish the technology in use in the production of food in the district.

The study revealed that majority of the farmers does not use irrigation technology at all. About 64.2% of the respondents were found not to use it at all while 21.7% were found to be using it to some extent. The agricultural officers who accounted for about 56.5% confirmed that irrigation is not widely used. This means that farmers in the district have not embraced any substantial technology that would otherwise boost food production.

5.2.7 The Role of Government Policy towards Sustainable Food Production

The government policy on sustainable food production normally gives direction on how and what should be done to improve on food security. The study sought to know whether there is such a policy to guide sustainable food production in the district and to also find out from the agricultural officers whether food sustainability in the area can be a reality.

The study found out that there is neither any minimum land size policy that has been established in the country, nor any policy on credit accessibility. However majority were of the opinion that sustainable food production in the district is a reality. 87.5% of the agricultural officers said that reality to food sustainability is very possible in the district. The study concludes that the farmers were ready to embrace any support by the government especially in terms of access to credit to buy farm inputs and certified seeds in order to improve crop yields.

5.3 Discussion of the Findings

The discussions that follow show how land size; soil fertility, farm inputs, and technology and government policy affect food sustainability in Nyeri Central District. The study of these variables was expected to shed more light on the factors that contribute to the inadequate food production and also to guide the policy makers in formulating a policy that will address the sustainable food production in the area.

5.3.1 Background Information of the Farmers

The literature of the study revealed that African farmers were mainly women of all ages. Namanga (2009) reported that Africa's women smallholder farmers, who dominate the agricultural sector, require a lot of assistance. Farmers have limited education and resources to support a large proportion of the population, yet they dominate agricultural production. (Kasryno, 1995).

However, the study found out that in Nyeri Central District, majority of the farmers were men who mainly own the farms though they are not necessarily the ones who till the land. It is important that the agricultural officers impress upon all gender to take up a fair share of working in the farms incase there is no other form of constant income. The couples will share

ideas and farming skills and maybe tackle challenges to sustainable food production in their household.

5.3.2 The Effects of Land Fragmentation on Sustainable Food Production

Limited farming space could arise as a result of cultural and legal traditions in form of inheritance and gifts or due to land scarcity (Rembold 2000). Agriculture represents a third of the gross national product of sub-Saharan African economies, However, the small-scale holdings are a hectare or less of land, and produce one-quarter the average global yield. “There is an increasing trend in the number of land parcels and a decreasing trend in the size of land parcels primarily due to hereditary tradition of equal division of land among the inheritors in Thailand due to population increase” Niroula (2007).

In Kenya, the pressure for farming space aggravates the high rate of land fragmentation in the country’s arable land areas, which is closely tied to cultural values and practices associated with land ownership as well as territorialism practiced by ethnic groups The Government of Kenya report, (1998) states that food production has fallen greatly since the 1990s, due to population growth, inheritance, lack of employment and poverty. This has resulted in land ownership changing hands more frequently to a younger generation that unfortunately is disinterested in farming activities. It is predicted that at one time, sixty per cent of Kenya’s population will be too young to contribute to the national economy through food production

The largest number of farmers in the district inherited land whereby they owned between one and two acres. The plots are multi-purpose in that they have put up structures and also carry out other activities. The study concludes that the limited sizes of the plots to the youths are not meant for growing crops. Instead, most of the youths prefer building rental structures to make quick money to alleviate poverty. This has a negative impact to food sustainability.

5.3.3 Impact of Land Fragmentation on Food Production in the District

Africa has considerable arable land but highly fragmented due to the growing population size and the customary inheritance practices. In most developing economies, population growth was identified as the major cause of land fragmentation, which shrinks the available arable lands. Since land is a limited resource and societies are dynamic, a farmland passes from one generation to another where it is subdivided into more or less equal parcels among the inheritors, “the size of a Tennis Court,” (Osei,2003).

