

**∞ EFFECTS OF SOIL AND WATER CONSERVATION PRACTICES
ON FOOD SECURITY OF SMALL SCALE HOUSEHOLDS: A CASE
STUDY OF MACHAKOS COUNTY, KENYA /**

**BY
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REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS
IN SOCIOLOGY OF THE UNIVERSITY OF NAIROBI**

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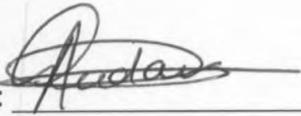


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DECLARATION

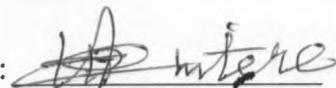
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DEDICATED

TO

**MY GRACEFUL
FAMILY**

Whose prayers & sympathies
steer my way towards success

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ABSTRACT

The economic performance and development prospects of many developing countries like Kenya are largely dependent on cash crop production. The heavy dependence of these developing countries on agricultural commodities exposes them to adverse economic impacts, sometimes with harmful consequences for growth and the reduction of poverty (Doppler, 2004). The study covered Muisuni area in Kangundo, Machakos district in a quest to establish the effects of soil and water conservation practices of food security. The study had a response rate of 52 per cent where 57.7 percent (i.e. 30) respondents were male and 42.3 percent (22) were female. 61.5 percent were of secondary & above education levels, as expected, 71.2 percent were elderly with 41 years and above and the majority 90.4 percent was married.

The study was looking at answering its research questions of a) to establish how farmers in the study area are exposed to agricultural extension educative efforts; b) to establish the level of food security among the households sampled; c) to examine the characteristics of the households sampled; d) to find out the types of soil and water conservation practices recommended and used and finally e) their level of adoption by households. The study mainly used frequency tables on every variable to try and look at the significance in relationship between the independent variable and the dependent variable in our case being food security. This study focused on water and soil conservation to impact on the food production (maize) and security in developing countries was a modest attempt to bridge the knowledge gap on the various ways to deal with rain water sources, reduce soil degradation and increase food production.

From the multivariate level, there were 5 household characteristics variables in the model, the model showed a weak relationship where 37.98 percent of the variation in food security is accounted for by the independent variables in the model. From the results as well, age was seen as having the highest strength in variation as compared to the other four independent variables, meaning that for the age variable, we would expect an increase of 20.95 percent in the food security variable score for every one unit increase in age value assuming that all the other variables in the model are held constant. According to the model, it also shows that gender has a highly negative variation to the dependent variable food security.

The study therefore concluded that Age is a very important factor to food security as amongst others, it shows that the respondents are well exposed to information and are conclusively aware of what to expect and where to go to in cases of agricultural deficiencies. The study recommended further research to food security as food security does not only focus on crop yield. The study therefore recommends further conclusive research be done to combine the various components of food security in order to get the conclusive impact of independent variables to food security. Early warning systems should be put in place in order to assist the farmers plan and have knowledge on what decisions to make on their farming practices. Partnering with the private sector should also be encouraged this will facilitate sharing of information.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATED	iii
ACKNOWLEDGEMENTS.....	iv
ABSTRACT	v
TABLE OF CONTENTS	vi
LIST OF TABLES.....	viii
LIST OF FIGURES	ix
LIST OF MAPS	x
CHAPTER ONE: INTRODUCTION	1
1.0 Background of the Study	1
1.1 Statement of the Problem.....	4
1.2 Research Questions.....	6
1.3 Objectives of the Study.....	6
1.4 Significance of the Study	7
1.5 Scope of the Study	7
1.6 Limitations and Delimitations of the Study	8
1.7 Definition of Key Concepts	8
CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK.....	10
2.0 Introduction.....	10
2.1 Exposure of Households to Extension Education.....	10
2.2 Food Security among the Small Scale Households	17
2.3 Household Characteristics	21
2.4 Soil and Water Conservation Practices.....	27
2.6 Theoretical Framework.....	31
2.7 Conceptual Framework.....	34
2.8 Operational Definitions	36

CHAPTER THREE: RESEARCH METHODOLOGY	39
3.0 Introduction.....	39
3.1 Study Site.....	39
3.2 Unit of Analysis and observation	42
3.3 Sampling Design and Sampling Technique.....	42
3.4 Data Collection	45
3.4.1 Type and Sources of Data.....	45
3.4.2 Data Collection Instrument.....	46
3.4.3 Data Collection Procedure	46
3.5 Data Analysis and Presentation Methods	47
 CHAPTER FOUR: DATA PRESENTATION	48
4.0 Introduction.....	48
4.1 Level of food security among the households sampled.....	48
4.2 Level of adoption of farm inputs and practices as recommended by the extension services	49
4.3 Characteristics of the households sampled	53
4.4 Exposure to agricultural extension education efforts.	58
 CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS	63
5.0 Summary of Findings	63
5.1 Conclusions.....	63
5.2 Recommendations.....	64
 REFERENCES	65
 APPENDICES.....	74
APPENDIX I: QUESTIONNAIRE.....	74
APPENDIX II: OBSERVATION TOOL	80
APPENDIX III: MUISUNI FARMERS' COOPERATIVE CATCHMENT AREA.....	81

LIST OF TABLES

Table 1: Table showing the soil and water conservation types	27
Table 2: Table showing the types of extension education facilities	36
Table 3: Machakos Population of Livelihood Zones.....	40
Table 4: Crop sufficient to last your household to the next harvest?	48
Table 5: Farmer’s Livelihoods.....	49
Table 6: Adopted: Soil conservation measures on cultivated fields.....	50
Table 7: Adopted: Soil conservation measures on degraded hillsides.	50
Table 8: Adopted: Soil conservation measures to rehabilitate gullies.....	51
Table 9: What is the state of the new farm soil & water conservation method?	51
Table 10: Has the information on soil & water conservation methods increased your maize crop yield?.....	52
Table 11: Relationship between state of the new farm soil & water conservation method and food security.....	52
Table 12: Distribution of respondents who are food secure by their education levels.....	54
Table 13: Distribution of respondents who are food secure by their religion	55
Table 14: Distribution of respondents who are food secure by their age	56
Table 15: Distribution of respondents who are food secure by their marital status	56
Table 16: Model fitting information	57
Table 17: Food Security and Household Characteristics on the multivariate level.....	57
Table 18: Farmers seeking/ receiving information on soil and water conservation techniques	58
Table 19: Main reason for seeking information extension workers	59
Table 20: The format of receiving information	59
Table 21: Medium through which information about soil and water conservation techniques practiced in your farm was derived from?.....	60
Table 22: Did the information on soil & water conservation methods increase your maize crop yield?	60
Table 23: Food security and types of soil and water conservation practices.....	62

LIST OF FIGURES

Figure 1: Conceptual Framework	35
Figure 2: Gender and Food Security	53
Figure 3: Percentage distribution of farmers of educational level.....	54
Figure 4: Percentage of Distribution of Farmers by Religion	55
Figure 5: List some of the soil and conservation practices and respondents use and are aware of	61

LIST OF MAPS

Map1: Map showing Kangundo location within Machakos.....41

CHAPTER ONE

INTRODUCTION

1.0 Background of the Study

The economic performance and development prospects of many developing countries like Kenya are largely dependent on cash crop production. The heavy dependence of these developing countries on agricultural commodities exposes them to adverse economic impacts, sometimes with harmful consequences for growth and the reduction of poverty (Doppler, 2004). Declining living standards and poverty is evident among many rural families that for a long time depended on food crops as a major source of income and spent most of their resources in their production while foregoing other sources of livelihood (Republic of Kenya, 2000). The production of food both has a great effect on, and is greatly affected by, the environment. While the developed countries look at long-term problems such as global warming, depletion of the ozone layer, loss of biodiversity and food surpluses, the problems of less developed countries are more pressing and immediate – chronic food shortages and increasing population; scarcity of arable land and water. (Republic of Kenya, 2002).

Surface runoff and resulting soil erosion are the principal means by which fertilizers, sediment, and pesticide residues reach surface waters. Infiltration of ponded runoff through permeable soils can move nitrogen and pesticide residues into ground water. Controlling water flow through and out of your farm will greatly reduce transport of contaminants off site, and will preserve your farm's productivity. The ability of the land to produce is limited and therefore there is a limit to the number of people that can subsist on a given area. The limits of production are determined by the natural environment for example climate, soil, relief, dominating geomorphologic processes, vegetation cover and the prevailing land use and management level which are influenced by a range of socio – economic and cultural variables (Republic of Kenya, 2000). Any use of land beyond these limits will in the long run only result in environmental degradation and lowered productivity, unless land management is strongly changed for which the costs in general

are prohibitive. It is therefore important that knowledge of these limits will be known to the development planners before any development action is undertaken (Haastreht and Schomaker, 1985).

Land degradation is a process of change of land quality that can only be assessed realistically by comparing the existing conditions with some baseline conditions established at a given period in the past. Land degradation indicators are selected to monitor the trend of change. Some indicators such as soil characteristics and climatic parameters may change over a period of decades or generations while others like vegetation, population and settlement may show significant changes even on annual basis. Land degradation encompasses changes in any or all the aspects of land (soils, minerals, water and vegetation) that adversely affect its quality and hence the ability to support societal needs, especially agricultural and forestry production and water resources (Government of Kenya and UNEP, 1997). For sound land-use planning, particularly for agricultural purposes, there is a need for a good understanding of the nature of soil resources, the relative risks of degradation, the type of degradation and where the degradation occurs (Republic of Kenya, 2004).

Water pollution is a major off-site impact of soil erosion. Water pollution causes deterioration of the aquatic habitats, increased water treatment costs and clogging of water distribution systems. Sediment is a major pollutant of the surface water and is a major carrier of agricultural chemicals into the water systems. Major soil pollutants have their source from effluent disposal from industries, slaughterhouses and sewerage. Land use pattern may contribute to pollutants flowing into water or soil within a certain region and therefore determine the water and soil quality. Agrochemical wastes from horticultural farms contribute to soil and river pollution.

The main causes of fertility decline are continuous cultivation and little use of inorganic fertilizers because of the high cost of fertilizer and erratic availability. This leads to the loss of plant nutrients through erosion, harvested crops and leaching. Salinity and sodicity problems are common in the ASAL (Arid and Semi Arid Land) where they have

naturally formed under the prevailing climatic conditions and due to high rates of evapotranspiration and lack of leaching water. About 40 percent or about 25 million hectares of the land of Kenya is covered by soils that have salinity and/or sodicity problem(s). Land degradation by salinization is on the increase in irrigated ASAL areas where irrigation of unsuitable soils or use of poor quality irrigation water is a common practice. The land under irrigation in Kenya is estimated to be about 84,000 ha (Ngigi, 2002). According to Mugwanja et al., (1995), about 26,000ha is considered salt degraded. This is caused mainly by poor irrigation management and poor drainage, especially in areas with high ground water table. This therefore requires continuous land degradation assessment and monitoring and indication of the necessary remedial measures before reaching devastating levels.

The concept of 'food security' has developed over the past three decades. Concerns about food security up to the end of the 1970s were directed more at the national and international level, and concerned the ability of countries to secure adequate food supplies (Sloane, 2001). Only later did the level of analysis shift to include a focus on food security at local level, even down to households and individuals. Conserving both water and soil benefits both the grower and the environment. Practices that limit runoff conserve topsoil, the life-blood of food production, and reduce the transport of contaminants (sediment, fertilizers, agri-chemicals, etc.) off the farm.

Since the beginning of the new century, there seems to be a renewed interest in agriculture. According to the World Development Report (2008), agriculture is a vital development tool for enhancing the Millennium Development Goal (MDG) of alleviating poverty and hunger. It has the potential to drive development in Kenya, enhancing economic growth and improving the welfare of millions of people. In a report by FAO (2006) agriculture employs 62 percent of the population in Sub-Saharan Africa (SSA) and generates 27 percent of Gross Domestic Product (GDP). Additionally a report by UNDP (2008) agriculture supports up to 75 percent of Kenyan population including those who reside and work in urban centres and accounts for approximately one third of the Gross Domestic Product (GDP), employs more than two thirds of the labor force and

about 70 percent of the export earnings. It generates almost all the country's food requirements and provides a significant proportion of raw materials for the agro-based industries.

However agriculture is almost totally dependent on rain water. According to Kenya Meteorological Department (KMD) report of 2009, Kenya has two rain seasons with the short season in the months of October to December and the long rains in the months of March to May. Interestingly, a lot of this rain water wastes away especially in the rain deficient areas. This leads to loss of agricultural production which could have been reduced if adequate water harvesting strategies were in place. As a result more than 2.5 million people, nearly a third of the population in the rain deficient areas are malnourished and almost half live on less than a dollar a day (Yosef, 2004). This weak economic performance is closely linked to slow productivity growth in the agricultural sector. A UNDP (2003) survey indicates that there is need to encourage both water and soil conservation to increase food productivity and hence ensure food security. Therefore, this study looks at the effects of soil and water conservation methods to food security. Food security measured as the amount of maize yield to last farmers until the next harvest.

