SOCIO-ECONOMIC FACTORS INFLUENCING ADOPTION OF IMPROVED MAIZE STORAGE SYSTEMS IN BUNGOMA DISTRICT, KENYA

BY

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DECLARATION

This Research Project is my original work and has not been submitted to any other University.

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DEDICATION

This research project is dedicated to my beloved mother Jane Oburu and my siblings for their insurmountable love, warmth, encouragement, financial assistance and for being near me at moments of need.

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LIST OF ABBREVIATION AND ACRONYMS

AFC - Agricultural Finance Corp oration

CGA - Cereal Growers Association

FAO - Food and Agricultural Organization

IMSS - Improved Maize Storage Systems

GOK - Government of Kenya

KARI - Kenya Agricultural Research Institute

KMDP - Kenya Maize Development Program

LGB - Larger Grain Borer

MOA - Ministry of Agriculture

NCBP - National Cereals and Produce Board

OAF - One Acre Fund

PPS - Population Proportional to Size

SSA - Sub Saharan Africa

SPSS - Statistical Package for Social Scientists

UON - University of Nairobi

USA - United States of America

ABSTRACT

Post-harvest facilities or appropriate storage technology has been the major problem of Kenyan agricultural sector and has resulted in inconsiderable waste of agricultural output and great loss to the economy. The purpose of this study was to determine socio-economic factors influencing adoption of improved maize storage systems in Bungoma District. The specific objectives of the study were: to establish the extent to which education of farmers influences adoption of improved maize storage systems, determine role of training of farmers in influencing adoption of improved maize storage systems, examine how cultural factors influence adoption of improved maize storage systems, and determine how economic status of farmers influence adoption of improved maize storage systems in the district. The target population of the study was 60,000 small scale farmers undertaking maize farming in Bungoma District from which a sample size of 204 was drawn and involved in the survey. The study utilized multistage cluster sampling technique by use of administrative clusters and thereafter simple random sampling to interview farmers by use of questionnaires. Pilot testing was done in Kakamega District to assess validity and test retest method to ensure reliability. Data obtained from close ended questions was analyzed using quantitative techniques such as frequencies and percentage counts and presented using frequencies and percentage tables with the aid of SPSS (Statistical Packages for Social Scientists). Qualitative data was transcribed, organized into various emerging themes and reported narratively. The study findings revealed that education strongly influenced adoption of IMSS. Although most people had knowledge on IMSS, there was still low adoption, with 62% of farmers who had knowledge not adopting. The results show that training influences adoption of IMSS in that majority who had received training had adopted, of whom 81% indicated it was beneficial to them. Farmers' beliefs and attitude influenced adoption of IMSS, with over 50% indicating beliefs hindered them from adoption. About 51% of farmers who got income from farming reported adoption while 13% stated income was too little to adopt. The study thus recommended that, there needs to be a greater focus on awareness creation of IMSS to farmers, more training needs to be offered to maize farmers to improve their technical know-how, more advocacy initiatives should be put in place to subsidize costs of agricultural products, farmers should form support groups to access financial services to support them in adopting newer, improved methods. Areas for further research are suggested on: access to financial services by farmers in Bungoma District and its role in adoption of newer storage technologies, the role of newer storage technologies on food security and income in Bungoma District. .

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Storage is particularly important in agriculture because crop production is seasonal while demands for agricultural commodities are more evenly spread throughout the year. In this circumstance, there is need to meet current demand while storing excess supply during the harvesting season for gradual release to the market during off season periods . Through this process, seasonal prices are stabilized. Post-harvest food losses are one of the important sources of food insecurity in Africa (AMCOST, 2006).

Over the last two decades, the level of produced food has decreased dramatically in Sub-Saharan Africa (SSA) resulting in general deterioration in the standard of living of the population. The challenge facing SSA Agriculture is therefore to feed a population that is increasing at an annual rate of about 3%, and which will double in about 20 years (FAO, 2010). The problem of food shortage in developing countries could be overcome through use of variety of modern agricultural technologies like improved storage systems, seeds, fertilizers, fungicides, pesticides and agricultural machinery (Liberio, 2009). Some of the benefits that can occur to farmers from use of improved agricultural storage technologies include reduced risks from pest and disease pressure thus leading to high harvest index (FAO, 2010). Productivity of crops is directly linked to the use of recommended storage methods (Mwanga, 2002).

Inadequacy of improved storage systems has contributed mainly to low maize supplies in SSA countries, for example Nigeria, Ghana and Togo. Agricultural production in SSA is still highly dominated by the small scale farmers who are responsible for about 95% of total production (Daramola, 2004). Taking the case of Nigeria, there has been tremendous loss of food products

in the past decades and to present day, due to lack of proper and adaptable processing and storage facilities. This could be further attributed to lack of exposure and training to the small scale farmers. Losses have been estimated at 30-50% of production with a bulk of harvested cereal grains and tubers lost due to poor methods of storage.

Likewise in Ghana most farmers experience very high storage losses, with estimates reported at between 30-40% (Boxall, 1995). One of the recent factors contributing to high storage losses being experienced by Ghanaian farmers is a destructive pest of stored maize, the Larger Grain Borer (LGB). This insect turns the maize grains into powder, causing high losses to farmers and threatening their food supply and income. This is majorly as a result of poor storage methods after harvest season Preliminary results of a draft model to predict the possible impact of LGB in Ghana indicate that, if no action is taken to curb the outbreak of the pest, it could cause losses in maize of up to 30 billion cedes (about US$17 million) per annum (Boxall, 1995). Ghana's Ministry for Food and Agriculture also concedes that yields for most crops are typically 20–60% below levels achievable with the use of available technologies. Accessibility has to do with physical availability as well as financial means to procure the facilities.

The main cereal grown in Togo is maize, 95% of which is produced by small-scale farmers who suffer substantial losses because of insects and mildew due to poor traditional storage methods. According to Smith, Philip and Kwami (1994), a research team developed a series of methods to improve maize storage, thereby increasing farmers' income by minimizing losses. Improved storage systems also increase the amount of food available to families throughout the year. Farmers in Togo thus showed great interest in the research findings which involved no major changes to their usual methods except for little extra cost of adopting improved storage systems. These simple adopted improved methods increased the harvest and improved the quality of the

maize, with farmers noting losses of 9%, compared to between 15-50% using ordinary traditional methods (Smith *et al.*, 1994).

The situation is not much different in East Africa. In Tanzania, a study was conducted on the quality of maize. The main interest of the study was to examine the elements which affected stored maize; however it did not consider the storage systems which might have led the seeds being eaten up by fungus. The report showed that susceptibility of maize to fungal infection was influenced by several conditions such as high humidity, non-improved storage technologies and insect activity in maize (Sweeny, 2000). Non-improved storage systems, a common phenomenon with traditional farmers allow insect infestations to occur, which lead to increase in moisture content of the maize. These facts raised questions regarding the quality of maize stored using roof and sack storage methods in Katumba ward in Tanzania in terms of its nutritional value, the degree to which it is safe for consumption and its implications on household food security.

In Kenya maize is the most important cereal and staple food for over 90% of the population. Maize accounts for more than 20% of all agricultural production and 25% of agricultural employment in Kenya (Republic of Kenya, 2007). Crop yields have decreased due to unfavorable weather conditions, inadequate policies and weak agricultural institutions which are responsible for disseminating relevant knowledge on improved maize storage systems to small scale farmers. Central to this is a reduction in Government involvement and expenditure on agriculture which results in low investment and support for farmers, but the most assumed problem is that of post- harvest storage mechanisms. Grain losses contribute to food insecurity and low farm incomes. Due to this, the on-farm maize yield is too low to keep up with the rate of population growth, leading to serious food insecurity and poverty **(**Odendo, Groote and Odongo, 1999). Maize is still cheaper to produce than buy, but production is far below national demand, meaning Kenya imports maize in most years. Maize storage therefore poses a recurrent problem

in the country which is most acute among poor farmers, an aspect which needs to be addressed (Gari, 2004).

The problem of maize storage is quite rampant in Western Kenya. A study conducted on the efficacy of traditional maize storage methods used by the farmers within Busia County revealed that most farmers used traditional methods of storage which are inefficient and therefore caused even higher post-harvest losses (Ogada, 2009). These farmers would obviously gain by adopting improved storage methods through reduced post-harvest losses and better incomes. To improve adoption, it is necessary to understand why farmers continue to use poor storage methods.

1.2 Statement of Problem

Kenya's national maize supply levels have been declining from an all-time high of over 43.3million bags to about 33.9 million between 2012 and 2013 (Tegemeo Institute and East African Grain Council, 2013). According to FAO (2010) and Ministry of Agriculture (2011), poor adoption of improved storage systems account for low agricultural supply in Kenya resulting in low incomes and poor standard of living for small scale farmers in rural areas.

A number of factors are likely to play a role in low adoption of improved storage systems in the country. There is need to understand which factors affect adoption so that appropriate interventions are designed. One important factor is the low ratio of extension personnel to farmers, which may contribute to lack of knowledge and awareness of improved storage mechanisms and technical knowhow among small scale farmers. Bungoma District is one of the most affected in this aspect as it is reported that the ratio of extension officer to farmers is quite low at 1:34 (World Bank, 2011).

Inadequate information even affects farmers' ability to access credit. According to the World Bank (2011) report, small scale farmers do not acquire credit facilities because they are afraid that they might default due to inadequate information at their disposal about the existence of such facilities.

Most small scale farmers in Kenya are poor with 57% living below the poverty line (CNFA and AGMARK, 2005). Poor farmers often do not have access to appropriate credit to finance farming inputs and capital investments, both which are key to increasing adoption rates and raising agricultural productivity (GOK 2011). The poverty profile of Kenya is high that the World Bank (2011) considered it crucial for targeted efforts aimed at reducing the depth and severity of poverty in all regions of the country. High interest rates, lack of collateral, tough conditions imposed by lending institutions and small land sizes all act against farmers in attempt to acquire credit. Farmers with small land sizes may not readily adopt improved maize storage systems since most of the harvested maize is used for consumption. According to World Bank (2011), 81% of the small scale farmers in Bungoma District have land sizes of less than three acres.