Land fragmentation is a sign problem, which seriously affects rural development. In Kenya, pressure on land in areas of high density has made the average land parcels economically and socially unviable (Omosa M, 1998). The study identified land fragmentation in the country’s

arable land areas as a closely tied factor to population pressure and the cultural inheritance practices. Even where some sons have prospered and settled in towns, custom demands that they must own a piece of their father's land, which affects the size and shape of the plots. Some farmers went as far as calling these small fragments "tongues" due their strip-like shape. Hunger and poverty levels were also found to have contributed to land fragmentation. Some farmers have been forced to fragment their plots further for lease or for sale to see ends meet. The buyers do not necessarily grow food crops but may put up houses or grow cash crops.

Further research has showed that farmers no longer grow adequate food that has led to current global food crisis and to price hikes. The rise has further reduced the consumption of other foods such as fruits, vegetables, eggs and fish, which are rich in proteins and micronutrients (ECOSOC Report, 2008).

The study concludes that most farmers in Nyeri Central District do not produce adequate food to feed their families from the tiny plots. Most households are known to eat all the food from the farm before it is ready for harvest, thereby subjecting themselves to a long wait until the next season. This is due to the fact that they heavily rely on agricultural lands to feed themselves, and in the absence of enough food, they tend to suffer a lot

5.3.4 Impact of Soil Fertility on Sustainable Food Production

Soil fertility ultimately explains whether a region is able to have sustainable food production or not. One of the most important ingredients of sustainable agriculture is an adequate soil resource base to provide the nutrients and moisture essential to plant growth. Nevertheless, population increase and human activity cause soil degradation and might have greatly contributed to aggravation of food crisis (Mwaniki, 2004). There is rarely any harvest done to sustain the family for a season and the smallholdings are hardly left fallow to regain fertility so as to support food productivity. The situation was worse for the small-scale farmers in the district because most of them cannot afford the fertilizers or organic manure due to the poverty levels.

There are many cropping patterns and practices in farming activities for improving environment and increasing agricultural productivity, such as the "planting of trees and grass, forest technology, and agro-forestry" to prevent erosion (FAO 2005). Sustainable agriculture is a pre-requisite for sustainable food production. It is admitted that future agricultural systems must be sustainable, with, less negative impact on the environment.

Land fragmentation was also identified as a cause of land degradation in the area of study. Some farmers argued that they hardly plant trees because every space was meant for growing

food crops due to the limited parcel size. The results are serious soil erosion especially in the hilly areas of Tetu, which has an impact on sustainable food production. The study concludes that poor farming methods may explain why the district has not been able to produce enough food.

5.3.5. Effects of the Access to Farm Inputs on Sustainable Food Production

The reviewed literature showed that agricultural researches carried out in other developing economies provide a variety of methods of increasing food production, where farmers use these techniques to augment agricultural productivity. Some of them are the use of certified seeds and for Africa's women smallholder farmers who dominate the agricultural sector; the challenge involves access to finance and markets. Some governments have invested in programs to financially support the farmers to enact efficient agricultural methods. The solutions require public and private investments to transform Africa's smallholder-subsistence agriculture into a highly-productive system. (Kouame 2003)

The study found out that the farmers of Nyeri Central District have very little access to credit to be able to grow food sustainably. They also have little financial support to buy certified seeds and to implement new farming methods. This has led to reduced food production.

5.3.6 Effects of Technology on the Production of Food in the District

The only way for a country to survive in this more competitive world is to improve its competitiveness, by acquiring better technology to increase its efficiency in order to sustain agricultural development in general and food production in particular. Irrigated agriculture provides forty percent of the world's food production from seventeen percent of the cultivated area, and yields on irrigated land are often two to three times those of lands that are not irrigated (Migiro 2006). However, sub-Saharan African agriculture is mainly rain fed, with irrigated agriculture accounting for only 3% of the total cultivated area. The farmers are not provided with the technologies and infrastructure to enact efficient agricultural methods.