1.1 Statement of the Problem

Soil and water conservation projects in Africa have, at best, a patchy record. New policies and practices are needed. Despite this long history, researchers and development practitioners began to realize in the 1980s that soil and water conservation interventions had, at best, a patchy record (Shively, 2001). New approaches were developed that tapped into indigenous knowledge and were based on small-scale initiatives, participation of the local population and simple technologies. Soil and water conservation is not only achieved through technical, but also through social means. Thus interventions aiming at conservation need to address social institutions, for example, by broadening the scope and scale of social networks, rather than focusing solely on the development and extension of technologies (Mazzucato and Niemeijer, 2001). For example, this could be

achieved by helping people to be more mobile by organizing events where farmers from different areas can meet, through setting up bicycle or moped borrowing schemes making it possible for people to travel further than by foot. Another example is to support communication centers in which media ranging from the radio to the internet can be accessed.

The few studies which have looked at conceptual and perceptual issues surrounding land degradation have shown that land users are often aware of the processes influencing soil fertility, soil formation and soil erosion (Mazzucato and Niemeijer, 2000b). The Gourmantché from Eastern Burkina Faso, for instance, have a special term for water erosion and recognise not only rill and gully erosion, but also less conspicuous sheet erosion. Farmers readily explain the various qualities of different kinds of organic material as sources of soil fertility and note how cultivation, removal of natural vegetation, burning, animal trampling and grazing all affect soil erosion and soil fertility (Mazzucato and Niemeijer, 2000). In the case of the Gourmantché, and this is true for most other African farmers, there appears to be little need for awareness campaigns about land degradation. There is overuse of available land which coupled with drastic changes in climatic conditions have led to poor agricultural performance which according to Odhiambo (2004) is an important determinant of food security whereas hunger is a major constraint to achieving food security. This study focused on water and soil conservation to impact on the food production (maize) and security in developing countries was a modest attempt to bridge the knowledge gap on the various ways to deal with rain water sources, reduce soil degradation and increase food production. It was an effort to bring to light the influence and insights into the effects of soil and water conservation practices on food security of small scale households in Kenya where the small scale households in Machakos County, Kangundo Constituency and more specifically, Muisuni Sub location will be the context of focus.

1.2 Research Questions

This study strived to respond to the following research questions:

- a) How farmers were exposed to agricultural extension educative efforts in rain deficient areas in Machakos County, Kangundo Constituency, Muisuni Sub location?
- b) What are the relationships between food security and household characteristics in the semi arid areas in Machakos County, Kangundo Constituency, Muisuni Sub location?
- c) What are the farming soil and water conservation practices used in semi arid areas and level of adoption in Machakos County, Kangundo Constituency, Muisuni Sub location?

1.3 Objectives of the Study

Main objective

To investigate the effects of soil and water conservation practices on food security of small scale households in Kenya Machakos County, Kangundo Constituency, Muisuni Sub location.

Specific Objectives

The specific objectives of this study were:

- a) To establish the level of food security among the households sampled.
- b) To determine the types level of adoption of farm inputs and practices recommended by the extension services.
- c) To examine the characteristics of the households sampled.
- d) To establish how farmers in the study area are exposed to agricultural extension educative efforts.

1.4 Significance of the Study

Farmers will benefit from this study in that they will be enlightened on the water and soil conservation practices to use to ensure adequate food is produced from the semi arid areas in the country. This will increase their knowledge on the water harvesting, utilizing, soil conservation and the best farming methods to use in order to improve productivity.

The Government of Kenya will use the findings of the study to assess the water and soil conservation practices and food production and food security for small households in Kenya. The findings of the study compiled and an analysis of the effect of networking assessed from the firm's perspective.

Academicians and researchers will be able to learn more on water and soil conservation practices and how they impact on food production and food security for small scale households, thus they will be able to analyze fully the benefits of water and soil conservation practices and how they impact on food production and food security. This will help them when intending to conduct a study in the same field of networking. This study will help to identify areas for further study and contribute to knowledge about water and soil conservation practices and their impact on food production and food security in Kenya.

1.5 Scope of the Study

The study is about water and soil conservation practices, maize food production and food security for small scale households in Kenya. The study focused more on water and soil conservation practices and how their effects on maize food production to last the small scale households in Kenya in the study area of Machakos County, Kangundo Constituency and more specifically, Muisuni Sub location until the next harvest.

1.6 Limitations and Delimitations of the Study

The researcher encountered various limitations that tend to hinder access to information sought by the study. The main limitation of this study was its inability to include more counties. This was a case focusing on Machakos County, Kangundo Constituency and more specifically, Muisuni Sub location.

The researcher encountered problems of time as the research was undertaken in a short period which limits time for doing a wider research. However the researcher countered the limitation by carrying out the research across the stakeholders in the county which enabled generalization of the study findings.

The respondents to be approached were reluctant in giving information fearing that the information sought might be used to intimidate them or print a negative image about them or the organization. The researcher handled the problem by carrying with her an introduction letter from the University and assured them that the information they give will be treated confidentially and it will be used purely for academic purposes.

1.7 Definition of Key Concepts

Cash Crop - a readily salable crop that is grown and gathered for the market (as vegetables or cotton or tobacco)

Loss of Biodiversity - The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems.

Salinity Problems - relating to or containing salt; salty.

Soil salination - Is the accumulation of free salts to such an extent that it leads to degradation of soils and vegetation.

ASAL Arid and Semi Arid Land

Food Security Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (FAO 2009)

Millennium Development Goals (MDGs) originated from the Millennium Declaration produced by the United Nations 2000. The Declaration asserts that every individual has the right to dignity, freedom, equality, a basic standard of living that includes freedom from hunger and violence, and encourages tolerance and solidarity

MDGs are eight international development goals that all 192 United Nations member states and at least 23 international organizations have agreed to achieve by the year 2015. They include eradicating extreme poverty, reducing child mortality rates, fighting disease epidemics such as AIDS, and developing a global partnership for development, ensuring environmental sustainability, and developing a global partnership for development

Agriculture Extension Services According to Syngenta Foundation 2012, agricultural extension is the function of providing need- and demand-based knowledge in agronomic techniques and skills to rural communities in a systematic, participatory manner, with the objective of improving their production, income, and (by implication) quality of life. Extension is essentially education and it aims to bring about positive behavioral changes among farmers.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.0 Introduction

This chapter summarizes the information from other researchers who carried out their research in the same field of study. The specific areas covered here were agriculture, soil and water conservation and food security, rain water harvesting, water conservation practices, soil conservation practices, agricultural practices and food supply and finally empirical studies.

2.1 Exposure of Households to Extension Education

Agriculture extension is an educational service for advising, training and informing the farmer concerning practical and scientific matters relating to his/her farm business and influencing him/her to use improved techniques in his/her farming operations for which this purpose includes livestock and crop production, farm management, conservation and marketing. In the past, technology transfer models adopted by most agricultural extension systems was top down in approach (Roling, 1998) and extension staff were expected to obtain technologies from researchers, package and transfer them to small holder farmers. The training and visits (T&V) education system was such a model introduced in India and Africa (Bindlish Evenson, 1997) that was expected to bring researchers and extension staff closer in the process of technology transfer.

This study looked at the effects of these agricultural extensions in terms of visits by public extension workers, access to information through the radio, newspapers and magazines and attending workshops and their impacts to food security.

According to Shin and Evans (1991), the main reason for seeking information by Illinois agriculture and horticulture Extension advisors was to answer client inquiries. In their study, they categorized information sources into three types: oral, written and electronic.

Written-only sources accounted for the largest single share (45.9 percent), followed closely by written and oral combination (43 percent). Less than three percent used electronic information sources. Radhakrishna and Thomson (1996) found that extension agents regularly seek information to carry out their day-to-day work. Extension agents frequently communicate with a variety of information sources. Prominent among these were: clients, another agent in the office, another agent in another county, extension specialists, their immediate supervisor, local news agencies, local business organizations, state and federal agencies, and local school teachers and administrators.

Gholamreza and Naser (2005) investigated the factors influencing information-seeking behaviour of Extension workers in Zanzan Province, Iran. His research showed that there was a significant relationship between age, level of education, years of experience, and the worker's level of job-related information with information-seeking behavior. The main reason for seeking information by extension workers was holding training courses, followed by solving daily problems of farmers and up-dating their information, respectively. According to Gholamreza and Naser (2005), Provincial Extension Specialists who were working for the Ministry of Jihad-e Sazandegi reported radio, TV, computer, seminars and training courses as their five most used information sources and channels. They indicated the lack of knowledgeable and skilled information personnel as the main problem of the information system of the Ministry of Jihad-e Sazandegi in Iran.

The study borrowed from other studies on the same to see the extent to which these services were offered and their effects as per food security. The study by Koriala, G. (2003) Gender analysis of agricultural extension delivery system of Nepal: A case of Nawalparasi district, found that, by and large, the gender aspect was not adequately taken into consideration in the total agricultural extension system. Relatively, the proportion of male farmers as compared to female farmers was found to be involved in the research activities of generating agricultural technologies. Gender-wise, the extent of participation of male farmers was found to be greater than their female counterparts in agricultural extension programs. While the female respondents preferred separate women farmers groups and considered to be more effective for the purpose of extension delivery, the

male farmers remained indifferent in this matter. Similarly, the female respondents preferred the female extension personnel for effective extension service; the male respondents did not show any particular preference for either male or female extension personnel. Despite the preference shown by a larger proportion of female farmers, only a limited number of female extension personnel were found to be involved in the extension service. The study came out with the suggestion that taking gender aspects into consideration at the implementation level is equally important as at the policy level. Similarly, the entire agricultural extension system needed to be more gender sensitive than ever before in order to make it more effective in serving the farming community in an effort to alleviate the prevailing widespread poverty in the country through agriculture development.

The major output of the study by Deribe K. K. (2007) on Agricultural Information Networks of Farm Women and Role of Agricultural Extension in Dale Woreda, indicates that knowledge of dairy farming practice of women farmers was significantly influenced by communication skill, interpersonal trust, social participation, total annual income, extension participation, empathy of respondents and access to credit. The major constraints identified in agricultural information network of farm women were low participation of women in extension programs; poor access to credit; absence of market information and alternative market for products; extension methods contribute less as source of information.

Mahapatra (1987), explains that, in India, women learned of extension messages-“some in a clear way and others not so clear”- through indirect channels of communication such as husbands, neighbors and other villagers. However, this indirect effect of the extension system on women did not significantly change production. The challenges to any extension service is how best to communicate with the prime actors in the agricultural activity.

Russell *et al.* (1989) argued that agricultural extension had two main traditions. The first was technical innovation. This was the basis of the original notions of extension, because training farmers and grazers about new technologies and new knowledge was seen to be the key to improving the productivity of agriculture. In this area the key words were diffusion of innovations, adoption, farming systems research, extension and research linkages, and results becoming technology and new knowledge, in agricultural systems etc. The second tradition was human resource development. This was a completely different and much newer tradition that has grown out of the question about why the technical innovation process has not been used in some conditions, and some technologies have had negative effects for producers or farmers and grazers. The key words in the human resource area were: community development, establishment building, leadership development, normative, organization and education strategies, and development delivery systems.

Bird (1994) argued that decentralized extension systems have showed evidence of increased resource mobilization and reduced strain on central finance, greater accountability, and more responsive administration which leads to maximum participation of local people resulting in more understanding of the government's role.

Muhamad *et al.* (1995) conducted a study to identify the approach utilized in generating and disseminating cocoa technology to smallholders in Malaysia. The respondents consisted of 499 cocoa smallholders selected randomly from six main cocoa growing regions. The study revealed that the generation and dissemination of cocoa technology utilized the research-transfer model. Through the training and visit mechanism, a majority of cocoa farmers do regularly receive recommended practices generated by research institutions. The utilization of recommended technology is still relatively low related to this is the farmers' social economic status and the limitations inherent in the research-transfer model.

Crowder (1996) in his research entitled *Decentralized Extension: Effects and Opportunities* suggested a series of recommendations to improve local extension including the formation of partnerships based on collaboration among extension units, NGOs, People's organizations, and universities. Among other recommendations included training of extension agents to help shift them from top-down to community-based (participatory) approaches; Operationalization of decentralization through special representative bodies and councils so that farmers can participate in local decision making and strong linkages with regional and national offices of agriculture (Extension), to facilitate information and knowledge sharing.

Kelly (1997) surveyed local landholders with government officers in relation to goat management in the Mulga Lands of south - west Queensland, Australia. In this survey she used action learning and problem solving approaches. She found when landholders and government agents share decision-making and work together; they adopt the best goat management on their properties.

Guadagni (2001) said that decentralization of Agricultural Extension services promotes farmer centered integrated approach. This includes farmer's participation in planning and plan implementation. Such locally specific and depends upon the identification and use of farmer group[s with resources and technological requirements for extension activities.

Anderson and Feder (2003) analyzed the considerations that lead policy makers to undertake extension investments as a key public responsibility, as well as the complex set of factors and intra-agency incentives that explain why different extension systems' performance varies. They provided a conceptual framework outlining farmers' demand for information, the welfare economic characterizations of extension services, and the organizational and political attributes that govern the performance of extension systems. The conceptual framework was used to examine several extension modalities and to analyze their likely and actual effectiveness. Specifically, the modalities reviewed include Training and Visit extension, decentralized systems, Fee-for-Service and privatized extension, and Farmer-Field-Schools. They also discussed methodological issues

pertaining to the assessment of extension outcomes, and a review of the empirical literature on extension impact. They emphasized that the efficiency gains that can come from locally decentralized delivery systems with incentive structures based on largely private provision that in poorer countries will still be publicly-funded. In wealthier countries, and for particular higher income farmer groups, extension systems will likely evolve into fee-for-service organizations.