Cultural factors involve the norms or beliefs that a society holds. The existence of cultural factors may hinder farmers from adoption of improved maize storage systems since they are usually tied to old traditions and beliefs that go against adoption of new or improved innovations (Nkoya, Schroeder & Norman, 2007). Findings by KARI (2012) revealed that Bungoma District still relies on non- improved traditional storage methods for their maize. The fact that Bungoma District trails behind other neighboring districts justified the choice of study area in order to investigate the reasons which contribute to the poor adoption or non-adoption of improved maize storage systems. Addressing the challenges relating to adoption of improved maize storage systems in the district is one of the best approaches to curb food insecurity and raise rural incomes.

1.3 Purpose of the Study

The purpose of the study was to determine the socio-economic factors influencing adoption of improved maize storage systems in Bungoma District- Kenya.

1.4 Objectives of the Study

The study was guided by the following objectives:

1. To establish the extent to which education of farmers influences adoption of improved maize storage systems in Bungoma District.
2. To determine the role of training of farmers in influencing adoption of improved maize storage systems in Bungoma District.
3. To examine how cultural factors influence adoption of improved maize storage systems in Bungoma District.
4. To determine how economic status of farmers influence adoption of improved maize storage systems in Bungoma District.

1.5 Research Questions

This study sought to answer the following questions:

1. To what extent does education of farmers influence adoption of improved maize storage systems in Bungoma District?
2. To what extent does training of farmers influence adoption of improved maize storage systems in Bungoma District?
3. How do cultural factors influence adoption of improved maize storage systems in Bungoma District?
4. How does economic status of farmers' influence adoption of improved maize storage systems in Bungoma District?

1.6 Significance of the Study

The Ministry of Agriculture plays a significant role of overseeing agricultural activities in Kenya. It was therefore hoped that the findings of this study would be found useful by the Ministry of Agriculture. It is hoped that the findings of this study would add knowledge to the existing literature on the socio-economic factors influencing adoption of improved maize storage

systems in Bungoma District. It is also hoped that the study would provide an impetus for further research by building a foundation upon which other related studies could be anchored. Finally, it is hoped that this document would act as a source of reference to all stakeholders in the agricultural sector.

1.7 Basic Assumptions of the Study

The following assumptions guided the study;

The farmers chosen for the study have experienced challenges concerning adoption of improved maize storage systems. Participants' responses reflected their real experiences in relation to adoption of improved maize storage systems. Respondents selected were willing to readily give accurate information as stipulated in the questionnaires.

The instruments used for the study would appropriately measure adoption of improved maize storage systems. Finally, the sample chosen for the study would be a fair representation of the entire targeted population.

1.8 Limitations of the Study

This study would have been conducted among all farmers in Kenya to improve its external validity; however, this was not possible due to the vastness of the country. For this reason, the findings of the study cannot be used for generalization among all farmers in Kenya. Instead, the findings can only be relevant to farmers in Bungoma District and any other district with similar features. The study intended to draw responses from 204 respondents, a process which required time thus this was overcome by use of research assistants who assisted in administering questionnaires. It also took time to secure appointments from village elders who would help research assistants in home identification, because of their busy schedule, prior arrangements were made to counter this setback. The problem of transportation was a challenge thus the researcher used flexible means of transport like motorbikes and bicycles to access the inaccessible areas of the District in order to overcome inaccessibility.

1.9 Delimitations of the Study

The study was de-limited among small scale farmers in Bungoma District in Bungoma County. This is because findings by KARI (2012) revealed that Bungoma District still relies on non-improved traditional storage methods for their maize. The fact that Bungoma District trails behind other neighboring Districts informed the researcher to de-limit the study to Bungoma District in order to investigate the reasons which could have contributed to the poor adoption or non-adoption of improved maize storage systems. The study was also de-limited to descriptive survey as a research design since it had varied demographic characteristics such as gender, age, socioeconomic status thus, the design was most appropriate in collecting information on opinion and experiences of respondents.

1.10 Definition of Significant Terms used in the Study

Adoption: Use of improved methods of storing maize or having particular attitude towards improved maize storage methods

Cultural factors: Beliefs, values and traditions that influence adoption of improved maize storage systems

Economic status: Farmers level of income and size of land under cultivation that influence adoption of improved maize storage systems

Improved maize storage systems: Modern methods of storing maize by small scale farmers (Such as improved granary, chemical use, metal bin, plastic containers, shelving, improved mud silo), as opposed to traditional methods (such as traditional granary, sacks, sisal baskets / kiondos)

Socio- economic factors: Social, cultural and financial aspects guiding small scale farmers on Improved maize storage systems

1.11 Organization of the Study

The study was organized into five chapters; chapter One basically gives the introduction and describes the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, basic assumptions of the study, limitations of the study, delimitations of the study, definition of significant terms used in the study and organization of the study.

Chapter Two provides a review of literature related to the study. This is presented thematically in line with research objectives, the theoretical framework, the conceptual frame work as well as the summary of literature reviewed.

Chapter Three focuses on the research methodology which is discussed under the following sub-headings; Research design, target population, sample size, sample selection, research instruments, pilot testing of the instruments, validity and reliability of research instruments, data collection procedures, data analysis technique and ethical issues in research.

Chapter Four presents the findings of the study discussed under thematic subsections in line with the study objectives. The thematic subsections include, the demographic characteristics of the respondents; education and adoption of improved maize storage systems by farmers; training and adoption of improved maize storage systems; cultural factors and adoption of improved maize storage systems and; economic status and adoption of improved maize storage systems

Chapter Five presents the conclusions and recommendations of the study. The conclusions section makes conclusions based on the findings. The recommendations section suggests possible ways of improving maize storage systems in Bungoma District. It also makes suggestions for further study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains a review of literature related to the topic thematically arranged as per the research objectives. It also highlights the theoretical framework, the conceptual framework as well as the summary of literature review.

2.2 Education of Farmers and Adoption of Improved Storage Systems

Increasing literacy and numeracy help farmers to acquire and understand information and to adopt new methods in a rapidly changing environment. Education helps in improved attitudes, beliefs and habits thus may lead to greater willingness to accept risk, adopt innovations, save for investment and generally to embrace productive practices (Appleton and Balihuta, 1996). Education may either increase prior access to external sources of information or enhance the ability to acquire information through experience with new adoption.

Phillips, Joseph, Robert and Marble (1994) reviewed a study using 22 data sets in America, and were able to confirm that the average increase in farm output owing to an additional four years of schooling was 10.5%. Appleton and Balihuta (1996) point out on surveys conducted in two African studies and showed that education was not found to be significant in either. The findings point out that the effect of education on agricultural output is usually not significant, though in some cases it can be large, indicating that there is substantial variation in returns to schooling both within and between the areas surveyed.

A survey carried out in by Khan and Keatinge (2000) in India –Swat, on the level of awareness of farmers and their degree for adopting the recommended storage systems revealed that less than 50% of farmers had adopted improved systems. Besides, due to problem of major resource availability, one quarter to half of all farmers felt lack of confidence in the recommendation for the improved or new storage systems. Another study undertaken by Soni, Pathak and Kashikar

(2000) in Sagar District also stated that there was a positive association between the level of education of farmers and the extent of adoption of modern storage methods. 100 farmers were interviewed and results showed that lack of knowledge was a major obstacle in adopting improved storage systems within the region.

According to Saha, Love and Schwart, (1994) farmers can only adopt new system if they are sufficiently informed about it. Moreover, after having decided whether to adopt an innovation, adopters also decide whether to modify it. The study of Doss *et al.,* (2003) on adoption of wheat storage technology in Eastern Africa cited several reasons given by farmers for not adopting improved storage systems. The first was simply being unaware of the systems or their benefits; this included misconceptions about the related costs and benefits. The second reason was that the systems were not profitable, given the complex sets of decisions that farmers had to make about how to allocate land and labor across agricultural and non-agricultural activities. This may be due to the fact that appropriate methods for farmers' conditions were not available or that farmers preferred to use local methods.

According to Adegbola and Gardebroek (2007), educated farmers are able to better process information, allocate inputs more efficiently, and more accurately assess the profitability of new or improved, and easily adapt to changes as compared to farmers with no education. In Mozambique, Saha *et al.* (1994) reported that the level of education attained by households is positively associated with households' adoption behaviors. They revealed that education positively influenced households to quickly respond to their current low agricultural productivity by adopting improved storage systems that increased productivity, household income and their standard of living. However, they also reported that most household heads in Mozambique were illiterate and had attended school for only a few years.

Farmers in Benin rural areas frequently use granaries to store their maize; the granaries vary in shape and capacity and also from one place to another based on agro-climatic conditions, ethnic and some socio-economic factors (Gwinner, Harnisch and Mueck, 1996). Diop, Hounhouigan, and Kossou (1997) revealed that both the wooden and earthen storage methods have been less adopted whilst the attacks of pests remain an important storage constraint for maize producers. Drawing from these experiences, the new post-harvest projects used a participatory approach of educating and training farmers on development and usage of improved storage innovations. To increase the probability of adoption, research has been concentrated on the improvement of local maize granaries identified by the farmers as most effective against pests. This approach led to the development dissemination of improved wooden granary which started in 1992 with a project funded by the Food and Agricultural Organization (FAO).