This sad scenario was found to apply in the district, where little or no support is accorded the farmers by the government. The study concluded that majority of the farmers in the district do not use any substantial form of technology in food production, yet there are different technologies that the farmers should take advantage of. For instance, farmers should use technologies, such as capture of water in ponds, in which water should be collected to grow enough food. They can also embrace biotechnology and organic farming.

5.3.7 The Role of Government Policy towards Sustainable Food Production

Most of the developed economies have food policies and hardly ever make their people go hungry, but not so for the developing ones. The sad bit is that the latter are well located within the tropics agricultural activities. The literature review showed Kenya has no clearly defined national land policy, which leaves the land issue very complex and sensitive – a key reason for the struggle for independence in the 1950s. The study affirmed that since The Swynnerton Land Consolidation Plan of 1954 that eliminated the indigenous land tenure and imposed the private property rights along the lines of English Law (Morgan, 1972), all farmers including those in Nyeri Central District, have been deed – holding property owners. The farms have varying sizes depending on the source, but they were found to produce little food. Agricultural officers said that it is very possible in the district. The study found that the farmers were ready to embrace any support by the government especially in terms of access to credit to buy farm inputs.

The practice of land subdivision between generations has contributed to extreme land fragmentation and increasing landlessness in a country where there is neither any minimum land size policy that has been established in the country, nor is there any on credit accessibility. This missing link has contributed to the current food insecurity.

5.4 Conclusions of the study

The study came up with various conclusions derived from the objectives and the research questions. They are presented in the following sections that represent the variables.

5.4.1 Background Information of the Farmers in Nyeri Central District

The study found out that though there was gender imbalance among the farmers in the district, they were not too old to embark on intensive farming. Their adequate education level means that the farmers are capable of applying basic farming skills towards sustainable food production. It is further concluded that the young and energetic adults have shunned farming, leaving the older people to toil the farms. A change of attitude is needed if sustainable food is to become a reality.

5.4.2 The Effects of Land Size on Sustainable Food Production

The study showed that in general, land holdings in Nyeri Central District ranged from a low of 2 acres that leads to the conclusion that majority of the farmers might not be producing enough food to sustain them. Their tightly spaced shambas constrains sustainable food production where a smaller area of cropland results in less food per person on average. Also, since majority of the farmers in the district got their pieces of land through inheritance, the

still family- owned parcels are awaiting further fragmentation. This may largely explain why some members may not be utilizing the land maximally. A member of the family may feel that there is no point in putting much input into a piece of land that may eventually end up with another family member when inheritance is finally put into effect.

5.4.3 Impact of Land Fragmentation on Food Production in the District.

The study concluded that in Nyeri Central District most households consume all the food from the farm before it was ready for harvest, thereby subjecting themselves to a long wait until the next season. Though most farmers grew both food crops and cash crops, the latter dominated in most farms with a view that it would yield better economic returns, with which foodstuffs can be bought. Unfortunately, the prices of coffee and tea are also on the rocks and the families have been left money less to buy food. This shows that there is a bias by the farmers in the area to grow cash crops over food crops and therefore the non-attainment of food security.

5.4.4 Impact of Soil Fertility on Sustainable Food Production.

The study found out that the farmers in Nyeri Central District apply fertilizers and manure to a large extent, though they might be underrating or overrating the amounts per acre. The study concludes that the application modes, the type and the amount definitely have an impact on sustainability of food production. The study also found out that most of the agricultural land throughout Nyeri Central District was over cropped. Farmers grow all manner of food crops on a single plot in a mixed form, from cereals to tubers. Through observations, the study identified maize, beans, sweet potatoes and bananas cropped together. A relatively good number subdivided their plots and grew the food crops separately from the cash crops. For instance, coffee in the lower areas and tea in the higher zones, were mono-cropped away from the cereals and the vegetables.

There was evidence of soil degradation in the area due to poor farming methods. There is need to employ better farming methods so as to sustain food productivity but with the poverty levels in the rural areas, most of the small-scale farmers do not have access to the necessary resources to be able to improve crop yields.