Feder *et. al.* (2004a) evaluated the impact of farmer field schools, an intensive participatory training program emphasizing integrated pest management. The evaluation focus on whether program participation has improved yields and reduced pesticide use among graduates and their neighbors who may have gained knowledge from graduates through informal communications. The results revealed that, employing a modified difference-in-differences model indicate that the program did not have significant impacts on the performance of graduates and their neighbors.

Feder *et. al.* (2004b) stated that Farmer Field Schools (FFS) were an intensive training approach introduced in the last decade in many developing countries to promote knowledge and uptake of ecologically sensible production approaches, and in particular, integrated pest management which, minimize the use of pesticide. Because of the high training cost, the viability of the program depends crucially on the effectiveness of knowledge diffusion from trained farmers to other farmers. They conducted a research study and collected data through panel discussion from Indonesia to assess the extent of diffusion of knowledge regarding integrated pest management from trained farmers to other farmers. The results of the study confirmed that better knowledge leads indeed to reduced pesticide use, and that trained farmers make a modest gain in knowledge. However, there was no significant diffusion of knowledge to other farmers who reside in the same villages as the trained farmers. These results implied that revision in the training procedures and curriculum need to be considered if the FFS approach was to become viable and effective.

Alene and Manyong (2006) conducted a research study to examine the magnitude and sources of yield variation among adopters of improved cowpea varieties in northern Nigeria promoted through farmer-to-farmer diffusion. The results revealed important efficiency differences between the lead farmers who had contacts with breeders and the follower farmers who get technology and information from the lead farmers. Differential adoption of the package of seed, insecticide, fertilizer, and recommended cereal-cowpea cropping pattern provides much of the explanation for yield variation among adopters.

The component often missing, and hence accounting for much of the yield variation, was the crop management technology relating to the cereal-cowpea cropping pattern. No efficiency variation was attributed to the source of technology and information, such as whether improved cowpea was obtained from breeders or lead farmers. Technology source has a rather indirect influence on efficiency through its effect on package adoption where breeders promote greater package adoption among the lead farmers than the lead farmers do among the follower farmers. Possible ways of disseminating crop management technological information through the farmer-to-farmer technology diffusion are recommended to better exploit the yield and profitability potentials of improved cowpea varieties in northern Nigeria.

Chaudhary *et. al.* (2006) concluded that utilization of agricultural technology by the farmers play an important role in boosting the agricultural production. Keeping in view its importance, they suggested that extension agencies need to put more efforts in creating awareness and facilitating the farmers for the utilization of latest agricultural technology by the farmers.

In the Kenyan context, the farmer field school (FFS) approach has gained prominence as an extension methodology following its success in training Asian farmers on IPM technologies (Abate & Duveskog, 2003). It was first introduced on a small scale in 1995 the FAO's Special Program for Security (SPFS) to promote maize (*Zea mays*) based IPM in western Kenya. Since then, over 1500 FFS have been initiated to promote IPM technologies for maize, vegetable; and poultry production, soil fertility management,

water harvesting, dairy cattle production, and management of HIV/AIDS (Abate & Duveskog).

The FFS approach has principles and concepts that make it a truly participatory extension methodology (Khisa, 2003; Leuwis et al., 1998; Pontius, Dilts & Barlett, 2002). The basic principle of FFS is the emphasis in growing/ raising a healthy crop/animal with least disruption of the agro-ecosystem. The training methodology is based on learning by doing and it embraces the discovery based learning among the learners. The education of adults is multifaceted, complex processes which encompass many subjects and interest areas.

Based by the above, this study looked at the extent to which these smallholder farmers in Muisuni sub location have access to these extension services on Soil and Water Conservation practices and their effects to Food security.

2.2 Food Security among the Small Scale Households

There are so many definitions to food security among agricultural researchers which revolve from sufficient calorie intake per day Reardon and Taylor (1996) to diversification of livelihoods Ali (2005). The other various food security categories and definitions are something's to do with Social networks have also been found to have a great impact on food security. Jennifer Lamb (2011) in her study to investigate the relationship between smallholder farm household networks for food acquisition and agricultural production, food security and dietary quality in the Mount Elgon region of western Kenya and eastern Uganda. The study found out that network for agricultural production and food acquisition have a positive impact on food security is both timely and significant to research and development efforts which seek to improve food security for smallholders. The conclusion that increased contacts for agricultural production confirmed that working with smallholders to improve farming practices is a way to improve food security. Overall, the results suggested that both food acquisition networks and agricultural production networks are important avenues through which gains in food

security may be realized. However, development efforts need to be mindful of the crops and attitudes promoted by these networks to secure gains in both caloric sufficiency and dietary quality.

Lima (2008) tends to think the contrary to social network support especially in developed nations. As much as, Waterloo Region in Canada, Ontario counts on a very supportive government that strengthens local food initiatives and combines efforts with non-state organizations in order to promote a healthy food system. Despite possessing notable local food traditions, its food system is much more globalized than Feira de Santana's. Most of its food is imported, and much of the arable land is used for agro-industrial cash-crops. This has hampered the operations of the smaller local farmers, damaged the environment (due to long transportations and intensive, conventional agriculture), and contributed to poor eating habits. Although Waterloo Region faces less food deprivation than Feira de Santana, it has a much bigger problem with respect to overconsumption and obesity – half of the local population is overweight with associated health concerns. The study concluded stressing the need to consider food security from a systems perspective, taking into account social and environmental factors. Thus, it highlights the need to promote sustainable food systems, and draws some recommendations for achieving it.

In another study to try describe food security on the overall findings of the research by Georgina Rockson (2012) on Land administration for food security: A research synthesis, shows that land experts believe land administration has greater role to play in ensuring sustainable development of land and eventually food security (Enemark, et al., 2010) This can be achieved through securing land rights of the citizens through land acts governing the use of land (ECA, 2004; Kabumbuli et al., 2008) Land administration is also helping to facilitate food security, by providing geographic information to food security strategies and international organisation system directly, however their strategies often depend on sound land use management to enable agricultural production. The synthesis led to a conceptual framework that can be utilized by land professionals to demonstrate and understand the contemporary role(s) and issues associated with land administration in support of food security.

Based on the fact that Machakos inhabitants highly rely on agricultural activities, new research by Murton (1997) found that agricultural intensification has not been a homogeneous experience. Therefore, rising living standards is experienced largely by those families who have access to non-farm income. This income facilitates security during agricultural crisis such as drought, and enables a virtuous cycle of on-farm investment, leading to higher agricultural yields, rising incomes and higher standard of living. In contrast, families without access to such income usually experience a cycle of declining soil fertility and declining yields per head. In the past it used to be easy for farmers to obtain non-farm income and so make economic progress, but this is affected today on account of slow economic growth, structural changes and population growth (Hoogmoed, 1999). Consequently, only very few farmers have access to affordable capital necessary for investment into cash crop farming.

Ahmed Ali (2005) in his research by comparing livelihood and food security issues of rural households in Bangladesh discovered that achieving livelihood and food security is a major goal of households. Livelihood diversification is one of the ways to achieve, maintain or enhance livelihood security (Ellis, 2000). As is also shown by his research, households stick to or change their livelihood strategies or diversify their livelihood activities based on their present needs and past experiences (Pennartz and Niehof, 1999). A household's attitude towards risk is considered to be the most dominant factor in livelihood diversification (Reardon and Taylor, 1996; Fafchamps, 2004). Niehof (2004) argues that diversification occurs because of good or bad experiences. This research reveals that two-thirds of the household heads have more than one source of income from both the agricultural and non-agricultural sectors. Saha (2001) reported that dependence on farm labor declined at a rate of 0.26 percent while non-farm sector income increased at a rate of 2.89 percent. Most households diversify their income sources to cope with on-farm and off-farm risks to their income (Kumar, 1991). Brons (2005), however, argues that income diversification alone is insufficient to sustain livelihood. It can be a coping mechanism rather than a means of sustaining livelihood.

The unequal land distribution is another factor contributing to poverty in Machakos County. Murton (1997) points that in 1965, the poorest fifth of households in Machakos owned 8 percent of the land whereas by 1996 the figure was 3 percent, thereby indicating that the amount of land owned by poor families decreased. While in 1965 the richest farmers owned 40 percent of the land, the figure is now over 55 percent, and so the amount of land owned by the rich has increased over the years. It is the differential access to non-farm income that has caused the unfavorable changes in the distribution of land making land very expensive. Furthermore, limited access to rural credit is an important determinant to poverty in Machakos, and therefore those with access to non-farm income through employment and informal sectors work can afford to buy significant portion of land. With this situation today, the issue of non-farm income is considered in two folds. While the non-poor use non-farm income for productive investment in agricultural ventures, poorer households are compelled to use non-farm income to offset the shortfall in their food needs. Thereafter, poorer households are often left with little incentives to engage into agricultural investment. Escaping from this predicament calls for greater access to land and non-farm income, but at the same time controlling for high population growth. But the Machakos experience clearly demonstrates that even in an area vulnerable to soil degradation, a large population can be sustained through a combination of endogenous and exogenous technological change supported by a conducive policy framework and sustained local initiative (ODI, 1999).

In consideration of these problems, the Machakos Integrated Development Program was implemented (1978-1988), which included the development of new roads, which opened up the area for trade with Nairobi. The opening of new market opportunities, increased communication with Nairobi as a trade market and the extension directed to profitable crops, created incentives for farmers to privately invest in land improvement (Murton, 1997). The greatest expansion of bench terracing techniques took place in the 1970s and 1980s, partly in response to the Machakos Integrated Development Program. By the 1980s, soil losses were no longer as drastic as before. This is a result of intensive land capitalization, through investment in terracing, construction of dams that collect water,

and introduction of new farming techniques. By 1985, about 85 percent of land that required conservation work had some form of conservation on it.

This paper however looked at food security in terms of and comparing it to the types of soil and water conservation practices as practiced by small holder farmers in machakos, kangundo in Muisuni sublocation. The study recognized that there is very little literature on the effects of soil and conservation practices and food security and attempts to dig deep into this by focusing on Muisuni area of Kangundo constituency. The study took up the measure of food security if the harvested yield will be enough to last the homestead to the next harvest period and thus it will be considered to be homestead food secure or insecure. It goes further to look at the various soil and water conservation methods that directly relate to food security and how they correlate and how significant each method is to food security.

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2.3 Household Characteristics

Food Security and Education Level

Food insecurity and illiteracy involve more than 800 million people today, most of whom live in rural areas. This paper aimed also to explain the linkages existing between education, development, and food security.

Francesco Burchi (2006) *Education, Human Development, and Food Security in Rural Areas: Assessing Causalities* explored the role given to education in the different development theories, evolved since 1960s on, and then I concentrated on the double role attributed to education by the Human Development Approach: education has 1) a direct role, and 2) an instrumental role. Following the Human Development Approach, then, I analyzed how education contributed to fighting food insecurity in rural areas of developing countries. The empirical analysis proved that basic education, and not higher education, is a key factor for food security; an increase of younger children's school attendance by 100 percent can reduce food insecurity.

In the sampled household the percentage of households with illiterate heads were higher among food insecure households than among food secured households. In the survey 79.5 percent (1383) of the household heads were found to be illiterate who could not read and write while only 20.5 percent (357) of them were found to be literate.

In the study by Frehiwot F. Seid (2007) on *Food Security and its Determinants in Rural Households in Amhara Region*, the regression model found out that literate household have negative association with food insecurity

As Mukudi (2003) claims, education has a key role in accessing public information, especially concerning health, nutrition, and hygiene. Acquiring knowledge about how to avoid and face illnesses is essential since people with diseases require more calories to be food secure. Furthermore, nowadays it is well known that people need to have, where possible, an adequate and diversified diet in order to build a stronger immune system and avoid morbidity and mortality. Finally, even following right hygienic practices is essential to prevent diseases like diarrhea. Mass Media such as radios are widely spread in African countries, even among poor people living in rural areas; therefore only people with a minimum level of education can properly capture and elaborate that information. Even more relevant is the role of basic education on literacy in acquiring this type of information from written messages. This argument, indeed, should be extended in an inter temporal dimension: "parental education has been found to invariably influence

nutritional outcomes of the children. Children of less educated parents and those of parents with no educational exposure consistently score poorly on nutritional status indices” (Mukudi 2003, 246).

Moreover, there is a gender aspect that does matter for ensuring long-term food security. In fact, the specific impact of women’s education is higher: girls who attend school and obtain at least the basic skills can even teach right health and hygienic practices to their children once they become mothers. This means that female education should be at the centre of the analysis because it has an additional direct effect on nutritional status. Schnell-Anzola, Rowe and LeVine (2005) bring the example of an empirical research carried out by Glewwe in Morocco, which showed that maternal “education improves child health primarily by increasing health knowledge” (Glewwe 1997, 151) and that it does not depend prevalently on the subjects studied in class, but on the very general abilities to read, write, reflect, and process information.

Education, then, is fundamental to promote agency, which expresses the capacity of rural poor to escape from poverty and hunger with their own power. Who is educated is more likely to find a job, but has also a capacity to use more rationally the resources he or she owns. Educated and informed people are more likely to select valuable objectives in life, such as having stable access to food for their household. Even in this argument, there is a gender factor. Mothers showed to assign a higher value to the well-being of their children, allocating more resources to health, and nutrition (Sen 1999, 195-196). Quoting still Sen (1999, 197), “female literacy...is found to have an unambiguous and statistically significant reducing impact on under-five mortality, even after controlling for male literacy.” Therefore, a more active role of women in family is likely to lead to lower mortality rates, which, in developing countries, are mostly due to malnutrition.