A study conducted in Nigeria by Okoedo and Onemoleas (2009) on factors affecting the adoption of corn storage technologies, indicated that corn farmers in the study area experienced serious post- harvest losses particularly due to grain rot. Most farmers claimed not to be aware of improved technologies. The main reason for low adoption was lack of awareness of the improved storage methods. The study revealed that 66.9% of the farmers did not adopt any of the improved corn storage methods while the rest had adopted at least one of the methods. This showed that the level of adoption was very poor in the study area and probably explained the seriousness of post-harvest storage losses experienced by farmers. The study recorded high percentage of non-response because respondents could not explain their non-adoption for improved storage systems whose existence they were not aware of such as refrigeration and irradiation. The study also revealed that despite dissemination of information on improved systems some farmers did not adopt due to other reasons such as high costs and non availability of resources and technology. This thus justifies need to improve level of education among

farmers but also access to the required technology and materials so as to improve storage mechanisms. Farmers' educational background is a potential factor in determining their readiness to accept and properly adopt an innovation (Swamson *et al.,* 1994).

In Kenya, a study conducted by Odenya, Onginjo and Kebenney (2008), on adoption of improved sugarcane varieties in Nyando District showed the importance of education in adoption. Of the sampled farmers about 76.7% of farmers interviewed were aware of the existence of the improved sugarcane varieties while the rest were not aware and had never heard of the existence of improved sugarcane varieties in their area. Farmers who had knowledge on improved sugarcane varieties also wanted to be involved in variety of development trials.

2.3 Training and Adoption of Improved Maize Storage Systems

Rao and Rao (2006) indicated that training increases farmers experience in relation to adoption. Through training farmers are able to understand the nature of risks associated with each of the new systems and are willing to face risks associated with the method. Ani (2002) and Iheanacho (2000) indicated that training to a large extent affects farmers' technical know-how and decision making. Besides, it influences farmers' understanding of climatic and weather conditions as well as other factors affecting storage.

A study on the adoption of new storage technologies carried out by Khanna (2010) in India found out that agricultural productivity remained low in Fata region in India as compared to other settled areas of the province. The reasons included poor extension services and lack of communication between the rural people and extension agents. The study indicated that the benefits of training farmers resulted in improvement in their productivity with use of better storage methods. This is supported by findings of Ahmad (1997) in India's Nowshera District, which revealed different extension methods used by agricultural extension staff. He observed that extension workers contacted farmers through farm and home visits, demonstrations, radio

and television, lectures, tours, press office calls and wall slogans. All of these methods were found to be effective in motivating the farmers to adopt improved and new storage systems. Ahmad (1997) further reported that greater effectiveness of extension methods can be ensured through regular training by providing farmers with required facilities, reorganization of extension programs and involving local leaders as agents for dissemination of information.

A study conducted by Wekesa, Mwangi, Verkuijl and Groote (2003) on adoption of maize storage systems in coastal lowlands of Kenya revealed that farmers who had been trained had greater influence in adoption of new or improved technology. They had contact with extension services through training, participated in farming courses and listened regularly to agricultural programs on the radio hence were more likely to be adopters of new and improved farm storage systems. The farmers also had membership in various groups where they could meet on certain days and share ideas concerning farming activities. Membership in an organization, such as a farmers association, also leads to better access to information related to adoption of improved storage systems through training (Wekesa *et al.*, 2003).

A study conducted in Kenya's Embu District by Ouma, Murithi, Mwangi, Gethi, and Groote (2002), showed the importance of training to farmers and this was proven by findings which revealed that 90% of adopters of improved maize had better access to extension services than non-adopters. The main source of extension services was offered by the Ministry of Agriculture, Non Governmental Organizations and other trained farmers, where the main extension advice was on fertilizer use and seed spacing. The farmers on average had been visited twice by extension agents within the year in relation to the two planting seasons. More than 90% of the farmers were members of a cooperative or farmers' group which provided them with credit to purchase inputs and helped in improving productivity (Ouma *et al.*, 2002).

2.4 Cultural Factors and Adoption of Improved Maize Storage Systems

Culture is intertwined to any technological adoption. Farming technology is closely related to culture of the people and beliefs about farming. The beliefs people hold about farming and the way that they use or think about farming practices has an impact on how they adapt to upcoming changes in the society (Clay, 2004). According to (Doss *et al.,* 2003), numerous studies of technologies adoption in developing countries have used farmers' socio-demography characteristics such as gender, age, education, household size to explain household adoption behaviors. These studies reported that the rate of new adoption was higher among male-headed households, compared to female-headed households, because of discrimination. Women have less access to farm management practices, external inputs, services, and information due to cultural values.

Perceptions of the characteristics of new agricultural storage systems are also important factors associated with farmers' demand for new agricultural storage systems (Adesina and Forson, 1995). Farmers may subjectively evaluate the cultural aspects of new methods differently. Thus, understanding farmers' perceptions is important in designing and promoting adoption of improved storage systems. A study conducted by Michelle (2005) on Adoption of soy beans in Togo revealed that the adoption rate of improved storage methods is usually high if the methods meet farmers' expectations. An improved storage system will be adopted at exceptionally high rates if it is technically and economically superior to local systems. They are also superior if they produce higher yield compared to ordinary traditional methods.

In Bukina Faso, Adesina and Forson (1995) reported that farmers adopted improved storage method because it gave high yield compared to the previously used traditional methods. Neill and Lee (2005) argue that farmers' adoption of new and improved agricultural storage systems is also affected by their perception of the amount of initial capital investment and labour requirements they will have to allocate if they adopt the new systems. Martel, Bernsten and

Weber (2000) conducted a case study of the marketing of dry beans in Honduras and argued that farmers adopted improved storage systems because they perceived that these methods could reduce other associated costs common with traditional methods, and reduce risk of losses due to crop diseases during post harvest.

According to Martel *et al*., (2000), Benin farmers adopted systems that were consistent with their needs, their cultural status and their attitudes towards the particular class of innovations. The intensity of an individual's attitude towards an innovation is a major determinant of the anticipated adoption behavior (Lemon, 2010). The attitude of a decision-maker towards an innovation depends on his valuations of the set of characteristics of that innovation (Wossink *et al.,* 2007). Accordingly, negative perceptions on innovation characteristics are sometimes mentioned as a main reason for lack of adoption. It also may explain the limited adoption by farmers of some innovations derived from on-station research (Becker, Ladha and Ali, 2005). Therefore, a challenge for agricultural researchers is to properly anticipate the characteristics of innovations that will be demanded by farmers in the future and to develop innovations accordingly (Kshirsagar *et al.*, 2002).

Farmers' perceptions of the specific characteristics of the innovation are important in determining whether or not to adopt it (Adesina and Zinnah, 2003). But very few studies assess the characteristics perceived by farmers as important if adoption of a new mechanism is to be achieved. Ani (2002) also revealed that there is a relationship between adoption of farm practices and marital status of the farmers. The general perception is that due to cultural factors, women may have little decision making authority in farming. Hence, marital status of women could be an important factor in adoption of any innovation.

Ani (2002) further explains that farmers' attitudes are significant factors in adoption of improved storage systems. As expected, holding negative attitudes towards new innovation has an impact on adoption. Farmers' perceptions of production characteristics such as yield, maturity rate,

drought resistance, and insect resistance determine selection and adoption (Hintze, Renkow and Sain, 2003).

A study conducted in Mozambique on the cultural determinants of adoption of maize varieties revealed that family size played an important role in adoption. The results on family size indicated that about 25% of households in study area had between nine and twelve members. These numbers are higher than the average family size in rural areas of Mozambique which is approximately six members. Assuming that adoption of new varieties required more labor inputs, the rural households with relatively large families could rely on their household to meet the labour demands. A study conducted by Feder *et al.,* (1985) contradicted this finding by indicating that the total number of family members does not always mean availability of labour because some families may have higher dependency rates than others. Thus while the relatively large family size may suggest more labor for cultivation, more precise results on labour availability would need to be provided by information on dependency ratios. This determines whether a farmer will adopt an improved storage system.

Owokunle (2008) agrees that majority of land development scheme participants in Kwara state of Nigeria received assistance from their wives and children to operate their farms so the larger the families, the better the chances of adoption of new or improved storage innovation. A study by Jibowo (1992), on effects of farmers' demographic factors on adoption of grain storage systems in West Nigeria indicated that more men engaged in farming activities than women thus confirming that gender is related to adoption. In the study, 75% of respondents who engaged in farming were within the age range of 30-50 years. In a study conducted in Tanzania by Liberio (2009) on factors contributing to adoption of new sunflower storage systems revealed that 73% of farmers were males. According to these results, males dominated sunflower storage business

in the ward. These findings complied with that of Stephens (2002) who argued that though most storage systems are considered gender neutral, they are often gender biased during their introduction and use by societies.

Attitude can influence farmer's choice of adoption either positively or negatively. A study conducted in Kenya by Odenya *et al.,* (2008), on adoption of improved sugarcane varieties in Nyando District revealed that farmer's preference of improved sugarcane varieties was based on their early maturity characteristics and this was a great indication that farmers had changed their attitude on the old commercial varieties despite the fact that, there were some milling companies who wanted the farmers to continue planting the old varieties.

2.5 Economic Status and Adoption of Improved Maize Storage Systems

Storage facilities not only offer the opportunity to smooth hunger between staple crop harvests but farmers are possibly able to improve farm incomes by storing crops and selling at premium prices when demand outstrips supply later in the post-harvest period (Florkowski and Xi-Ling, 1990). Approximately 50% of the world's undernourished population is made up of low-income farm households. Therefore, the top priority in addressing hunger problems is to decrease poverty levels among these farmers, and increase their productivity so they can feed themselves and their families.

An empirical study conducted by Khanna (2010) on the status of adoption of improved storage systems in USA, indicated that due to high costs of materials used in improved storage systems, there was uncertainty among the small farmers in adopting improved storage systems. However, despite significant advances in food storage methods, many African communities still rely on traditional non- improved storage methods for food, fodder and seed. Although relatively simple and inexpensive to construct and maintain, non-improved traditional storage systems lead to substantial post-harvest losses (Mughogho, 2009).