5.4.5 Effects of the Access to Farm Inputs

Most farmers expressed interest in the use of certified seeds, but cited poverty levels but also stated that they had no access to credit to buy these seeds. They argued that this problem also had an impact on the access to farming implements and failure to buy farming chemicals such as fungicides and pesticides. This setback was cited as a drawback to unsustainable food production.

The big number of the farmers that were found in the district using uncertified seeds might explain why the region does not sustain itself in food production. This is evidence enough that with support, the farmers would be ready to practice better farming for domestic and commercial purposes.

5.4.6 Effects of Technology on the Production of Food in the District

The study concluded that majority of the farmers in the district do not use any substantial form of technology in food production. There are different technologies that are likely to enhance the efficiency of crop improvement programs in the area if only the farmers are sensitized and empowered to farm sustainably. The availability of education in agricultural research and technologies is crucial to ensuring sustainable food supply. The acquisition of education allows people to address societal issues, such as hunger, through innovation and the creation of technology. When farmers are educated on agricultural research, they can apply the knowledge to implement the effective farming methods to increase food production.

5.4.7 The Role of Government Policy towards Sustainable Food Production

There is a multitude of factors leading to unsustainability of food production in the district but this study identified government policy as a major block behind this process. Study findings show that though there are natural factors such as population growth and climatic conditions that hinder food sustenance, lack of access to farm inputs and credit, lack of technological innovations and above all, failure to set the minimum acreage for farming, the weakness points to lack of clear government policy. The result has been hunger and poverty in a district that is climatically well situated in matters of farming activities.

It is therefore concluded that food sustainability in Nyeri Central District can be a reality to provide the farmers with increased and improved food. Future agricultural systems depend on the greater interest by all stakeholders since there is no doubt that sustainable agricultural practices are the pre-requisite for sustainable food production. No doubt this will emanate from a working government policy.

5.5 Recommendations of the study

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This study recommends a greater harmonization between government agricultural policies, the agricultural extension officers and the farmers. This demand for hastening of the 2009 proposed land reforms that should be seen to be working, more constant access to farm inputs and low- interest credit to the small-scale farmers the farmers will take more interest because through agricultural productivity, they will reduce hunger and the poverty levels and stimulate more economic development.

By some farmers growing enough food, they could sell the surplus to acquire other goods and services. They would also invest and become income-generated in other goods and services, and the country would no doubt achieve Vision 2030 and the Millennium Development Goals.

However, all this entails a change of attitude towards diversification of farming practices such as the bias of cash versus food crops on a tiny plot and embrace new technological innovations such as biotechnology.

It is therefore recommended that the government put in place a firm and working policy on agricultural production. The farmers will respond accordingly with a behavior change towards food production for all and for the future generations.

From the findings of this study, it is believed that if a household of heirs or neighbors agree to consolidate their farms and choose to build on the less arable area, they could easily pool their efforts together towards greater food sustainability. The farmers will have advantage of space to practice diversified agriculture have more bargaining power towards credit accessibility and to do construction of an irrigation pond

The study also greatly recommends that the government look into the issue of expansion of urban areas into the arable lands. It is the researcher's great conviction that the growth and extension of towns should be directed towards the agriculturally unviable areas.

5.6 Areas for Further Research

The study gave a detailed report on the key factors that influence food sustainability in Nyeri Central District. However the findings and conclusions show that the concept of food sustainability is not fully exhausted. The following areas can be studied to widen and deepen the research.

5.6.1 The role of urban planning in sustainable food production

The study brought out a suggestion, that there seems to be no urban planning policy in the country. There is urban sprawl into the arable lands that is reducing farming space.

5.6.2 Use of modern technology

There is a hidden fear in the use modern technology such as biotechnology and of GMO foods in the rural areas. The government has not come out clearly to sensitize the people about the issue. A researcher can find out the reason behind embracing of this example of biotechnology.

5.6.3 Impact of soil fertility in farming practices

A more comprehensive study on this area is needed since the farmers have the knowledge into the dangers land degradation, and yet are slow in applying mitigating factors against it.