Food Security and Income Levels

Even as theoretically you may say that food insecurity exists in the households belonging to the lower income groups. Studies found that Twenty percent of U.S. households

classified as food insecure had midrange or high incomes, according to responses to the 1995-97 Current Population Survey. But a study by Mark and C. Brent (2002) on food security in higher income households investigated the extent to which these households are food insecure and what proportion of them may have been identified as food insecure because of problems in the measurement methods. The study found that a small proportion, at most, of measured food insecurity among middle- and high-income households appears to be due to misunderstanding of questions or to random or erratic responses. Some households in these income groups are food insecure due to factors such as uneven incomes or changes in household composition during the year or to the existence of multiple economic units in the same household.

The findings in the same study by Mark and C. Brent (2002) found out as expected that food insecurity and hunger declined sharply with increasing household income. The prevalence rate of food insecurity was more than six times as high among households with incomes less than 1.85 times the poverty line than among households above that line (24.6 percent vs. 3.8 percent). Food insecurity with hunger was over seven times more prevalent for low-income households than for middle/high-income households (9.0 percent vs. 1.2 percent). However, food insecurity and hunger did not decline to negligible levels until income rose to about five times the poverty threshold. Due to such a large proportion of households were in this middle-income range, households with incomes above 1.85 times the poverty threshold accounted for a substantial share of all food insecure households about 20 percent and for 17 percent of all households with hunger. For households with annual incomes above \$50,000, the prevalence of food insecurity and hunger was lower still, and these households accounted for only about 3 percent of all food insecurity and 2 percent of all hunger in the Nation.

Food Security and Religion

Despite enough food production to feed everyone on the planet, there are 850 million people around the world who are food insecure. This includes people in developing and industrialized countries. Food insecurity may not be just “not having enough amounts of

food” but “not having food that is appropriate according to culture and religion”. The global agri-food system has restricted access to food and resulted in environmental damage by displacing family farming, and leading to the establishment of industrial monocultures.

This study took a different perspective on food insecurity by linking food to culture and religion and the food system. This study built on another study by Yousaf Khan (2010) entitled it's not Just Food Sustainable Food Security for Immigrants: Barriers and Opportunities in the Waterloo region of Canada that borrowed from criteria by Lima (2008) on sustainable food security. The criteria include physical and economic access to food, religious and cultural adequacy of food and the food system's environmental and social effects.

The criteria were applied to the case study of Waterloo Region by examining existing policies and initiatives to address food insecurity in the Region. The case study analysis explored barriers and opportunities to foster sustainable food security for immigrants in Waterloo Region. The case study included an embedded case study of South Asian Muslim community of immigrants in Cambridge, Waterloo Region. The study findings revealed that in most cases the current food system of Waterloo Region is largely industrial and contains major gaps in fulfilling the criteria of access, sustainability, social justice, and cultural and spiritual attitudes. This food system only partially meets or even fails to meet the criteria. As evidenced in the case study, current governance arrangements to address the issue of food insecurity resulted in exclusion of immigrant populations. The issue goes beyond food and emerges in other planning decisions like the allocation of public spaces. The study recommended broader multicultural policy at the regional government level to include the issues of immigrants.

This study borrowed from Khan (2010) to see if culture and religious beliefs are important factors along with price and accessibility when making food choices. Key informants from the Khan (2010) expert group were interviewed about the criteria of availability consumption of food according to religious beliefs. The majority of

respondents agreed that the food environment of Waterloo Region is really influenced by the dominant food culture of North America, which values cheap, quick, convenient, and tasty meal. Therefore, there is very less accommodation for people of other religions and culture to observe their food choices, although it is improving slowly.

Food Security and Marital Status

I reviewed the study by Frehiwot F. Seid (2007) on Food Security and its Determinants in Rural Households in Amhara region. Although the prevalence and participation rate of single headed households were small in number 53.9 percent of the total married household heads found to be food insecure while 62.55 percent of the total widowed, 67.36 percent of the total divorced and 64 percent of the total separated household heads were found to be food insecure. Thus, about half of two parent households and more than 60 percent of single-headed households were found to be food insecure households in the study area.

In the same study of Although the participation rate of female-headed rural households was small in number the rate of food insecurity among them was found to be highest and accounted for a quarter (235) of the total food insecure sampled households or 65.1 percent (235) of the total female-headed sampled households. In addition the study also found out that in the regression level, the female headed household increase the food insecurity problem than the male headed household

Most of the findings in the descriptive analysis were consistence with the result obtained from the model. The model was fitted with 9 explanatory variables .The regression model shows that larger household sizes significantly increase the problem of household food insecurity.

Food Security and Head of Homestead Age

In the study by Frehiwot F. Seid (2007) on Food Security and its Determinants in Rural Households in Amhara Region where it found out that except for the mean age, the mean of all the rest six variables (per capita food expenditure, kilo calorie per day per adult equivalent, total expenditure per adult equivalent, adult equivalent household size, household size, and number of livestock possessed) were found to be higher for food secured households than for food insecure households.

2.4 Soil and Water Conservation Practices

Soil and water conservation are synonymous terms, in that one cannot be mentioned without mentioning the other in agriculture. A study by Habtamu E. (2006) was guided by the objective to describe soil conservation measures introduced to Anna watershed, Hadiya zone, Ethiopia and to investigate how farmers have adopted introduced conservation measures. It also aimed to assess factors that affect farmers' adoption. The data for the study came mainly from farmers in the study catchment. It was analyzed using two methods: descriptive and regression methods.

Soil conservation measures introduced to the area can be grouped into three depending on the land use type in which they are installed;

Table 1: Table showing the soil and water conservation types

	Soil Conservation Types
soil conservation measures on cultivated fields	soil bunds and fanya juu
soil conservation measures on degraded hillsides	area closure, hillside terrace, micro-basins and plantations
soil conservation measures to rehabilitate gullies	Brash wood check-dams and Rock fill/ loose rock check-dams

Soil bunds

These are embankments constructed from soil along the contour with water collection channel or basin at its upper side. They are constructed by throwing soil dug from basin down slope. They are constructed to control runoff and erosion from cultivation fields by reducing the slope length of the field which ultimately reduces and stops velocity of runoff.

Fanya juu terrace

Fanya juu is a Swahili term having meaning of throwing up-hill (Menfes, 1992; Woldeamlak, 2003). These are embankments constructed by throwing the soil dug from basin to uphill. Like bunds, embankments of fanya juu terrace are laid following contour of fields. They are usually constructed in the fields sloping above 10 percent.

Hillside Closure

It is the closure of areas and denying access to all human and livestock activity, and allowing it to recover by natural process. These areas have been closed to improve land affected by severe erosion, limited vegetation and low fertility through natural regeneration.

Hillside terraces

These are physical structures constructed in steep degraded slopes and shallow soils. These are constructed along the contour. The main objective of constructing hillside terraces is to control runoff, allow sufficient time for percolation of runoff and maintain fertility of soil.

Micro basin

These are small structures constructed by excavating half circle shaped basins for tree planting. For the construction of micro-basin, soil is excavated in 1m diameter to conserve water for plantation.

Rock fill/ loose rock check-dams

These are structures built across the bottom of a gully to reduce the velocity of runoff and prevent deepening and widening of the gully. They are constructed from rock and are economical compared to Brush wood check-dams for gully control (Menfes, 1992).

Farmers responded to soil conservation measures introduced on cultivation fields differently. From 110 respondents, 53 percent removed conservation structures completely, 20 percent removed selectively and the remaining 21 percent of the interviewee retained these structures in their original state.

It was found that farmers' decision to remove completely, to remove selectively or retain in the original state is influenced by different factors. Farmers that perceived the problem of soil erosion better, planned to continue in the farming, and try new technologies were more likely to retain conservation structures. Likewise, farmers that cultivate their own lands, attended soil conservation trainings and those perceived traditional conservation measures to be less effective in retaining soil erosion compared to the introduced soil conservation technologies were more likely to make decision to retain conservation structures installed on their farmland. On the contrary, farmers that were old, having large farmland, plowing black soil and involved in off-farm activities are less likely to retain conservation structures.

Different measures need to be undertaken to address the problem of low level of adoption of conservation structures. Appropriate conservation measures need to be found out instead of heavy reliance on the physical conservation measures especially on cultivation fields. Farmers also need to be made aware of the economic significance of soil erosion on the cultivated fields better. Farmers that lack required labor need to be provided with supports that enable them to retain conservation structures. Farmers that try new technologies by themselves on their own land also need to be targeted.

Farmers need to be provided with trainings on impact of soil erosion and available conservation measures. Information on ineffectiveness of traditional conservation measures has to be disseminated among farmers. Furthermore, farmers have to be made to remain on the agricultural sector, by making the sector more productive, and cultivate their own land.

Physical conservation methods also have barriers which farmers try to cautiously look into while adopting these methods for soil and water conservation. According to Campbell (1991) physical conservation structures take 5 – 15 years period before farmers see the initial benefit from investment in soil conservation. Recent study also indicated that farmers' fear of redistribution of land discouraged them from undertaking conservation measures (Woldeamlk, 2003).

They take large proportion of area out of production. According to Campbell (1991), introduced conservation measures through bund and terraces took up to 10 percent of the precious resource of farmers. The proportion these measures take increased rapidly with increasing slope of the field (Belay, 1992). Nevertheless, the benefit these structures increase from infiltration and reduced soil loss do not outweigh the loss of land to conservation works and the reduced yields caused by vermin living in terraces, water-logging and disturbance of the soil profile (Wood, 1990). These structures also require frequent maintenance, which is high labor demanding. These all resulted in negative attitude towards conservation (Yeraswork, 1988).

2.5 Adoption of soil and water conservation measures

There are sizable farm level empirical studies on farmers' adoption of conservation measures. They have taken a range of approaches to definition and measurements of farmer's adoption of conservation measures. Many of these studies rely on simulation models of conservation decision making to project the influence of various factors on farmer's decision on erosion control measures. In these studies, farmers' adoption of conservation measures was defined in different ways that are far from uniform. For

instance, Ervin and Ervin (1982) used reduction in farm soil loss, estimated with USLE (Wischmeier and Smith, 1978) as a measure of conservation adoption. Saliba and Bromley (1986) used indices of conservation effort derived from USLE (P-factor and C-factors). Norris and Batie (1987), Featherstone and Goodwin (1993) and Lichtenberg (2001) used farmers' overall conservation effort using total spending on soil conservation. Many others used proportion of farmland managed with conservation practices as an indicator of adoption of erosion control measures (Lee and Stewart, 1983; Bultena et al, 1983; Gould et al, 1989). Carlson et al (1981), Kessler (2006), Geoffer (2004), and Traoré et al (1998) used a number of conservation practices a farmer employed out of list of practices to control soil erosion. Others used existence of conservation structures on the farmland (Woldeamlak, 2003; Wogayehu and Lars, 2003; Bekele, 1998; Belay, 1992). All these indices measure different aspects of conservation effort of farmers and cannot be regarded as equivalent to each other.

While these measures of farmers' effort to conserve the soil can be regarded as appropriate to address the objectives of each study, they limit the comparability of the results across the studies. If they were equivalent and comparable, it could have been possible to use them to piece together to a picture of soil conservation decision making across regions (Saliba and Bromley, 1986). In this study, farmers' conservation adoption behavior was conceptualized as retention of conservation structures introduced to the area, involving three alternatives of decisions: removing completely, removing selectively and retaining totally in the original state.

2.6 Theoretical Framework

The theoretical framework used in this study was Adoption and Diffusion of Farm innovation. Adoption and Diffusion is defined as the process by which an innovation is adopted and gains acceptance by members of a certain community. A number of factors interact to influence the diffusion of an innovation. The four major factors that influence the diffusion process are the innovation itself, how information about the innovation is communicated, time, and the nature of the social system into which the innovation is

being introduced (Rogers, 1995). Diffusion research, in its simplest form, investigates how these major factors, and a multitude of other factors, interact to facilitate or impede the adoption of a specific product or practice among members of a particular adopter group.

The study of diffusion theory is potentially valuable to the field of instructional technology for three reasons. First, most instructional technologists do not understand why their products are, or are not, adopted. In a very real sense, the underlying causes of instructional technology's diffusion problem remain a mystery to the field. There appear to be as many reasons for instructional technology's lack of utilization as there are instructional technologists. Some instructional technologists blame teachers and an intrinsic resistance to change as the primary causes of instructional technology's diffusion problem, others cite entrenched bureaucracies and inadequate funding (Schneberger and Jost, 1994). By better understanding the multitude of factors that influence adoption of innovations, instructional technologists were better able to explain, predict and account for the factors that impede or facilitate the diffusion of their products.

Second, instructional technology is inherently an innovation-based discipline. Many of the products produced by instructional technologists represent radical innovations in the form, organization, sequence, and delivery of instruction. An instructional technologist who understands the innovation process and theories of innovation diffusion will be more fully prepared to work effectively with clients and potential adopters (Schiffman, 1991).

Third, the study of diffusion theory could lead to the development of a systematic, prescriptive model of adoption and diffusion. Instructional technologists have long used systematic models to guide the process of instructional development (ID). These systematic ID models have resulted in the design and development of effective and pedagogically sound innovations. A systematic model of diffusion could help guide the process of adoption and diffusion in a similar manner and, perhaps, with similarly effective results.