Okoedo and Onemoleas (2009) revealed that non availability and high cost of improved storage systems also account for farmers non- adoption of storage systems. This matches the findings of Satyanarayani *et al.,* (1999) for poor adoption of improved storage systems in India, where 18.5% complained of high costs of the improved systems and non-availability of the technology. Most farmers rely only on farming as their main source of income thus neglecting other economic activities which can also generate income. In terms of resources, wealthier farmers have better access to extension information and stand a better chance to use their own resources to experiment with new and improved storage mechanisms (CIMMYT, 1993). Many times it is farmers with more resources in terms of capital, land and labor that are able to take advantage and adopt new or improved methods and practices (Liberio, 2009).

In Tanzania, farm size significantly affects improved seed storage adoption. A study conducted by Nkonoki (1994), on adoption of new storage systems in sunflower plantation revealed that land size owned by farmers ranged from 0.4 ha to 14.6 ha. The farmers with larger farms are likely to be better informed, able to take greater risks associated with various adoption processes, and have more opportunity to experiment. The author also states that resources such as land size may make it easier for a farmer to alter farm practices. In terms of equitability this implies the need for research, extension and planning agencies to be sensitive to the needs of smaller farmers through developing and disseminating/ implementing storage systems and strategies that are relevant to their needs (Nkoya, *et al*., 2007).

Ouma *et al.,* (2002), in a study conducted in Kenya's Embu District on the Socio-economic and technical factors affecting adoption of improved maize seed and fertilizer technology, revealed that a considerable number of farmers cited high price of certified seed, coupled with lack of credit and low price of maize as the main limitation to using improved maize seed on a

continuous basis. About 86% of adopters and 79% of non adopters indicated that the high price of improved maize seed was the major constraint. Other important constraints revealed in the study were the low selling price of maize and lack of credit which was stated by 12% of adopters and 18% of non-adopters of improved maize seed and fertilizer technology.

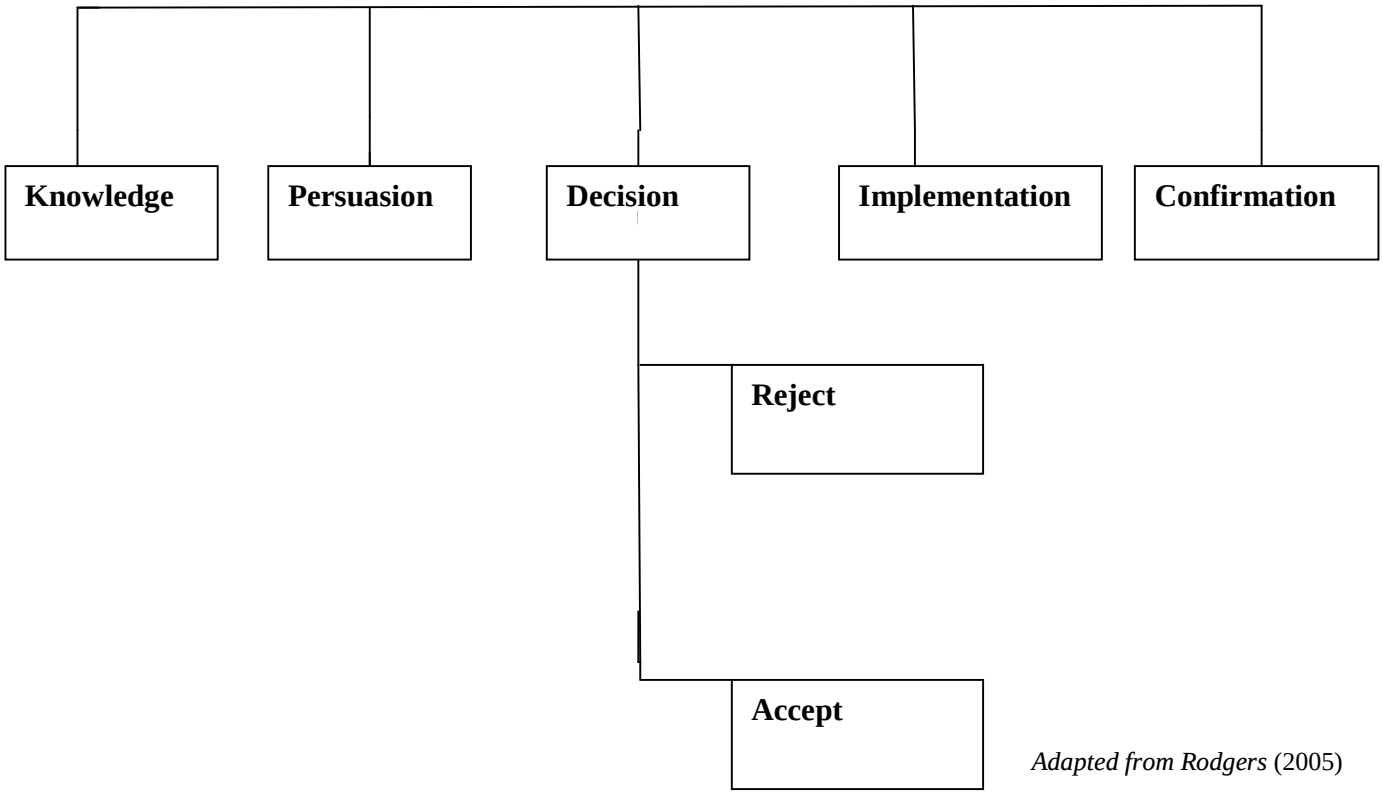
A study on adoption of improved sugarcane varieties in Nyando by Odenya *et al*., (2008), revealed that 45.3% of farmers in the sugar zone used family labor in their plantations; about 24% were found to hire labor while 21.3% used both family and hired labor. The major source of family labor were women while men were found to complement occasionally especially when oxen were used for weeding, participating mostly during land preparation. They provided least labor during weeding, a critical period for the crop. The aspect of land size under cultivation is thus seen as important in adoption. However, the level of family labor committed to farming was found to be a major factor that affected sugarcane production. This was evident in most families where the family relied mostly on school going children. The labor constraint was also identified as one of the reasons why many farmers broadcast sorghum instead of planting it in an organized manner with good spacing (Salasya *et al.,* 1996).

2.6 Theoretical Framework

The study is hinged on Diffusion Theory which was developed by Rogers (2005). In his book, *Diffusion of Innovations,* Rogers's points out that diffusion is not a single, all-encompassing theory but it has several theoretical perspectives that relate to the overall concept of diffusion; it is a meta-theory.

This theory concerns the spread of innovation, ideas, and technology through a culture or cultures. Diffusion theory states that there are many qualities in different people that cause them to accept or not to accept an innovation. There are five stages to the process of adopting an innovation. The first stage is knowledge, in which an individual becomes aware of an innovation

but has no information about it. Next is persuasion, in which the individual becomes actively interested in seeking knowledge about the innovation. The third stage is of decision making where the individual weighs the advantages and disadvantages of the innovation and decides whether or not to adopt it. After the decision comes implementation, in which the individual actually does adopt and use the innovation. Confirmation is the final stage. After adopting the innovation, the individual makes a final decision about whether or not to continue using it based on his own personal experience with it. These same stages apply, to varying degrees, to groups of people or as individual.



Adapted from Rodgers (2005)

Figure 2.1: Stages of Diffusion Theory

In relation to this study, several parameters have been identified as influencing the adoption behavior of farmers from qualitative and quantitative models such as socio-economic and cultural. As noted by Degnet and Belay (2001), the reasons for adoption or non-adoption at farm

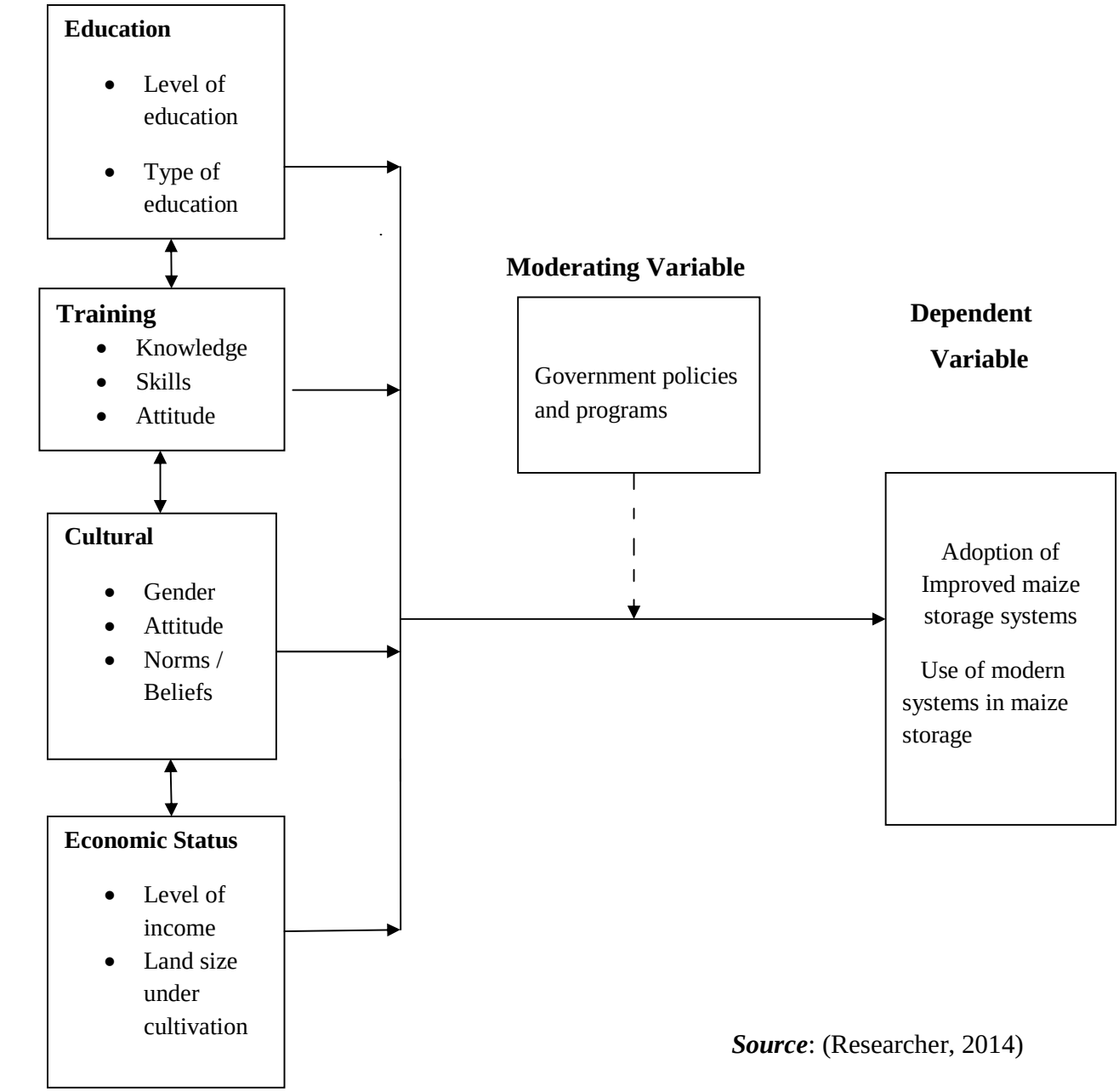
level vary over space and time. Farmers' adoption of improved maize storage systems will be increased if they perceive that the innovation has an advantage over previous methods. This can be promoted through educating, training and sensitizing farmers thus enabling them to easily make decisions acquire and obtain necessary management skills in relation to adoption of improved maize storage systems.