5.6.4 Factors influencing agricultural land fragmentation

The study brought out clearly that this factor is seen as a great contributor to unsustainable food production. A deeper study is needed to understand its role towards this concept.

5.7 Summary

The chapter looked at the findings of the study as they had been presented in the previous chapter. In-depth discussions were made with reference to the five research questions. The study came up with recommendations that are believed will be helpful to the government, and the farmers. The conclusions show that serious considerations and change of attitude should be made at all levels if the concept of sustainable food production is meant to succeed, not just for the current populations, but also for the future generations.

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APPENDICES

APPENDIX A: QUESTIONNAIRE FOR FARMERS

You have been chosen as a respondent in this study.

INSTRUCTIONS

Kindly complete this questionnaire as honestly as possible and provide the most accurate information. Do not write your name. Please tick where appropriate. (✓)

Thank you.

SECTION A

Background information

1. Gender

Male { }

Female { }

2. Age group 18 – 25 26-35 36-45

Above 46

3 Level of education.

a) Primary { }

b) Secondary { }

c) Tertiary { }

4. Type(s) of farming you practice.

a) Commercial farming

b) Subsistence farming

c) Others (Specify)

SECTION B

Land size

5 What is the acreage of your land?

- a) Between 0 and 2 acres
- b) Between 3 and 5 acres
- c) Between 6 and 8 acres
- d) Over 8 acres

6 What do you grow in your land?

- a) Cash crops i.e. tea and coffee
- b) Foods crop i.e. maize, beans, vegetables etc
- c) Both cash and food crops.
- d) None of the above.

If food crops, do you grow enough?

YES NO

If not adequate, why?

- a) The land/soil is poor.
- b) The rainfall is not enough.
- c) Not able to afford proper seeds.
- d) Land size is small.
- e) All of the above.

f) 7 How did you acquire your land?

- a) Through inheritance.
- b) Through buying.

8 Have you mechanized your farm?

YES NO

If not, why?

- a) Lack of funds
- b) The size of the land is very small

The Soil fertility

9 Do you apply any form of manure?

YES NO

If yes, how often do you apply manure to your land?

- a) Very often
- b) Often
- c) Rarely
- d) Never

10 Which form of farming do you practice?

- a) Inter-cropping
- b) Mono-cropping
- c) None of the above
- d) The two above

Farm inputs

11 Do you use certified seeds when planting?

YES NO

12. Do you have access to cheap credit from the banks for farming?

YES NO

Technology in farming

13 To what extent do you use any of the following technologies in farming?

	Greatly	Moderately	To a little extent.	Not at all
Irrigation				
Rain-fed farming				

14. Unsustainable food production in Nyeri central district is as a result of poor farming methods. To what extent do you agree with the statement?

- 1) Strongly agree
- 2) Agree.
- 3) Disagree
- 4) Strongly disagree
- 5) Indifferent

Government policy

15. In your own opinion, how would you assess the impact of land fragmentation on food production in Nyeri central district?

- a) Has reduced the arable land
- b) Has led to poor food production
- c) Has no impact to food production in the area.
- d) No idea

16. To what extent do you agree with the following statement?

- 1. The over use of the land has led to poor food production.
- 2. There has been slow uptake of modern farming methods in the district.
- 3. Farmers have been having poor access to credit facilities due to poor farm produce
- 4. There has been over reliance on cash crop farming in the area hence compromising food production.

	1	2	3	4
Strongly agree	{ }	{ }	{ }	{ }
Agree.	{ }	{ }	{ }	{ }
Disagree	{ }	{ }	{ }	{ }
Don't know	{ }	{ }	{ }	{ }

END

**THANK YOU FOR TAKING YOUR TIME TO COMPLETE THIS
QUESTIONNAIRE**

APPENDIX B: QUESTIONNAIRE FOR AGRICULTURAL OFFICERS

You have been chosen as a respondent in this study.