Before discussing how diffusion theory has been incorporated into instructional technology, provided was a brief background and overview of general diffusion theory. The most important fact to consider in discussing diffusion theory is that it is not one, well-defined, unified, and comprehensive theory. A large number of theories, from a wide variety of disciplines, each focusing on a different element of the innovation process, combine to create a meta-theory of diffusion.

The most likely reason why there is not a unified theory of diffusion is that the study of innovation diffusion is a fairly recent field. (Rogers 1995) points out that a 1943 study by Ryan and Gross at Iowa State University provided the genesis of modern diffusion research. The Ryan and (Gross 1943) study, from the field of rural sociology, used interviews with adopters of an innovation to examine a number of factors related to adoption. The interview-based methodology used in the Ryan and Gross study has remained the predominant diffusion research methodology ever since (Rogers, 1995). A number of researchers from rural sociology (e.g., Fliegel and Kivlin, 1962) and other disciplines (e.g., Weinstein, 1986) have built on the Ryan and Gross' work to conduct studies and develop theories related to the diffusion of innovations.

The researcher did the most to synthesize all of the most significant findings and compelling theories related to diffusion is Everett M. Rogers. Rogers' book *Diffusion of Innovations*, first published in 1960, and now in its fourth edition (Rogers, 1995) is the closest any researcher has come to presenting a unified theory of diffusion. Four of the theories discussed by Rogers are among the most widely-used theories of diffusion: Innovation Decision Process; Individual Innovativeness; Rate of adoption; and Perceived Attributes

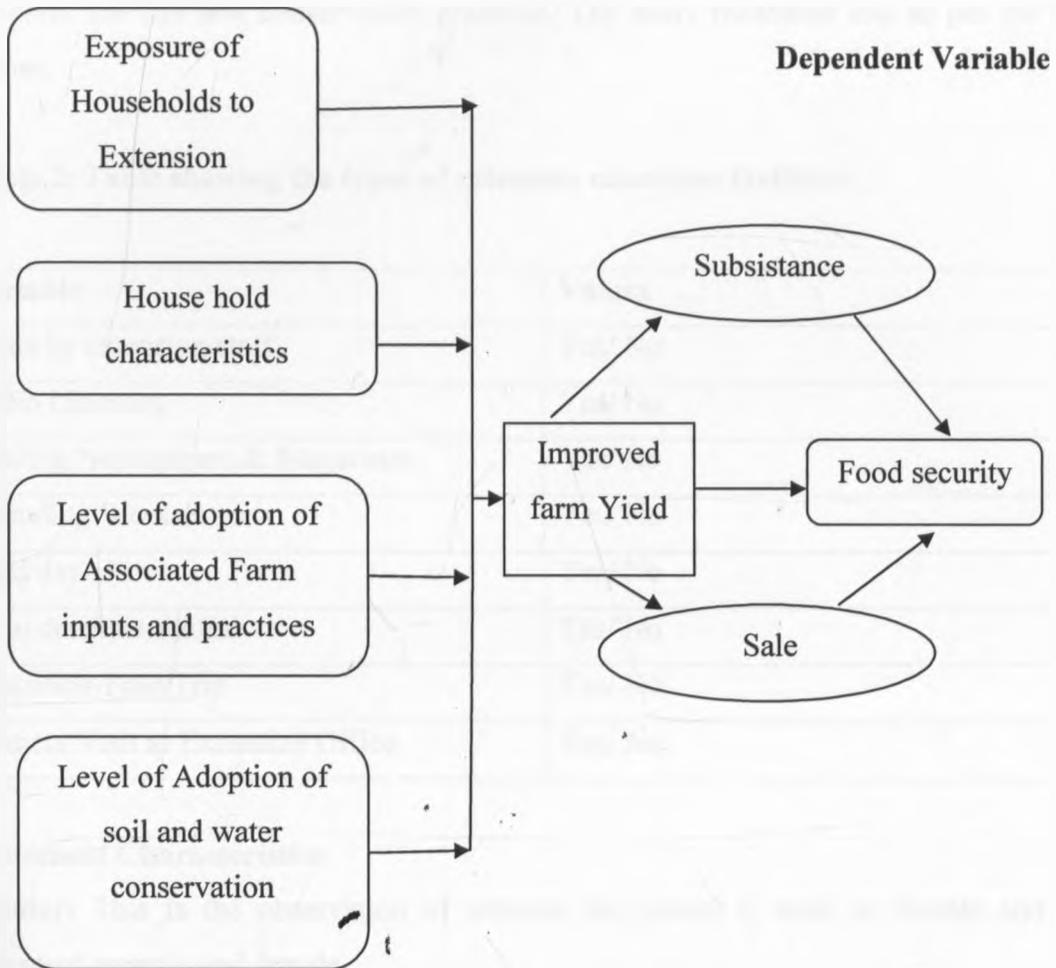
2.7 Conceptual Framework

The study conceptual framework was guided solely by the literature review and it went beyond the methods used for soil and water conservation practices to look at their effects, that is if the already identified methods used for soil and water conservation truly and directly affect food security of small holder farmers in Machakos county. The study further discussed how the independent variables that includes exposure to Household Extension, Household Characteristics (gender, occupation/Income levels, education level, religion, age and marital status), Adoption of recommended farm inputs and practices and the level of adoption of soil and water conservation practices affect the dependent variable which is the measure of Food security of a homestead.

This study investigated as to whether a farmer by using the various methods of soil and water conservation measures increases or reduces their farm maize yields and thus affecting their food security levels. The study also recognized that food security is a multidisciplinary issue and is not affected only by soil and water conservation. The researcher went further to investigate the different other independent variables that have been listed above on a multivariate level to identify the most significant variable that affect food security within Muisuni farmers.

Figure 1: Conceptual Framework

Independent Variables



The Perceived effects of soil and water conservation practices on food security

Source: Adopted from IFAD 2012

2.8 Operational Definitions

Exposure of Households to Extension Education

This is basically the diffusion aspect of the whole study whereas the study sought to find out whether the household / farmer has access to some basic training or information that concerns the soil and conservation practices. The study measured this as per the table below;

Table 2: Table showing the types of extension education facilities

Variable	Values
Visits by extension staff	Yes/ No
Radio Listening	Yes/ No
Reading Newspapers & Magazines	Yes/ No
Attending Workshops	Yes/ No
Field day	Yes/ No
Farm demonstrations	Yes/ No
Education Tour/Trip	Yes/ No
Farmers Visit to Extension Office	Yes/ No

Household Characteristics

Gender: This is the observation of whether the farmer is male or female and it is measured as male and female.

Occupation: This was in two categories measured as a full time farmer if the farmer derives his livelihood from farming activities only, part-time farmer if she/he has off farm occupation to add on for example business person, government/NGO employee as a few examples.

Education Level: This referred to the number of years the farmer attended school and it was measured in two categories only as follows Primary and Secondary & above

Household Income: This was estimated income earned by the farmer and spouse in the past one year. This was categorized as high income farmers, middle income farmers and low income farmers.

Religion: This was basically the religious affiliation of the farmer measured as Christian, Muslim and other.

Age: This was the number of years the farmer has lived measured as range/ categories 18-30, 31-40 and 41 & above.

Marital Status: This was the marital condition of the farmer to ascertain whether he / she was married or not and it was measured in the following categories single; married; divorced; separated; and other.

Adoption and Level of Adoption of farm inputs and practices

The study found out which of the listed soil and water conservation practices are practiced by Muisuni farmers, that may include 1) Ploughing and planting along the contour 2) Rotation of crop and grass 3) Manure favoring the growth of crops 4) Leaving crop residue on the ground combined with terraces, “Fanya Juu”, cut off drain, artificial waterway all as listed by the Farm Management Handbook for Eastern Povince (Ministry of Agriculture and GTZ, 2006); and it will be a Yes if the practice exists and a No if the practice is not there. The practices were not restricted to these listed ones only.

The study measured this by observation in the following ways removing completely for total rejection, removing selectively for partial adoption and retaining totally in the original state for total adoption.

Adoption of other inputs and practices

In this category the researcher found out if there are other farm inputs and practices that farmers in Muisuni are practicing that are not listed in the report. The researcher further categorized and measured the level of adoption as the previously listed methods.

Food Security

Food security has two indicators of a) household own production and b) household income. For the sake of this study, the first option was used to measure the food security among the household and which was basically the level of yield of maize a farmer has harvested and if it lasted the household until the next harvest measured as follows; Somewhat food secure, food secure and lastly, very food insecure.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

In this chapter, a rationale for the research design and methodology that guided the study is highlighted. It involved a blueprint for the collection, measurement and analysis of data. This section was an overall scheme, plan or structure conceived to aid the researcher in answering the raised research question. In this stage, most decisions about how research was executed and how respondents will be approached, as well as when, where and how the research were completed. Therefore in this section the research identified the procedures and techniques that were used in the collection, processing and analysis of data. Specifically the following subsections were included; research design, target population, data collection instruments, data collection procedures and finally data analysis.

This involved collecting information from the selected farms and agricultural extension officers working in Machakos County on water and soil conservation practices and how they impact on food production and food security for small scale households. This was relevant in collecting the data required as time and distance are the limiting factors that inhibit collecting the data from all the districts across the country.

3.1 Study Site

The old Machakos district, in Eastern province, covers a total area of 6051Km² with a projected population of 1,073,605. The district recently was subdivided into 4 districts namely; Machakos, Yatta, Mwala and Kangundo districts. The district borders Makueni to the south, Kitui to the east, Mbeere and Mwingi to the north east, Thika to the North West and Nairobi and Kajiado to the west. Administratively, Machakos is divided into 4 divisions (Central, Athi River, Kalama and Kathiani), Kangundo into 2 (Matungulu and

Kangundo), Yatta into 5 (Ndithini, Yatta, Masinga, Katangi and Mwala into 2 (Mwala and Yathui). The district has four main livelihood zones as indicated in Table 3 below.

Table 3: Machakos Population of Livelihood Zones

Livelihood Zone	Total Population	Percentage
Mixed Farming: irrigated horticulture	9,176	0.8
Mixed farming: coffee/ Dairy and horticulture	356,921	33.2
Mixed farming: livestock/food crop/horticulture	645,891	60.2
Formal/ informal employment: ranching	8,196	
Formal employment/business/trade	62,597	5.83

Source: KFSSG Machakos Short Rains Assessment Report 2008

The main crops grown in the district are maize and beans which are the staple food. Other crops grown in the district are cowpeas, pigeon peas, green grams, sorghum and millet. Cotton and coffee growing and horticulture are practiced but at a very small scale.

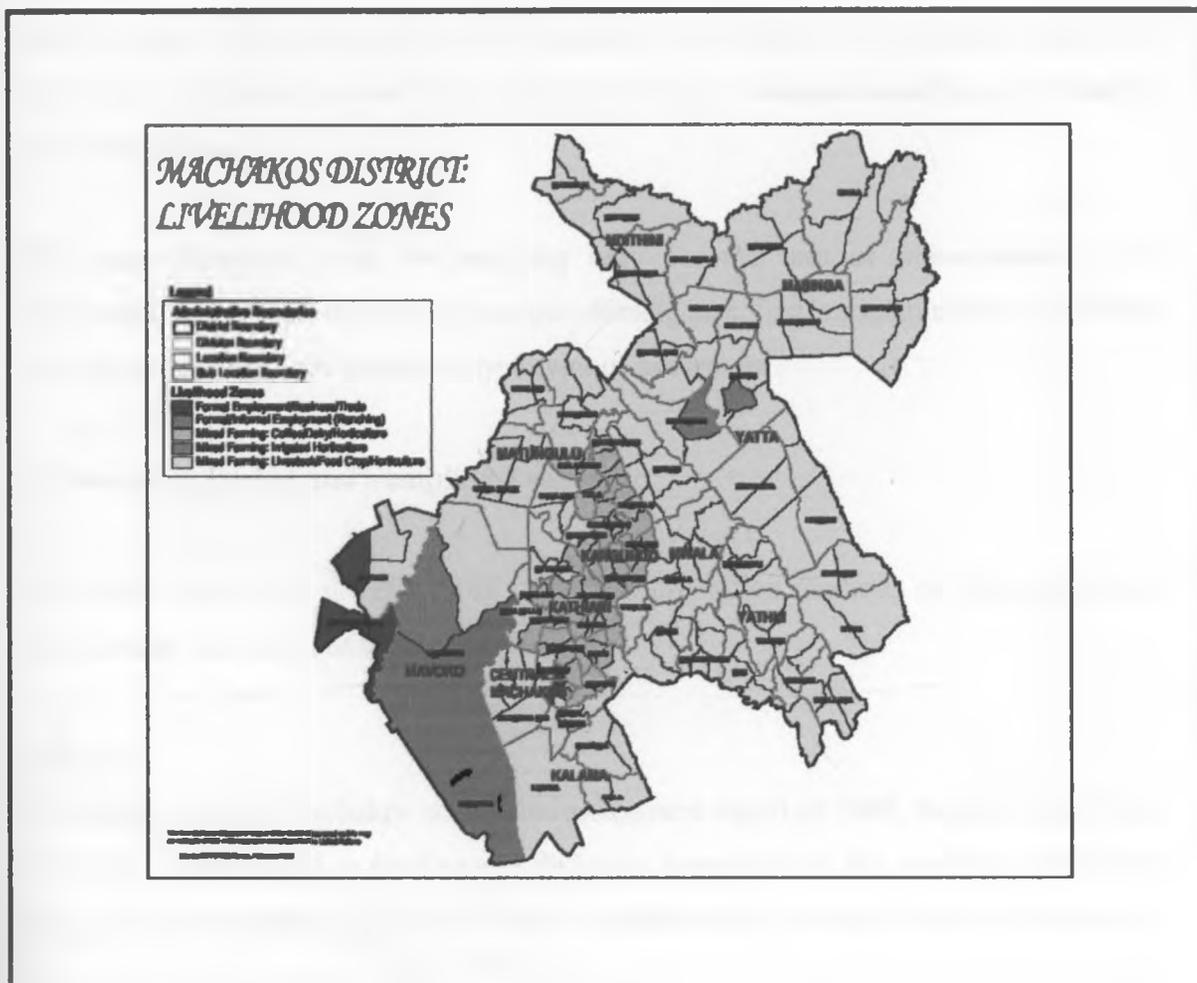
The district was on relief operation in form of Food for Work from 2004 to February 2007. The operation stopped due to successive good performance of both 2006 short and long rains which had improved the food security situation in the district.