Farmers with adequate knowledge are more likely to make decisions which enhance adoption while illiterate farmers are likely to reject an adoption. Through education, farmers develop positive attitude which often encourage them to learn skills necessary for implementation and not be reluctant in adoption due to cultural beliefs and norms of society. Education is also important for the confirmation stage to help a farmer decide whether to accept and utilize improved storage systems, and at a later stage, whether to improve or modify the innovation. Thus the theory plays significant role in adoption of improved maize storage systems.

2.7 Conceptual Framework

This section describes the perceived conceptual framework that guided the study.

Independent Variables



Source: (Researcher, 2014)

Figure 2.2: Perceived Conceptual Framework showing Relationships between variables

The diagram in Figure 2.2 reflects the concept of socio-economic factors influencing adoption of improved maize storage systems in Bungoma District. The diagram is a figurative representation of the interplay among the variables used in the study. The variables which have been conceptualized as independent variables include; education, training, cultural factors, farmer's economic status and how they influence adoption of improved maize storage systems.

Exposure to education, formal or informal will increase a farmer's ability to obtain process and use information relevant to the adoption of an improved storage system, enabling them to learn or adopt new skills or methods easily. The skills and attitude farmers' possess will determine how well they handle or accept the storage equipment.

Cultural factors influences adoption of improved storage systems through gender disparities, norms, attitudes and the number of individuals in the household. In most cases, women are the vital contributors to farm work while the men engage themselves more in commercial activities. Women tend to lag behind with evolving technology used in storage methods and this is because of limited access to better techniques or technologies thus improved storage methods tend to be ineffective. The farmers' attitude also influences adoption of improved maize storage systems in that they might be so reluctant in adoption of any given changes and development technology. In terms of labor, large households will be able to provide the labor required to produce more food thus greater need of adopting improved storage systems.

Economic differences are an important part of social structure. The type of job people do and amount of money they earn affects their adoption of improved maize storage methods. Wealthier farmers have the means of buying or adopting improved storage methods, so wealth is expected to be positively associated with the decision to adopt an improved storage system. A farmer's economic status is also determined by the land size under cultivation. A farmer with a large land area will tend to adopt improved storage methods as compared to farmers with small land sizes who will opt to store their grains even in the house.

The independent variables interplay with moderating variables in the periphery in order to enhance effective maize storage. The moderating variable in this case is the government policies and programs (here taken also as including programs of NGOs). With proper government reforms in place, the maize industry becomes a key element in accelerating growth and reducing

poverty. The existence of various government arms, such as, Kenya Maize Development Program (KMDP) and Cereal Growers Association (CGA), National Cereals and Produce Board (NCPB), work in close collaboration with other private sectors and Ministry of Agriculture (MOA) to ensure efficiency and effectiveness during both pre and post-harvest season. The study will assume that with increased level of education awareness, good adoption of technologies, right cultural practices and adequate level of income will lead to improved storage practices within Bungoma District.

2.8 Summary of Literature Review

Despite much focus on traditional storage methods used by small scale farmers, little has been done on factors influencing adoption of improved maize storage systems in Bungoma District. Most studies have focused on the elements affecting stored maize but not the storage systems in use. Other studies tend to examine the end economic losses encountered by small scale farmers after post-harvest season without considering factors which led to these post-harvest losses. These glaring omissions necessitate the need to examine the adoption rate of improved maize storage systems. Studies have examined the adoption of improved maize production technologies to increase productivity putting in place use of improved farm inputs, not considering adoption of improved storage systems to increase productivity as well.

On social factors and how it influences adoption behavior, few studies touch on family size as a factor hence most factors commonly considered are demographic characteristics. It is against these eminent knowledge gaps that this study has been initiated in order to redeem the existing situation.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter tackles issues about the research design and methodology. It has a brief description of the research design, variables, target population, sampling techniques and sample size, construction of research instruments, pilot study, validity and reliability of research instruments.

It also explores the techniques for data collection, ethical consideration and data analysis procedure.

3.2 Research Design

This study adopted descriptive survey research design with both qualitative and quantitative approaches. Descriptive survey design is a method of collecting information by interviewing or administering questionnaires to a sample of individuals hence suitable for extensive research. Descriptive research may involve any or all of the following aspects: observation, case studies, and surveys. It is an excellent vehicle for the measurement of characteristics of large population (Orodho, 2003). It maintains a high level of confidentiality, it is convenient and enables data to be collected faster, questions to be asked personally in an interview or impersonal through a questionnaire about things which cannot be observed easily. It also gives the researcher an opportunity to get accurate view of response to issues as well as test theories on social relationship at both the individual and group level (Kothari, 2003).

Descriptive design was appropriate for the study because it enabled the collection and analysis of both qualitative and quantitative data. On quantitative approach, the study used the closed-ended sections of the questionnaire to collect data on the socio-economic factors influencing adoption of improved maize storage systems. On the qualitative side, the study used the open-ended sections of the questionnaire to collect data on the same parameters i.e. socio-economic factors influencing adoption of improved maize storage systems.

3.3 Target Population

The study targeted small scale farmers within Bungoma District - Bungoma County. According to Ministry of Agriculture (2011), Bungoma District has a total population of about 60, 000 small scale farmers.

3.4 Sample Size and Sampling Techniques

This section describes the sample size and sample selection used in the study.

3.4.1 Sample Size

The researcher used a sample size of 204 farmers selected among the households in Bungoma District. According to Glenn (2009), pre-determined scientific table for determining sample sizes from given populations, a population size of 60,000 will have a complete representation of 204 respondents at 7% precision (See Appendix V).

3.4.2 Sampling Techniques

The study utilized multistage cluster sampling technique to sample respondents for the study. The researcher used the administrative clusters while selecting small scale farmers for the study. This technique was chosen because it is meant to overcome problems associated with a geographically dispersed population when face to face contact is needed. In order to obtain a fair representation of farmers from each of the clusters, the researcher employed Population Proportional to Size (PPS) sampling technique. Under Population Proportional to Size sampling technique, samples are included in the study depending on their numerical strength. In this study, small scale farmers in Bungoma District were selected from each administrative Division guided by PPS as presented in Table 3.1.

Table 3.1: Sample Size Determination

Division	Farmers Population Size	Sample Size
Chwele	10,100	34
Sirisia	6,050	20
Webuye	8,000	27
Bumula	2,950	10
Central	5,500	19
Kanduyi	12,000	41
Ndivisi	2,000	7
Tongaren	8,400	29
Malakisi	1,000	3
Kimilili	4,000	14

TOTAL	**60,000**	**204**

Source: (Housing Census, 2009; Researcher, 2014)

A total of 204 farmers from Bungoma District were selected for the study guided by multistage cluster sampling technique. This involved choosing a sample frame of relevant discrete groups from the administrative units: i.e. divisions, locations and sub-locations. According to Population and Housing Census (2009), Bungoma District has 10 divisions, 44 locations and 114 sub locations. From the 44 locations in Bungoma District, 22 locations were selected for the study. This formed about 50% of the total number of locations, 20% higher than 30% recommended sample population size according to Mugenda and Mugenda (2003).

On the same breadth, 38 sub-locations out of a total population of 114 sub-locations were selected for the study forming 33% of the total number of sub-locations, slightly 3% higher than Mugenda and Mugenda (2003). The 22 locations and 38 sub-locations earmarked for the study were selected using systematic random sampling technique. Locations were selected using the n^{th} interval of 2 i.e. every second location was considered for the study whereas the sub-locations were selected using the n^{th} interval of 3 i.e. every third sub-location was sampled for the study (Refer to Table 3.2).