INSTRUCTIONS

Kindly complete this questionnaire as honestly as possible and provide the most accurate information. Do not write your name. Please tick where appropriate. (✓)

Thank you.

SECTION A

Background information

1. Gender

Male { }

Female { }

2. Age group 18 – 25 26-35 36-45
Above 46

3 Level of education.

d) Primary { }

e) Secondary { }

f) Tertiary { }

4. What type of farming is commonly practiced in Nyeri central district?

a) Commercial farming

b) Subsistence farming

c) Others (Specify)

SECTION B

Land size

5 What is the acreage of the farms under food crop in the district?

a) Between 0 and 2 acres

b) Between 3 and 5 acres

c) Between 6 and 8 acres

d) Over 8 acres

6 Has there been land policy on the minimum size of land that can be under food production?

Yes

No

7. Which crops are generally grown in your area?

a) Cash crops i.e. tea and coffee

b) Foods crop i.e. maize, beans, vegetables etc

c) Both

d) Others, (Specify)-----

If food crops, in your opinion, are they enough?

YES

NO

If not, explain why.

a) The land/soil is poor

b) The rainfall is not enough

c) Not able to afford proper seeds

d) Land size is small

e) All of the above

8: To what extent is the farming in the area mechanized?

a) Greatly

b) Moderately

c) To a little extent

d) Not at all

The Soil fertility

9: Is it necessary to practice soil erosion prevention so as to contribute to sustainable food production?

a) Very important

b) Important

c) Moderately important

d) A little important

e) Farm inputs

10. Do the farmers in your area use certified seeds when planting?

YES NO

11. How often do you visit the farmers to advise them on the usage of fertilizers and manure on their farms?

- a) Very often
- b) Often
- c) Rarely
- d) Never

12. Are there institutions in your area that offer credit facilities to the farmers?

YES NO

Technology in farming

13. To what extent do the farmers use any of the following technologies in farming?

	Greatly	Moderately	To a little extent	Not at all
Irrigation				
Rain-fed farming				

14. Unsustainable food production in Nyeri central district is as a result of poor farming methods. To what extent do you agree with the statement?

- 1. Strongly agree
- 2. Agree.
- 3. Disagree
- 4. Strongly disagree
- 5. Don't know

Government policy

15. In your own opinion, how would you assess the impact of land fragmentation on food production in Nyeri central district?

- a) Has reduced the arable land
- b) Has led to poor food production
- c) Has no impact to food production in the area.
- d) No idea

16. To what extent do you agree with the following statement?

1. The over use of the land has led to poor food production.
2. There has been slow uptake of modern farming methods in the district.
3. Farmers have poor access to credit facilities due to poor farm produce
4. There has been over reliance on cash crop farming in the area hence compromising food production.

	1	2	3	4
Strongly agree	{ }	{ }	{ }	{ }
Agree.	{ }	{ }	{ }	{ }
Disagree	{ }	{ }	{ }	{ }
Strongly disagree	{ }	{ }	{ }	{ }

17. In your own opinion, to what extent is food sustainability in the district a reality?

- a) Very possible
- b) Possible
- c) Not possible
- d) Indifferent
- e) Don't know

END

THANK YOU FOR TAKING YOUR TIME TO COMPLETE THIS QUESTIONNAIRE

APPENDIX C: LETTER TO RESPONDENTS

June 2009

Agnes G. Njage
P.O. Box 2009-10100
Nyeri.
Tel. 0722892608

Dear Respondent,

REF: FILLING OF QUESTIONNAIRE

I am a student of the University of Nairobi pursuing a Master Degree. I am currently undertaking a research on the factors that influence sustainable food production in Nyeri Central District. The questionnaire attached herewith is meant for gathering information for this study.

Kindly complete the questionnaire as honestly as possible. All the information you give will be held with utmost confidence and will not be used for any other purpose except for this study.

Your positive response will be highly appreciated.

Yours sincerely,

Agnes G Njage
Researcher.

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