The general food security trend in the district was stable and expected to remain so in the next 6 months. The impact of 2007 short rains varied across the district with many parts of the district having positive impact on crops, particularly maize, livestock and water. However, a few places in the district, the situation is likely to deteriorate in the next 1-2 months following poor to total crop failure and result into sell of livestock. These areas are: Katangi, Yatta, Masinga and Yathui divisions.

The main threats to food security in the district remain to be poor performance and early cessation of rainfall, low adoption rate of drought tolerant crops, use of uncertified seeds and poor access to farm inputs especially in the low lands of the district. The study was

tempted to compare the two locations of Yatta and Muisuni, Yatta which is considered highly food insecure compared to areas like Muisuni which is considered food secure. However, this has been deemed impossible due to the researcher's limitation of time and budget and therefore the researcher settled with Muisuni which is a highly agricultural area.

Map1: Map showing Kangundo location within Machakos



Source: KFSSG 2008

3.2 Unit of Analysis and observation

According to Singleton, the entities (objects/events) under study are referred to in social research as unit of analysis (Singleton, 1998). Nachmis and Nachmis (1996) define the unit of analysis as the most elementary part of the phenomenon studied.

This study heavily borrowed from Chitere (1992) article on sampling of small holder farmers for involvement in farm adoption studies in western Kenya where it is identified that the unit of measure goes beyond a household and rather to a homestead owing to the fact that a homestead is what is practically existing in villages in such rural settings as that of Machakos.

This study therefore, took its sampling unit/ for the unit of measurement, to be homesteads rather than households are the ultimate sampling/ measurement units. Where the homestead heads are treated as synonymous to farmers

3.3 Sampling Design and Sampling Technique

This study focused on the effects of soil and conservation methods on food security on small holder farmers in Machakos County.

Sub sites

According to the of Machakos short rains assessment report of 2008, the twelve divisions Machakos were ranked as food secure divisions depending on the rainfall in the district parts. The divisions the researcher referred to district parts is what consists our sub sites.

Katangi, Yatta, Yathu and Masinga divisions were ranked 1st, 2nd, 3rd and 4th respectively as worst food secure divisions which according to the report were characterized with below, poorly distributed and early cessation of rainfall with low adoption of drought tolerant crops. Athi river, Kalama and Mwala are ranked 5th, 6th and 7th with poorly distributed rainfall. The remaining divisions consisting of Ndithini, Matungulu, Kathiani,

Machakos central and Kangundo were ranked 8th through to 12th respectively with no main food security threats.

Although Kangundo was ranked the best food secure place in Machakos these are only true if we only look at rainfall reliability in the area. Therefore Kangundo, which is where Muisuni falls is food secure, still there were reports that on the ground the inhabitants were always hungry and lack food in their homesteads. It is this that drove the researcher to investigate food security more deeply, to try and see if there were truly enough maize yields to last the home stead until the next harvest. Yatta is ranked second most food insecure locality in Machakos and the researcher had some interest to try and compare the two divisions in terms of the effects of soil and water conservation methods as it affects maize yield production and in effect, affecting food security but due to time and budget limitations, the researcher opted to only pick Kangundo/Muisuni location because of its proximity to the researcher and therefore budget friendliness. Also this not being a comparative study, the researcher chose to stick to one locality for her study.

Therefore the study picked a sub site of Machakos district, Kangundo division, Kangundo location and Muisuni sublocation and even more specifically around the Maiyuni village mainly because of the reasons above.

Self Help Groups/ Mwethia

The study recognized that Muisuni sub location is large and sparsely populated because of its rural nature and therefore to get a sample frame might be a daunting task and therefore for ease of this activity, the researcher identified to capture the correct sample frame would be through community self help groups in the area or what is locally referred to as 'Mwethia's'. The researcher identified three community groups in the area of interest where the sample will be picked and these included Muisuni Society, Kwamangu Society, Mavindu and Isinga Society groups. The researcher chose to pick Muisuni society group as it is the mother of these other groups. Its members exclusively grow maize and coffee which they bring to the society factories for sale.

Homestead Heads

The homestead heads were the head or the eldest member of the “boma” this being the head of the extended family of the same family living together with their own livestock and property in one shamba and they were picked to constitute our main sample. They were picked from the names enlisted in the chosen mwethia list meaning they must be members of the community grouping to be considered in our sample. Muisuni has approximately 800 members mostly men and totally mixed households. As pertains homestead heads, Muisuni has approximately 200 homestead heads which will consist the researcher’s sample frame (N). The researcher is targeted a sample (n) of maximum of 100 homestead heads out of the whole village population of Maiyuni.

The study adopted and was guided by sampling technique called non-area sampling as adopted by Chitere and Alghai (1991). The researcher carried out a short reconnaissance survey to acquaint herself with the area, its agronomic, entomological and socio-economic conditions, and to meet and discuss with the chief, agricultural agents, civic leaders and a few farmers. This was for the purposes of getting the unofficial village lists from the leaders of the area. The researcher identified the existing “mwethia’s” in the area that mainly including the agricultural societies in the area. From these self help groups or the “mwethia’s”, the researcher identified the existing list farmers from the villages in area who use the facilities of the extension officer to create her sampling frame.

The researcher went further and accessed the use of google maps by the help of GIS survey methods to get a simple map of the study area which included the sub-locations. The researcher carried out participatory GIS where from the maps, the identified “mwethia” leaders (who were our key informants) and identified the villages and the homesteads in the area within the map sketching out the “mwethia’s” boundaries that would also be the researcher’s study area, after which the names of the homesteads were revealed by the same “mwethia” leaders. Additional information such as the estimated population of the homesteads (N) were availed as well. To get the samples (n) then the

first homestead in each village was identified and the next sampling unit was selected serially as every fifth homestead in any one direction; the technique aims at approximating systematic sampling design. A selected homestead was substituted by the next one where its head could not be found.

Key Informants

The researcher used four key informants in the study, the key one being the homestead head, mwethia group leaders used mainly to get information on the extension worker/ services information which assisted the researcher in the reporting therein. The chairman of the self help group and the District extension officer also formed part of the key informants.

3.4 Data Collection

3.4.1 Type and Sources of Data

The study collected both primary and secondary data for the purpose of investigating the water and soil conservation practices and how they impacted on food production and food security for small scale households in Machakos District.

Primary Data

Primary data was collected using questionnaires to agricultural extension officers and farmers in Machakos District. Additionally the chairman of the self help group and the District extension officer formed part of the key informants.

Secondary Data

Secondary data was obtained from annual reports from the Ministry of Agriculture, journals, Kenya meteorological reports were used.

3.4.2 Data Collection Instrument

With respect to water and soil conservation practices on food security, this study utilized a questionnaire used in various previous research projects (Gicheru and Kiome, 2000; Odhiambo et al, 2004). The questionnaire designed in this study comprised two sections. The first part designed to determine fundamental issues including the demographic characteristics of the respondent, while the second part consisted of questions where the variables were be focused.

3.4.3 Data Collection Procedure

This study collected quantitative data using a self-administered questionnaire. The researcher dropped the questionnaires physically at the respondents' place of work. Nevertheless, where it proved difficult for the respondents to complete the questionnaire immediately, the researcher left the questionnaires with the respondents and picked them up later. The structured questions were used in an effort to conserve time and money as well as to facilitate in easier analysis as they are in immediate usable form; while the unstructured questions were used so as to encourage the respondent to give an in-depth and felt response without feeling held back in revealing of any information. Each questionnaire was coded and only the researcher knew which person responded. The coding technique was only used for the purpose of matching returned, completed questionnaires with those delivered to the respondents.

The researcher also used observation as a research method to review the level of adoption of soil and water conservation techniques.

3.5 Data Analysis and Presentation Methods

Before processing the responses, the completed questionnaires were edited for completeness and consistency. The data was then coded to enable the responses to be grouped into various categories. Data collected was purely quantitative and it was analyzed by descriptive analysis. The descriptive statistical tools such as SPSS and MS Excel will help the researcher described the data and determine the extent used. The findings were presented using tables and charts. Multivariate analysis was used to test the significance of the independent variable. Data analysis used SPSS and Microsoft excel, percentages, tabulations, means and other central tendencies. Tables were be used to summarize responses for further analysis and facilitate comparison.

CHAPTER FOUR

DATA PRESENTATION

4.0 Introduction

This chapter was dedicated to reporting of the findings. It is divided into several sections as per the objectives of the study.

4.1 Level of food security among the households sampled.

The first objective of this study was to establish the level of food security among the households sampled. The indicators for the objective being how much yield of maize and intercrop was obtained during the last harvest, was the crop yield sufficient to the household up to the next harvest, the reasons for insufficiency and lastly how to supplement food shortages.

Table 4: Crop sufficient to last your household to the next harvest?

Responses	Frequency	Percent
Yes	28	53.8
No	9	17.3
Missing	15	28.9
Total	52	100.0

As represented in table 4 above, a majority of the farmers 53.8 percent confirmed that they had sufficient maize yield to last up to the next harvest. This meant that they were food secure. However 17.3 percent were not food secure the main reason being poor rainfall. 28.9 percent respondents confirmed that rain failure was the main cause of food insecurity. When asked how they supplement the food shortages 80.8 percent confirmed that they purchase food.

It specifically looked at the comparison of livelihoods and food security issues in Muisuni area, the study just like that of Ali (2005) and Ellis (2000) discovered that livelihood diversification is one of the ways to achieve, maintain and enhance livelihood security. This study mainly looked at the homestead head attitude towards risk. This was to be shown in the study through the involvement of the homestead head occupation other than just farming activities. As revealed in table 2 below the study results showed that only 11.5 percent of the farmers were involved in other farming activities other than just farming (i.e. 11.5 percent of the farmers are part time farmers). These results are contrary to those of other researchers cited by this study showing that despite of some food shortages, most of the farmers have maintained to only farming activities.

Table 5: Farmer's Livelihoods

Farmer's Livelihoods	Frequency	Percent
Farming activities only	46	88.5
Part time farmer	6	11.5
Total	52	100.0

As shown in table 5 above majority of the farmers rely on farming activities as indicated, however it is quite logical that diversification is inevitable in the instances where the homesteads are faced with shortages and from the results some of the homesteads resulted to purchasing of food where they were faced with shortages. This is explained further in the food security level of the area as shown by table 4.1 where 53 percent are food secure.

4.2 Level of adoption of farm inputs and practices as recommended by the extension services

The second objective of this study was to determine the level of adoption of farm inputs and practices recommended by the extension services. The study reviewed this on the basis of adoptability of the farm practices to the farmers land and this was done mainly

by observation, the researcher reviewed the following main indicators; soil and water conservation practices adopted, if the currently used conservation methods are either fully, partly retained or completely removed from use in the farms in question, if the adoption of the methods has increased the maize yield.

According to table 6 below, the first indicator soil and water conservation practices adopted I reviewed measures on cultivated fields, degraded hillside and rehabilitated gullies. In cultivated fields, 48.1 percent confirmed that fanya juu was the most adopted as compared to 21.2 percent for soil bunds.

Table 6: Adopted: Soil conservation measures on cultivated fields

Conservation Measures	Frequency	Percent
Soil Bunds	11	21.2
Fanya Juu	25	48.1
Missing	16	30.8
Total	52	100.0

As indicated in Table 7 below measures taken in degraded hill sides confirmed that 78.8 percent did hill side terracing as compared to 3.8 percent who practiced micro-basins.

Table 7: Adopted: Soil conservation measures on degraded hillsides.

Conservation Measures	Frequency	Percent
Hill side Terrace	41	78.8
Micro-Basin	2	3.8
Missing	9	17.3
Total	52	100.0

As indicated in table 8 below, measures to rehabilitate gullies reported that check-dams was the only method used for adoption.

Table 8: Adopted: Soil conservation measures to rehabilitate gullies

Conservation Measures	Frequency	Percent
Check-Dams	5	9.6
Missing	47	90.4
Total	52	100.0

According to table 9 below, the results showed that in using new farm soil and water conservation method 57.7 percent retained totally in the original state. Additionally the results showed that 75 percent of the respondents confirmed that the new method increased their maize yield.

Table 9: What is the state of the new farm soil & water conservation method?