Table 3.2: Distribution of Respondents per Cluster

Category of Cluster	**Target population**	**Number selected**	**Percentage**	**Sampling Procedure**
Locations	44	22	50%	Systematic
Sub-locations	114	38	33%	Systematic

Researcher (2014)

The 204 small scale farmers earmarked for the study were chosen using population proportional to size (PPS) sampling technique. PPS enabled the researcher to select small scale farmers from the selected 38 sub-locations within Bungoma District depending on the numerical strength. Small scale farmers in each sub-location were selected randomly across the 38 sub-locations within the District so as to display the full 'face' of the District (Refer to Table 3.3). This is because random sampling provides equal opportunity for each and every member of the accessible population (in this study, farmers) to be included in the study.

$$\textbf{PPS formulae} = \frac{\text{Population of farmers in each Sub-location} \times \text{Sample Size}}{\text{Total Population in 38 Sub-locations}}$$

Table 3.3: Distribution of Respondents per Sub-location

Sub-location	Farmers Pop.	Sample size	Sub-location	Farmers pop.	Sample Size
1. Kamasielo	543	5	21. Siyombe	605	6
2. Township	499	4	22. Khasolo	510	5
3. Kimilili	685	6	23. Namatotoa	405	4
4. Bituyu	583	5	24. Khasoka	498	5
5. Kibingei	526	4	25. Lumboka	538	5
6. Kitayi	529	6	26. Samitsi	704	7
7. Chebukwabi	555	5	27. Nangili	681	6
8. Nasusi	521	5	28. Mateka	590	5

9. Nabikoto	456	4	29. Maraka	735	7
10. Musembe	568	6	30. Matisi	614	5
11. Mbongi	565	5	31. Sawawa	705	7
12. Kimakwa	431	4	32. Kulumbeni	674	7
13. Mapera	534	5	33. Sitikho	624	6
14. Makhonge	542	6	34. Kituni	599	7
15. Khalumuli	525	5	35. Kabuchai	507	6
16. Kamusinde	396	4	36. Kabuchonge	468	5
17. Matulo	334	3	37. Nalondo	529	6
18. Kabula	733	8	38. Mukhuyuni	574	6
19. Mayanja	533	5			
20. Watoya	434	4			
TOTAL				**21, 052**	**204**

(Housing Census, 2009; Researcher, 2014)

3.5 Research Instruments

The study used questionnaires to collect the data. The selection of tools was guided by; the nature of data that was supposed to be collected, the time available for the researcher as well as the objectives of the study. Questionnaires were used to solicit information on the view, opinion and perception of the farmers on adoption of improved maize storage systems since they are the most suitable tool for survey research (Oso and Onen, 2008).

The questionnaire was organized into different sections; each section of the questionnaire seeking information related to a specific objective. The first section sought to obtain information related to demographic characteristics of farmers; the second section addressed questions related to how education of farmers influences adoption of improved maize storage systems in Bungoma District. Section three addressed how training influences adoption of improved maize storage systems in Bungoma District. Section four addressed cultural factors and how they influence adoption of improved maize storage systems in Bungoma District. Lastly section five looked at economic status of farmers and how it influences adoption of improved maize storage systems in Bungoma District.

3.5.1 Pilot Testing

According to Mugenda and Mugenda (2003), a pre-test sample of a tenth of the total sample with homogenous characteristics is appropriate for a pilot study. For this study 20 farmers from Kakamega District which is equivalent to 10% of the sample size from the respondents were interviewed during the pilot study. This was because it is a neighboring District and has almost similar farming characteristics with the main area of study.

Questions were precise and concise to enhance the validity of the instrument. The researcher sought permission from the Chief of Mukhangu location to conduct interview with 20 farmers. After receiving permission, the researcher then obtained consent of all farmers and explained the purpose of the study to them and requested their willingness to fill in the questionnaires. The researcher went ahead and administered the questionnaires to the farmers who were assured of confidentiality. After two weeks, the same participants were requested to respond to the same questionnaires but without prior notification in order to ascertain any variation in the responses of the first and second test. This was important in the research process because it assisted the researcher to identify vague questions and unclear instructions.

It also assisted the researcher to capture the important comments and suggestions from participants that enabled the researcher to improve on the efficiency of the instrument.

3.5.2 Validity of Research Instruments

A research instrument is valid if it actually measures what it is supposed to measure and when the data collected through it accurately represents the respondents' opinions (Amin, 2005). Validity of the instrument was ascertained by conducting a pilot study. This ensured that the instructions were clear and all possible responses to a question were captured. In the study, content validity was determined through consultation with the research supervisors of University of Nairobi who evaluated the relevance and objectivity of each item in the instrumentation

process. Recommendations were also given and corrections made accordingly. Finally, peer review also improved the instrument further by ensuring that the tools collected required data.

3.5.3 Reliability of Research Instrument

Reliability is the extent to which research results are consistent and replicable (Amin, 2005). Although unreliability is always present to a certain extent, there will generally be a good deal of consistency in the result of a quality instrument gathered at different times. Therefore a test is reliable to the extent that it measures whatever it is measuring consistently (Best and Kahn, 2006). As a quality control measure, the test retest method was applied. This was done by administering the same questionnaire twice to farmers allowing an interval of two weeks in between. It should be noted however that the test retest method has limitations of assessing reliability as follows: the respondent may be sensitized by the first testing or they may tend to remember their previous responses during the second testing. Hence the test-retest method may either overestimate or underestimate the true reliability of the instrument. After pilot study, corrections were made where necessary.

3.6 Data Collection Procedures

In preparation for data collection, the researcher obtained a research permit from the National Council for Science and Technology so as to go and carry out research in the area of jurisdiction. Authority to collect data was also sought from the University of Nairobi. The study engaged five research assistants to help with data collection. This was followed by consensus building involving researcher and research assistants including their training on interviewing skills and ensuring completeness of the tools. This helped to discuss feasibility of proposed study design, set timeline, logistical requirement.

The research assistants collected data from the selected sub- locations. The researcher explained orally the usefulness of the study, requesting respondents to answer questions to the best of their ability and assuring them of total confidentiality. Before setting for the day, the researcher made consultations with research assistants on areas to be visited per day and how to collect the questionnaires. Data collected were coded and prepared for analysis. Before data entry, the questionnaires were checked for completeness and data cleaning was done to enhance data quality.

3.7 Data Analysis Techniques

Data analysis is the process of systematically searching and arranging field findings for presentation (Bogdan and Biklen, 1992). It involves organizing the data, breaking the data into categories and units and then searching for trends and patterns before deciding to report.

According to Bryman and Hawler (1997), data analysis seeks to fulfill research objectives and answer research questions, and that the choice of analysis usually depends on how the tools are suited to the study objectives and scale of measurements of the variables.

Following data collection, data entry was done and cleaned by checking for entry errors. The quantitative data obtained from closed ended questions were analyzed using quantitative techniques such as frequency tables and percentages. The strength of percentages indicated preferred response. Qualitative data obtained from open ended questions in the questionnaire were grouped into themes that were corresponding to the objectives of the study, transcribed and reported narratively. SPSS aided in analyzing quantitative data.

3.8 Ethical Considerations

The researcher explained to the respondent the purpose of the study. The researcher first of all sought respondents' consent to participate in the study while assuring them that their participation was voluntary. The respondents were not required to provide their names or any

specific form of identification on research instruments. Each of the participants was assured of total confidentiality and that the information they provide would be used for research purposes only. The five research assistants who assisted the researcher in conducting the research were trained on modest ways of administering the questionnaires to respondents without violating on their rights. During administration of the tools, the researchers observed decency, openness and honesty and finally carried out the study responsibly.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study which have been discussed under thematic subsections in line with the study objectives. The thematic subsections include the demographic characteristics of the respondents; education and adoption of improved maize storage systems by farmers; training and adoption of improved maize storage systems; cultural factors and adoption of improved maize storage systems, economic status and adoption of improved maize storage systems.

4.2 Questionnaire Response Rate.

A total of 204 questionnaires were administered to the small scale farmers. All questionnaires were returned forming 100% response rate. This was due to proper organization of field work and efficiency of research assistants. Sampled households that for various reasons could not participate were replaced by the researcher accordingly. The return rate was acceptable because according to Mugenda and Mugenda (2003), a response rate of 50% is adequate for analysis and reporting, a response rate of 60% is good and that of 70% and above is very good. The questionnaires were administered and collected on the same day from the farmers by the research assistants.

4.3 Demographic characteristics of respondents

The demographic characteristics that were considered in this section included, gender, age, the level of education of the participants, number of children and number of acres used by the household for planting maize. This gave a deeper insight on understanding the relationship between the variables under study.

4.3.1 Distribution of Respondents by Gender

The study sought to find out the gender of the respondents who participated in the study. This was considered important to reveal information on gender disparities among respondents who took part in the study. The results were as summarized in Table 4.1

Table 4.1: Distribution of respondents by gender

Gender	Frequency	Percent
Male	70	34
Female	134	66
Total	**204**	**100**

Out of 204 respondents interviewed (70)34% were male while 134(66%) were female. This findings show that majority of the people who participated in the study were females as

compared to men. This shows that females engage more in farming practices in Bungoma District as compared to men. A study by Liberio (2009) contradicts this by revealing that more males (73%) had adopted sunflower storage systems as compared to females (27%). Stephens (2002) also argued that though most technologies are considered gender neutral, they are often gender biased during their introduction and use by societies.

4.3.2 Distribution of Respondents by Age

The study sought to establish the distribution of respondents by Age. This was because; the researcher was interested in ascertaining whether age of respondents had influence on adoption of improved maize storage systems. In view of this, respondents were asked to state their ages. The results were as reflected in Table 4.2

Table 4.2: Distribution of respondents by Age

Respondents age	Frequency	Percent
20-29	61	29.9
30-39	53	26.0
40-49	38	18.6
50-59	26	12.8
60 & above	26	12.8
Total	**204**	**100**

Out of the 204 farmers interviewed, (61)29.9% were between ages 20-29, (53) 26.0% were between 30-39, (38)18.6% were between 40-49, 26(12.8%) between 50-59 and 26(12.8%) were 60years and above. Thus, findings revealed that a majority of the farmers interviewed were young farmers. This is in line with findings of Wasula (2000) who found out that age influenced adoption in that younger farmers are more inclined to adopt new practices.

4.3.3 Distribution of respondents by Number of Children

The study sought to establish the distribution of respondents by the number of children they had. The researcher was interested in respondents' number of children because the researcher wanted to establish whether the number of children had any impact on adoption of improved maize storage systems. In view of this, respondents were asked to state the number of children they had. Their responses were as illustrated in Table 4.3

Table 4.3: Distribution of respondents by number of children

Number of children	Frequency	Percent
0	14	7
1-3	80	39
4-6	66	32
7-9	28	14
9 & above	16	8
Total	**204**	**100**

Out of the 204 respondents, 14(7%) had no children, 80(39%) had between 1-3 children, 66 (32%) had 4-6 children and 28(14%) had 7-9 children; 16 (8%) of the respondents had 10 or more children. This shows that a vast majority of the respondents were parents with majority having 1-6 children, this enabled farmers to engage more in agricultural production because of the labour force available in the household, many times it is farmers with more labour that are able to take advantage of high production in agriculture. This is in line with a study done by Schwartz (2007) in Fuji which indicated that families who practiced farming as the major source of income, had significantly large families and stable inspired by the need for labor. Conversely, according to Kelly (2010), the use of family especially children as a source of labor in farms has significantly reduced due to the current policies and child's right advocacy.

4.3.4 Distribution of Respondents by Academic Qualification

The study sought to establish the distribution of respondents by academic Qualification. The researcher was interested in academic qualification of respondents because the researcher wanted to establish whether academic qualification of respondents had any impact on adoption of improved maize storage systems. In view of this, respondents were asked to state their highest level of education. Their responses were as illustrated in Table 4.4

Table 4.4: Distribution of respondents by Level of education

Respondents level of education	Frequency	Percent
Primary	136	67
High school	46	23
Vocational school /Diploma	13	6
University	3	1
None	6	3
Total	**204**	**100**

Findings revealed that an overwhelming (136)67% of the farmers had only attained primary school, (46)23% had attained secondary school education while just over (13)6% had attained vocational education or a diploma. Only (3)1% of the farmers interviewed had achieved higher education, 6(3%) had not received any schooling. This findings show that the education level among the farmers in Bungoma District is very low which may contribute to poor adoption. This suggests that farming is considered source of livelihood that does not require high level of education. However, according to Ndiema (2002) education is a significant factor in facilitating awareness and adoption of new or improved systems. High level of education enhances understanding of instructions given and also improves farmer's level of participation in farming activities.

4.3.5 Distribution of respondents by number of acres used for maize farming

The study sought to establish the distribution of respondents by the number of acres used for maize farming. The researcher was interested in the number of acres respondent had so as to establish whether the number of acres had any impact on adoption of improved maize storage systems. In view of this, respondents were asked to state the number of acres they had for maize farming. Their responses were as illustrated in Table 4.5

Table 4.5: Distribution of respondents by number of acres used for farming

Number of acres owned	Frequency	Percent
0-5	183	89.7
6-10	19	9.3
11-15	1	0.5
16 and above	1	0.5
Total	**204**	**100**

Findings revealed that, 183(89.7%) were growing their maize on 0-5 acres, 19(9.3%) were growing maize on between 6-10 acres of land while only about 2(1%) of them were growing their maze on more than 11 acres of land. These figures suggest that most maize farmers in Bungoma District are small scale farmers with majority having 0-5acres of land. Findings by Simtowe *et al.,* (2012) discovered a significant relationship between farm size and adoption of improved technology and stated that there was a positive correlation between farm size and adoption of improved technology. Farmers with large farms are more likely to adopt improved storage technology unlike those with small farm sizes since having larger farms strengthens farmer's capacity to produce more, which makes them interested in preserving their produce from loss.

4.4 Education and Adoption of Improved Maize Storage System

This section sought to establish the extent to which education of farmers influences adoption of improved maize storage systems within Bungoma District. Increasing literacy helps farmers to

acquire and understand information and to adopt new methods in a rapidly changing environment. It also helps in improved attitudes, beliefs and habits thus may lead to greater willingness to accept risks and adopt new innovations. Education may either increase prior access to external sources of information or enhance ability to acquire information through experience with new adoption.

4.4.1 Type of storage system currently used

The researcher was interested in knowing the type of storage system the respondents were currently using. In view of this, Respondents were asked the type of maize storage system that they were currently using. Their responses were as illustrated in Table 4.6

Table 4.6: Type of storage system currently used

Type of traditional storage	Frequency	Percent
Traditional granary	48	23.5
Sacks	110	53.9
Sisal Baskets/Kiondos	16	7.8
Others	30	14.7
Total	**204**	**100**

Out of the 204 respondents who participated in the study, 48(23.5%) reported using traditional granary, 110(53.9%) reported using sacks, 16(7.8%) reported using sisal baskets / kiondos and the others 30(14.7%) saying they used other maize storage systems. Findings from the study revealed that a majority of farmers still use the traditional systems of storing maize. None of the respondents reported using modern methods such as plastic containers, airtight or otherwise.

This is in line with study conducted by KARI (2012) where it was reported that Bungoma District still relies on traditional ways of storing their produce thus incurring high post harvest losses.

4.4.2 Awareness and sources of information of IMSS

To determine the extent to which education influences adoption of improved maize storage systems the respondents were asked whether they were aware of improved maize storage systems (IMSS). Their responses are presented in Table 4.7

Table 4.7: Awareness and adoption of IMSS

Awareness of IMSS	Adoption of IMSS		Total
	Yes	No	
Yes	51 (37.8%)	84 (62.2%)	**135**
No	3 (4.4%)	66 (95.7%)	**69**
Total	**54**	**150**	**204**

Out of 204 farmers who participated in the study, a majority of them indicated that they were aware of the improved systems. Interestingly, there was a very low rate of adoption of IMSS even amongst farmers who indicated they had knowledge of the systems. Findings reveal that only about 37.8% of farmers who said they had knowledge of IMSS actually adopted the improved systems, with 62.2% of them reportedly not adopting maybe due to other reasons. This is in line with findings of Okoedo and Onemoleas (2009) which indicated that despite dissemination of information on improved storage systems farmers still did not adopt improved storage systems due to reasons such as non availability of technology and high costs.

Table 4.8: Sources of information and adoption of IMSS

Sources of information	Adoption of IMSS		Total
	Yes	No	
Extension Officers	7 (53.9%)	6 (46.2%)	13
Exhibition	6 (85.7%)	1 (14.3%)	7

Seminars	21	(67.7%)	10	(32.3%)	31
Barazas	4	(17.4%)	19	(82.6%)	23
Friends/ Relatives	8	(18.2%)	36	(81.8%)	44
TV/ Radio	4	(25.0%)	12	(75.0%)	16
Others	1	(100.0%)	0	(0.0%)	1
Valid responses	51		84		135
Non-responsive					69
Total					**204**

Findings revealed that most of the respondents indicated that they had learnt about IMSS through their friends/ relatives. Other popular sources of information for learning about IMSS included through seminars and barazas (community meetings), with the media also contributing to awareness creation. Extension officers and exhibitions were among the least identified sources of information on IMSS.

Interestingly, although most respondents learnt about IMSS through friends and relatives, only 18% of the farmers who learnt about improved systems through them actually adopted them. On the contrary, while exhibitions were not a popular source of information on IMSS, an overwhelming 86% of those who learnt about the improved systems through this source actually went on to adopt IMSS.

This suggests that exhibitions were having a greater impact on the adoption of IMSS than any other source. Seminars and extension officers equally had high impact on adoption of IMSS, influencing 67.7% and 53.9% of the farmers who learnt from them respectively. Barazas had the least influence on the adoption of IMSS (17.4%). This is in line with findings of Ouma *et al.*, (2002) which indicated the benefits farmers received by getting information through sources such as extension officers and seminars among others.

4.4.3 Type of IMSS used

The researcher was interested in knowing the type of improved maize storage system the respondents were using. In view of this, the respondents were asked the type of IMSS they were currently using. The findings are presented in Table 4.9

Table 4.9: Type of IMSS commonly used by the farmers

Type of IMSS	Frequency	Percentage
Improved granary	17	31.5
chemical use	37	68.5
Metal bin/shelving	0	0
Valid responses	54	
Non responsive	150	
Total	**204**	**100**

Out of the 54 farmers who reported using IMSS, findings revealed that 17(31.5%) reported using improved granary while 37(68.5%) reported chemical use. None of the respondents reported using metal bin, shelving, and improved mud silo among other improved maize storage systems. This finding revealed that farmers in Bungoma only use improved granary and chemical as their improved storage systems. This shows there is low variety of IMSS as only two methods were commonly used. These findings are in line with that of Liberio (2009) which indicated that a variety of modern agricultural technologies like improved storage systems and agricultural machinery should be used to overcome the problem of food shortage.

4.4.4 Reasons for not Adopting IMSS

The study sought to know some of the reasons why the farmers had not adopted IMSS. In view of this the respondents were asked to state reasons why they had not adopted. This is presented in Table 4.10

Table 4.10: Reasons for not adopting

Reasons	Frequency	Percentage

Ignorance	22	14.7
Expensive	61	40.6
Lack of knowhow	53	35.7
Norms/beliefs	14	9.1
Valid responses	150	100
Non Responsive	54	
Total	**204**	

Findings revealed that 150 farmers had not adopted IMSS due to various reasons. 22(14.7%) reported they had not adopted due to ignorance, 61(40.6%) reported it was expensive, 53(35.7%) stated lack of knowhow, while 14(9.1%) stated norms and beliefs. Farmers, who reported the aspect of cost as a reason for not adopting, stated that the cost of materials and maintenance was quite high for them.

This findings support that of Okoedo and Onemoleas (2009), which revealed that high costs of storage systems lead to increased rate of non adoption since farmers cannot afford them. IMSS are considered very complicated especially for the unlearned, explaining low adoption. Lack of expertise on how to integrate the IMSS was reported as a huge limiting factor leading to the lack of adoption of IMSS by farmers. Lack of information on IMSS was also one of the reasons which contributed to lack of awareness. This finding is in line with Khann and Keatinge (2000) whose findings revealed that less than 50% of farmers in his study area had not adopted improved storage systems since they were not aware of them.

4.5 Training and Adoption of Improved Maize Storage Systems

The second objective of the study was to determine the role of training of farmers in influencing adoption of improved maize storage systems in the District. Training increases farmers experience in relation to adoption in that they are able to understand nature of risks associated with each of the new systems. Training to a larger extent also affects farmer's technical knowhow and decision making.