Farm Soil & Water Conservation Method	Frequency	Percent
Retained Totally in its original state	30	57.7
Missing	22	42.3
Total	52	100.0

Achieving livelihood and food security issues of rural households was a major goal of many farmers and thus every opportunity to attain new information on soil and water conservation method is important as it translates to increase maize crop yield as illustrated in (Table 10 below). The utilization of agricultural technology by farmers plays an important role in boosting the agricultural production.

Table 10: Has the information on soil & water conservation methods increased your maize crop yield?

Responses	Frequency	Percent
No	13	25.0
Yes	39	75.0
Total	52	100.0

In conclusion according to the results and as seen in Table 11 below all of the respondents said that they retained totally in the original state the new method of soil and conservation technique they had adopted in their farm. The study took a different turn of instead of using simulation to determine the state by which the technique of soil and water conservation method has been, the researcher went on the ground and observed for herself.

Table 11: Relationship between state of the new farm soil & water conservation method and food security

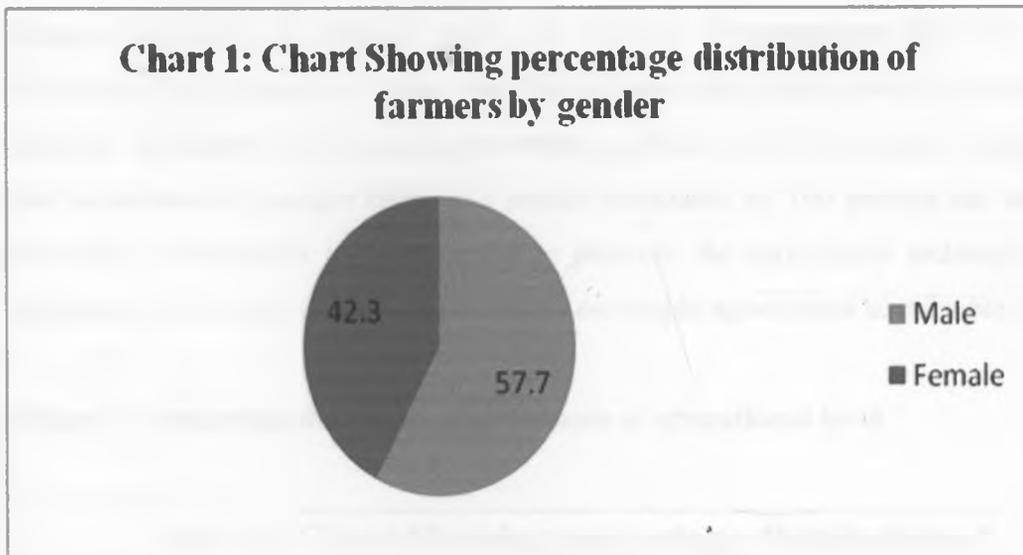
Presence of conservation methods	Food Security			
	Yes	No	Missing/DK	Total
State				
Count	18	9	3	30
retained totally in the original state	34.6	17.3	5.8	57.7
Count	10	0	12	22
Missing	19.2	0.0	23.1	42.3
Count	28	9	14	52
Total	53.8	17.3	28.8	100.0

4.3 Characteristics of the households sampled

Food Security and Household Characteristics

The third objective of this study was to examine the characteristics of the households sampled. The study therefore borrowed from Koriala G. (2003) where it was suggested that the whole extension system that there are more men (57.7 percent) who are involved in the agricultural extension services as compared to 42.3 percent of their female counter parts.

Figure 2: Gender and Food Security



Education Level and Food Security

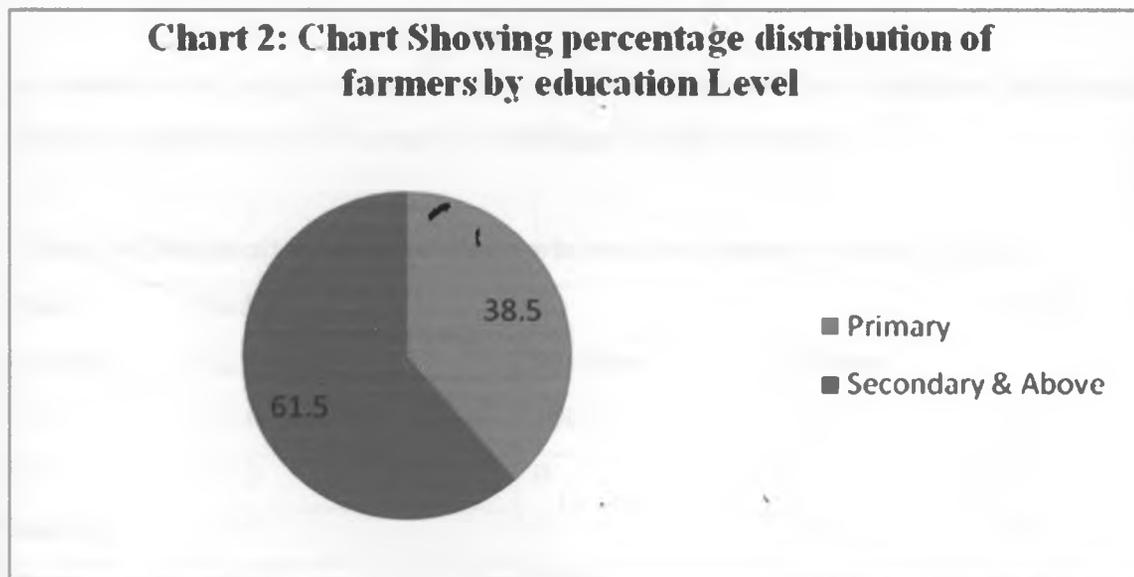
Moving further in this study as suggested earlier assessed the linkages that exist between education levels and food security. The study analyzed this by presenting frequency tables on the variables of education and food security and the results showed that the relationship that exists between the variables of food security and that of gender is not significant as shown by Table 12 below. The study is in agreement with the study done by Francesco Burchi (2006) which its empirical analysis indicated that basic education and not higher education is a key factor for food security as the results from the table below shows that of the percentage that are food secure, 55.0 percent are food secure with basic primary education as compared to 53.1 percent of their counter parts with secondary and above levels of education.

Table12: Distribution of respondents who are food secure by their education levels

Responses	Education Level		Total
	Primary	Secondary & Above	
Yes	55.0	53.1	53.8
No	20.0	15.6	17.3
Missing	25.0	31.3	28.9
Total	100.0	100.0	100.0

However as shown in Chart 3 below, the number of respondents with basic primary education (38.5 percent) is lower than that of secondary and above (61.5 percent) and therefore the study is of the recommendation, just like that of Francenco Burchi (2006), that an increase in younger children’s school attendance by 100 percent can reduce food insecurity as education is fundamental to promote the agricultural techniques as their recipients will be able to follow instructions on simple agricultural sustainable methods.

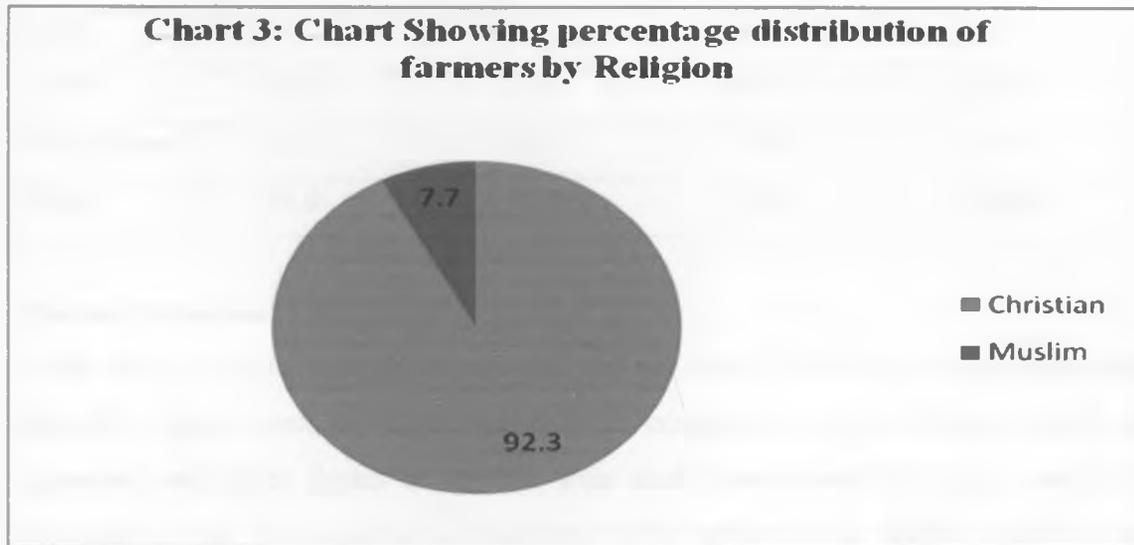
Figure 3: Percentage distribution of farmers of educational level



Religion and Food Security

Food insecurity as suggested earlier may not necessarily be not having enough amounts of food but not having food that is appropriate according to culture and religion. Musiuni area may not exhibit such religion extremes as most of the respondents are of Christian religion (92.3 percent) as shown by the Figure 4 below.

Figure 4: Percentage of Distribution of Farmers by Religion



As much as the religion is concerned in Muisuni, there is no significant relationship between religion and food security as exhibited in table 13 below.

Table 13: Distribution of respondents who are food secure by their religion

Food Secure	Religion			Total
	Christian	Muslim	Others	
Yes	50.0	100.0	33.3	53.8
No	17.3	0	0	17.3
Missing	14.3	0	66.7	28.9
Total	100.0	100.0	100.0	100.0

Homestead Head Age and Food Security

Results from the total population below suggested that most people were food secure 56.0 percent whereas the age group 41 and above were the most food secure group with 36.0 per cent of the respondents admitting they are food secure.

Table 14: Distribution of respondents who are food secure by their age

Age	Food Secure			Total
	Yes	No	Missing	
18-30	4.0	0	0	4.0
31-40	16.0	4.0	2.0	22.0
41 & above	36.0	14.0	24.0	74.0
Total	56.0	18.0	26.0	100.0

Marital Status and Food Security

Most studies that the research has quoted had the findings that the married respondents had the lowest levels of food insecurity as compared to the widowed, single and separated and other forms of unions. This study interviewed 90.4 per cent of the respondents who were married as compared to 9.6 percent of the single respondents and the results of the study further showed consistency with other descriptive analysis results of other studies as suggested earlier in the literature review where the suggestion was the married respondents had a higher level of food security where as the table 15 below showed that 48.1 percent of the respondents were married and were food secure as compared to 5.8 percent of the single respondents.

Table 15: Distribution of respondents who are food secure by their marital status

Marital Status	Food Secure			Total
	Yes	No	Missing	
Single	5.8	0	3.8	9.6
Married	48.1	17.3	25.0	90.4
Total	53.8	17.3	28.9	100.0

The conclusion was drawn from the table below (Table Model fitting Information) on the multivariate level, where there were 5 household characteristics variables in the model, the model showed a weak relationship where 37.98 percent of the variation in food security is accounted for by the independent variables in the model.

Table 16: Model fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	54.71			
Final	37.98	16.73	21.00	0.73

From the results as well, Age has been seen as having the highest strength in variation as compared to the other four independent variable, meaning that for the age variable, we would expect an increase of 20.95 percent in the food security variable score for every one unit increase in age value assuming that all the other variables in the model are held constant. According to the model, it also shows that gender has the highly negative variation to the dependent variable (food security).

Table 17: Food Security and Household Characteristics on the multivariate level

Characteristics	B	Std. Error	Wald	df	Sig.	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Intercept	19.62	1.33	216.82	1.00	0.00		
Gender	-18.25	0.85	462.30	1.00	0.00	0.00	0.00
Education Level	18.61	0.87	454.51	1.00	0.00	21778147.46	666563008.42
Religion	17.88	0.00	.	1.00	.	58279821.12	58279821.12
Age	20.95	0.00	.	1.00	.	1251880644.95	1251880644.95
Marital Status	-15.98	0.00	.	1.00	.	0.00	0.00

4.4 Exposure to agricultural extension education efforts.

The fourth objective of this study was to examine how farmers in the study are exposed to agricultural extension education efforts. The researcher asked several questions in the quest of delivering relevant answers in the search to meet the objective. When the farmers were asked if they receive/seek information as shown in the table 18 below on soil and water conservation techniques 47 farmers out of 52 or 90.4 percent of the farmers said they receive information.

Table 18: Farmers seeking/ receiving information on soil and water conservation techniques

Response	Frequency	Percent
Missing	3	5.8
Yes	47	90.4
No	2	3.8
Total	52	100.0

In table 19 below shows responses of the report, when asked about the main reason for farmers seeking information from extension workers, majority of the respondents (84.6 percent) declared that it was for the reasons of solving daily problems, this coincides with the finding of Shin and Evans (1991) that stated that the main reason for the extension worker to seek information was to answer the clients needs, the client here being the farmer, and this counters the findings of the report where the farmers seeks information from the extension workers mainly for solving daily problems and therefore the extension worker needs to be updated on the daily challenges facing the farmer in order to solve them.

Table 19: Main reason for seeking information extension workers

Reason for seeking information	Frequency	Percent
Other	3	5.8
To attend training courses	4	7.7
Solving daily problems of farmers	44	84.6
Updating information	1	1.9
Total	52	100.0

This study further reviewed the format in which the farmer receives information from the extension workers on the soil and water conservation techniques in order to boost their yield. Table 20 below shows that most farmers (90.4 percent) declared that they received the information orally as compared to 3.0 per cent of them who received the information in a written format.

Table 20: The format of receiving information

Format of receiving information	Frequency	Percent
Other	3	5.8
Oral	47	90.4
Written	2	3.8
Total	52	100.0

The results further indicated that majority of the respondents reported that they received information orally and this may be directly from the extension exercises or indirectly through here say from their neighbors, family and friends.

Table 21: Medium through which information about soil and water conservation techniques practiced in your farm was derived from?

Medium	Frequency	Percent
Other	1	1.9
Visit by extension worker	24	46.2
Radio listening	19	36.5
Farm demonstrations	6	11.5
Farmers visits to extension office	2	3.8
Total	52	100.0

The study by Feder et.al. (2004b) showed that better knowledge leads to better results that is better crop yield, the same was reinforced by Alene and Manyong (2006) who in their study agreed that more information on soil and water conservation techniques leads to better yield, Chaudhary et.al. Additionally concluded that agricultural techniques leads to boosts in agricultural production. With these common results when farmers in muisuni were asked if the information received helped them increase their crop yield, majority of them (75.0 percent) agreed that when they received the information, their crop yield increased significantly. The table 22 below further proclaimed that the information gathered by the respondents on the soil and conservation methods increased their maize yield and therefore boosting food security in muisuni.

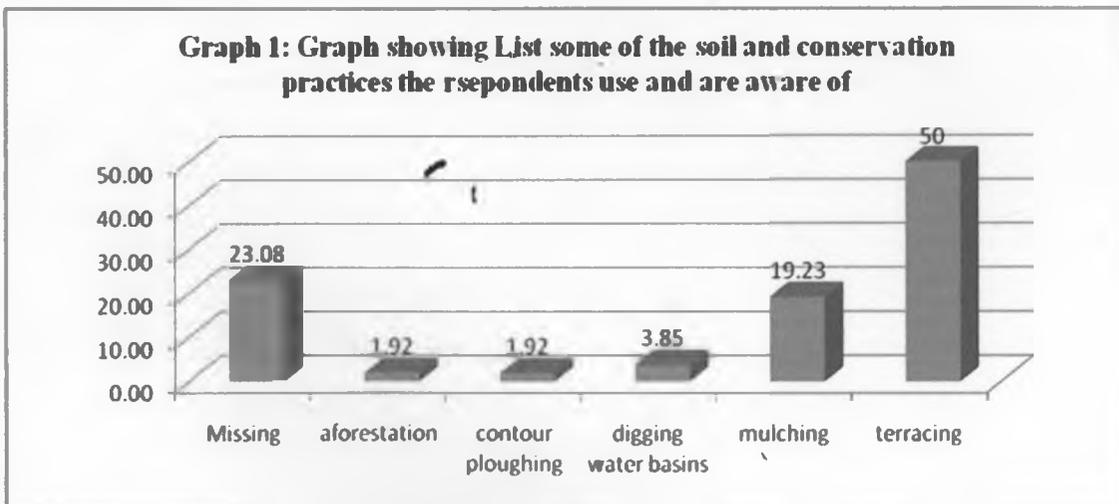
Table 22: Did the information on soil & water conservation methods increase your maize crop yield?

Responses	Frequency	Percent
Missing	13	25.0
Yes	39	75.0
Total	52	100.0

The study therefore concluded that when farmers receive information on the methods of soil and water conservation techniques is dependent farming method which directly influence the crop yield of the farmer and therefore dependent to each other. The results also shows that food security is also dependent to the medium through which the farmer receive the information on soil and water conservation techniques and therefore the study reiterates that more needs to be done to ensure that information which will increase crop yield does reach the farmer in the right and the most appropriate method, which is through the direct visits by the extension worker.

The soil and water conservation practices are synonymous terms in that one cannot be mentioned without mentioning the other in agriculture. This report mainly reviewed the various soil and water conservation methods used by the farmers, Graph 1 below shows the various methods farmers use. Figure 5 below indicates that terracing is mostly used 50.0 percent as a method of soil and water conservation. When going further the results shows that there is no significant relationship between food security and the methods of soil and water conservation in Muisuni

Figure 5: List some of the soil and conservation practices and respondents use and are aware of



In conclusion and following the study as represented in table 20 indicates that 15 respondents out of the total 23 shows that terracing is the most commonly used method that enhances food security.

Table 23: Food security and types of soil and water conservation practices

Practices	Yes	No	DK	Total
Missing	6	0	6	12
Aforestation	1	0	0	1
Contour ploughing	1	0	0	1
Digging water basins	0	0	2	2
Mulching	5	1	4	10
Terracing	15	8	3	26
Total	28	9	14	52

4.5 Conclusion

Training farmers on new technology and new knowledge is the key to improving the productivity of agriculture. As suggested from the findings a large population can be sustained through a combination of both endogenous and exogenous technological change to boost their food security level.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Summary of Findings

The study covered Muisuni area in Kangundo, Machakos district in a quest to establish the effects of soil and water conservation practices of food security. The study had a response rate of 52 per cent where 57.7 percent (30) respondents were male and 42.3 percent (22) were female. 61.5 percent were of secondary level education and above, as expected, 71.2 percent were elderly with 41 and above the majority 90.4% was married.

The study was looking at answering its objectives of “How farmers are exposed to agricultural extension educative efforts in rain deficient areas in Kenya?”; What are the levels of food security among the small scale households in rain deficient areas in Kenya?; What are the relationships between food security and household characteristics in the semi arid areas in Kenya?; What are the farming soil and water conservation practices used in semi arid areas in Kenya?; What is level of adoption of soil and water conservation practices used in rain deficient areas in Kenya?. The study mainly used frequency tables for the purposes of determining characteristics of the study population it further reviewed the household characteristics on the multivariate level in an attempt to review the significance in relationship between the independent variable and the dependent variable in our case being Food Security. The study established that only the variables of the new farming soil and water conservation and the medium through which the information on soil and water conservation techniques are received had significant relationship to food security.

5.1 Conclusions

There were 5 household characteristics variables in the model, the model showed a weak relationship where 37.98 percent of the variation in food security is accounted for by the

independent variables in the model. From the results as well, age has been seen as having the highest strength in variation as compared to the other four independent variable, meaning that for the age variable, we would expect an increase of 20.95 percent in the food security variable score for every one unit increase in age value assuming that all the other variables in the model are held constant. According to the model, it also shows that gender has the highly negative variation to the dependent variable food security. The study therefore concluded that Age is a very important factor to food security as amongst others, it show that the respondents are well exposed to information and are conclusively aware of what to expect and where to go to in cases of agricultural deficiencies.

5.2 Recommendations

The topic on agriculture is a very vast one and therefore it needs quite a substantial amount of time and money to study the subject effectively as it is only through extensive research that we can get the true picture on the ground. Although the study made a positive contribution to agriculture, it also recommends that food security should not only be looked at as the yield to last until the next harvest but also in dietary compositions.

The study therefore recommends further conclusive research be done to combine the various components of food security in order to get the conclusive impact of independent variables to food security. Early warning systems should be put in place in order to assist the farmers plan and have knowledge on what decisions to make on their farming practices. Partnering with the private sector should also be encouraged this will facilitate sharing of information.

Learn from other parts of the country or neighboring countries that have a successful record should be advised. Analyze their experiences to identify suitable strategies and approaches. Systematic research is advised to find out what is happening where, and the types of technologies impacts and lessons emerging. The Government should provide access to water, support for rain water harvesting. This would be a good investment by the government for the farmers.

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APPENDICES
APPENDIX I: QUESTIONNAIRE

EFFECTS OF SOIL AND WATER CONSERVATION PRACTICES ON FOOD SECURITY OF SMALL SCALE HOUSEHOLDS: A CASE STUDY OF MACHAKOS COUNTY, KENYA

Section 1: Introduction

The researcher is a Masters Student at the University of Nairobi pursuing a Masters Degree in Sociology – Disaster Management and is currently doing a study on the above topic in Muisuni area. The study involves investigating the effects of soil and water conservation methods as practice in Muisuni with the aim of getting the outcome of the various practices in regard to whether it enhances Food Security. The researcher has identified your participation from the area *mwethia*/ SelfHelp Group that has identified you as a beneficiary of the extension officers' services. The findings from this research aim to formulate policy recommendations that are aimed to increase food security in the area through diversifying the soil and water conservation methods farmers are using, therefore your open and free participation will be highly appreciated.

0.1 Farmers Name: _____ 0.2

Village _____

0.3 Date of Interview: ____/____/____

0.4 Enumerator: _____

0.5 GPS readings: _Alt: _____ Eastings: _____

Northings _____

Key Farm Household Demographics

1.1 Gender: male ___ female _____

1.2 Occupation: farming activities only____, part-time farmer (farming + e.g. business person, government/NGO employee e.t.c.)_____

1.2 a if part-time farmer what are your off farm occupation? List below

1.2 b what is your spouse's occupation? _____

1.2 c How much is your income earned in the last one year? _____

1.2 d How much is your *other income* earned in the last one year? _____

1.3 Education Level: Primary ___ Secondary & above ___ None ___

1.4 Are you a Christian ___ Muslim ___ and other ___

1.5 Age: 18-30 years ___ 31-40 years ___ and 41 years & above ___

1.6 Marital Status: single ___ married ___ divorced ___ separated ___ and other ___

If married, how many wives (for male respondents) _____

1.7 Do you own land? 1= Yes 0= No

1.7a if No above, how long have you lived on the land? A) Less than 1 year B) 2-5years
C) More than 6 years

1.7b what size is your land? A) Less than an acre B) More than acre C) Don't know

1.8 Do you own a mobile phone? A) Yes ___ B) No ___

1.9 Do you live close to a) road b) market c) community social hall d) other social amenities specify _____ d) none

Access to Extension Sources of Information

2.1 Do you receive/seek information on soil and water conservation techniques? 1=Yes
2=No

2.1 a What is the main reason for seeking information extension workers?

1. To hold training courses
2. Solving daily problems of farmers and(or)
3. up-dating their information

2.2.a In what form do you get the information as? 1=Oral 2=Written 3=Electronic
4=other

2.2.b Through whom or which medium did you get informa on about the soil and water
conservation technique that you are practicing in your farm?

Visits by extension staff	yes=1 no=0
Radio Listening	yes=1 no=0
Reading Newspapers & Magazines	yes=1 no=0
Attending Workshops	yes=1 no=0
Field day	yes=1 no=0
Farm demonstrations	yes=1 no=0
Education Tour/Trip	yes=1 no=0
Farmers Visit to Extension Office	yes=1 no=0
Phone Messages	yes=1 no=0
Indirectly through husband/wife, neighbor's And other villagers/ sources	yes=1 no=0

Adoption of Soil Conservation Practices

3.1 Which are some of the soil and water conservation practices you are aware of?

Which of the following soil and water conservation practices have you adopted?

3.2. soil conservation
measures on cultivated
fields

1= soil bunds

2= fanya juu

3=Other Specify

Code

3.3. soil conservation
measures on degraded
hillsides

1= area closure

2= hillside terrace

3= micro-basins

4= plantations

5=other (specify)

Code

3.4. soil conservation
measures to rehabilitate
gullies

1= Brash wood

2= check-dams

3= Rock fill/ loose rock

4=other (specify)

Code

3.5. Please list other methods of soil and water conservation methods that are used by the farmer other than the ones listed above _____

3.6. What is the state of the new farm soil & water conservation method? (this is done by observation)

1= removed completely 2=-removed selectively and 3=retained totally in the original state.

3.7. Has the information and adoption of soil & conservation methods increased your maize crop yield?

1=Yes 2=No

If yes above;

3.7.a Maize yield obtained before using farm inputs and practices methods (estimate no. of 90kg bags)_____

3.7.b Maize yield obtained after using farm inputs and practices methods (estimate no. of 90kg bags)_____

3.8. Which of the following farm inputs and practices did you use in the last one year?

Planted early (specify month)_____

Improved maize seed (specify type)_____

Chemical fertilizer (specify type)_____

Organic fertilizer (manure)_____

Planted in rows (specify) _____

Intercropped (specify intercrop e.g. beans)_____

Clearly weeded (specify no. of weedings in the last one year)_____

Controlled insect/ pests (specify) _____

Other (specify)_____

Food Security

3.9 How much yield of maize and intercrop did you obtain in the last harvest (90kg bags)

	Maize	Intercrop
Long rains	_____	_____
Short rains	_____	_____

4.0 Was the crop yield sufficient to last your household up to the next harvest?

Yes ___ No ___

4.0 a. if no above, approximately how long did the harvest last?'

Less than 3 months _____

3-5 months _____

6-8 months _____

Over 9 moths _____

4.0 b. if no above (in 4.0), what is the reason?

1. Rainfall failure _____
2. Crop failure _____
3. Crops damaged in storage _____
4. Poor cultivation _____
5. Other (specify) _____

4.1. If yield did not last until the next harvest, how did the household supplement your food shortage?

1. Purchase food
2. Borrow food
3. Started growing cash crops exclusively
4. Other (specify) _____

******THANK YOU FOR YOUR COOPERATION******

APPENDIX II: OBSERVATION TOOL

Types of Soil and Water Conservation Practices	Retained Totally	Retained Partially	Removed Completely
Cultivated Fields			
Degraded Hill Sides			
Rehabilitated Gullies			

APPENDIX III: MUISUNI FARMERS' COOPERATIVE CATCHMENT AREA