4.5.1 Training on IMSS

The researcher was interested to know if the respondents had received any training in relation to adoption of improved maize storage systems. Respondents were asked if they had received any training on the development, use and maintenance of IMSS. The findings is presented in Table 4.11

Table 4.11: Training on IMSS versus adoption of IMSS

Training on IMSS	Adoption of IMSS		Total
	Yes	No	
Yes	29 (65.9%)	15 (34.1%)	**44**
No	25 (15.6%)	135 (84.4)	**160**
Total	**54**	**150**	**204**

Findings in Table 4.11 reveal that a majority of the maize farmers in Bungoma District had not received training on IMSS. Somewhat expectedly, however, most of the farmers who had received training on IMSS had also adopted the improved storage systems (65.9%). This could suggest the influence that training has on the adoption of IMSS by maize farmers. This is in line with findings of Wekesa *et al.,* (2003) which indicated that farmers who had been trained were greater adopters of improved storage systems.

4.5.2 How long ago training was received

For those who had received the training, the researcher was interested to know how recently the training was conducted. Respondents were asked to state when they had received the training. Findings are presented in Table 4.12

Table 4.12: How long ago farmer was trained on IMSS

Duration	Frequency	Percentage

1-4months	20	45.5
5-8months	14	31.8
9-12months	10	22.7
valid response	44	
non responsive	160	
Total	**204**	**100**

Out of the 44 farmers who had been trained, 20(45.5%) indicated that they had received training within the last four months, 14(31.8%) indicated that they had received training between 5-8 months ago while 10(22.7%) had received training between 9-12 months ago.

4.5.3 Did farmers benefit from training?

The researcher was interested in knowing if the farmers who had been trained had benefited from the training. The respondents were asked to state the benefits they had received. The findings are presented in Table 4.13

Table 4.13: Did respondent benefit from IMSS Training

Benefited	**Frequency**	**Percentage**
Yes	36	81.4
No	8	18.6
Valid response	44	0
Non responsive	160	0
Total	**204**	**100**

Findings of the study indicated that out of the 44 farmers who had been trained, 36(81.4%) stated they had benefited while 8(18.6%) stated they had not. Unsurprisingly, most of the farmers who had received training on IMSS found it beneficial. This finding is in line with Ani (2000) and Iheanacho (2002) which revealed that farming experience through training to a large extent affects farmer's decision making and technical knowhow which increases productivity. Only

18.6% reported that they had not found the training beneficial to them at all. This shows the need to adopt improved maize storage systems because of its benefits to farmers.

4.5.4 Perceptions on IMSS

The researcher was also interested in assessing the perception of farmers on training in relation to IMSS. In view of this respondents were asked to state the degree to which training increased their knowledge or changed their attitude. Findings are presented in Table 4.14

Table 4.14: Perceptions on IMSS Training

Training increased knowledge			Training changed my attitude		
	Freq.	**Percent**		**Frequency**	**Percent**
Strongly agree	47	23.3	Strongly agree	62	30.2
Agree	138	67.4	Agree	104	51.2
Don't know	19	9.3	Don't know	38	18.6
Total	**204**	**100**	**Total**	**204**	**100.0**

In response to how training increased knowledge and skills on adoption, findings revealed that 47(23.3%) strongly agreed, 138(67.4) % agreed, 19(9.3%) indicated they don't know. This shows the perception of famers was positive in relation to training. In response to how training changed the farmer's attitude towards adoption of IMSS, 62(30.2%) strongly agreed, 104(51.2%) agreed, 38(18.6%) indicated they don't know. This finding shows the importance of training to farmers since training changed their attitude and increased their knowledge and skills towards adoption of improved maize storage systems, this suggesting that training could play a huge role in the adoption of IMSS by farmers in the District. This finding is similar to that of Martel *et al.*, (2000) which indicated that due to increased knowledge and skills from training, there was change in attitude and thus reduced losses in farm produce, thus increasing productivity.

4.6 Cultural Factors and Adoption of Improved Maize Storage Systems

The third objective of the study was to examine how cultural factors influence adoption of improved maize storage systems in Bungoma District. Farming technology is closely related to culture of people and beliefs about farming. The beliefs people hold about farming and the way they use or think about farming practices has an impact on how they adapt to changes in society.

4.6.1 Gender preferences in adoption of IMSS

The researcher was interested in knowing if there existed any gender preferences in relation to adoption of IMSS. The farmers were therefore asked whether they had any gender preferences in the adoption of IMSS. Findings are presented in Table 4.15

Table 4.15: Gender preferences in adoption of IMSS

Gender preference	Frequency	Percent
Yes	71	34.8
No	133	65.2
Total	**204**	**100**

Out of the 204 farmers who participated in the study, (71)35% indicated that they had gender preferences, with just over (133)65% indicating that they did not.

4.6.2 Examples of gender perceptions

The study sought to know some examples of gender perceptions the respondents had. Findings revealed that majority of the respondents stated they preferred women with reasons such as women were considered to be good farm managers, more receptive and had had willingness to adapt to new innovations. Few responses preferred males stating reasons such as males are energetic and have ability to adapt to new systems.

These findings indicate that in Bungoma District, there are gender perceptions with females being considered to engage more in farming practices than men. This contradicts findings of Jibowo (1992), from the study entitled Effects of Farmers' Demographic Factors on Adoption of Grain Storage Systems, which indicated that more men engaged in farming activities than women thus confirming that gender is significantly related to adoption of grain storage systems.

4.6.3 Beliefs and norms affecting maize storage system

Beliefs and norms influencing adoption of IMSS were also investigated. The respondents were asked to state the norms or beliefs they had. Findings revealed that Bungoma District has quite a number of beliefs and traditions. Some of the belief stated were: a mans input in decision making is key, protocol in marriage for polygamous families has to be considered before construction of a storage system, use of improved storage systems such as chemical use had adverse effects to their health, and females were not to be involved in construction of storage systems.

Finally some also responded that that there was no room for modern methods other than what their fore fathers left. This finding implies that farmers within Bungoma District are still tied to traditional norms and beliefs which hinder them from adoption of IMSS. This is in line with the findings of Nkoya *et al.*, (2007) which indicated that the existence of cultural factors such as traditions and beliefs may hinder farmers from adoption of improved storage systems since they are usually tied to old traditions and beliefs and more so reluctant in adoption of new or improved innovations.

4.6.4 Attitudes on IMSS

The researcher was interested in knowing how attitude influences adoption of IMSS. Farmers were asked to state how their attitude influenced adoption of IMSS. Findings from the study revealed that a majority of the farmers had negative attitude towards IMSS, stating reasons such

as it violated their beliefs, it was expensive, and it contributed to health complications. Nevertheless, there were positive attitudes that were reported that could lead to increased adoption of IMSS. For example, some reported that they thought IMSS led to better quality stock, and as such the need for better quality stock led them to adopting IMSS. These findings show that farmers have both positive and negative attitudes towards adoption of IMSS. These findings are in line with that of Odenya *et al.,* (2008) on adoption of improved sugarcane varieties in Kenya, which revealed that attitude can influence farmer's choice of adoption either positively or negatively.

4.7 Economic Status of Farmers and Adoption of Improved Maize Storage Systems

The fourth objective of the study was to determine how economic status of farmers influence adoption of improved maize storage systems in Bungoma District. Most farmers rely on farming as their major source of income thus economic status and land size under cultivation will determine their adoption rates.

4.7.1 Farming as a source of income

Farmers were asked whether they earned an income from their maize farming. Findings are presented in Table 4.16

Table 4.16: Farming as a source of income and adoption of IMSS

Farming as a source of income	Adoption of IMSS		**Total**
	Yes	No	
Yes	42 (31.1%)	93 (68.9%)	**135**
No	12 (17.4%)	57 (82.6%)	**69**

Total	**54**	**150**	**204**

Out of 204 farmers interviewed, most reported earning an income from farming; with just over a third reporting being subsistence farmers only. Nevertheless, cross tabulations of whether farmer gets income versus adoption of IMSS indicates that income from farming appears to have only a little influence on the adoption of improved storage systems, with only 31.1% of farmers currently getting an income from maize farming actually reporting the adoption of IMSS. Farm income can be used as capital for investment in adoption. Alternatively, farmers accessed funds from other sources to help in adoption of IMSS. This is in line with findings of Liberio (2009) which indicated that it is farmers with more resources in terms of capital, land and labor that are able to take advantage and adopt new or improved systems.

4.7.2 Role of income in adoption of IMSS

The respondents were also asked on the role of income in adoption of IMSS. The respondents gave different reasons. Findings revealed that income helped in adoption of better methods, some also stated that there was no income since they used whole produce for own consumption, some also stated income was too little. This finding implies that farmers reporting income as a factor in adoption of IMSS indicated that they adopted the new methods in order to increase their income since IMSS guaranteed higher quality outputs and yield, thereby increasing their income.

However, those who indicated that income did not influence their adoption of IMSS indicated that they used their produce for own consumption; hence no income to use for adoption. This is in line with findings of Liberio (2009) which indicated that it is farmers with more resources in terms of capital, land and labor that are able to take advantage and adopt new or improved systems.

4.7.3 Influence of acreage on adoption of IMSS

The size of land used for agriculture was also reported as a significant determinant of the adoption of IMSS by farmers. In view of this the farmers were asked the size of land they had and whether it had an influence on adoption of improved maize storage systems. The findings of the study are presented in Table 4.17

Table 4.17: Perceptions on influence of acreage on adoption of IMSS

Acreage influence	Frequency	Percent
Yes	172	84.3
No	32	15.7
Total	**204**	**100**

Findings revealed that 172(84.3%) stated acreage had an influence on adoption of IMSS while 32(15.7%) stated it had no influence.

This implies that most of the farmers had small acres of land and thus could not adopt IMSS because their produce was mainly for consumption. Farmers with large farm size are more likely to adopt IMSS this is because they have capacity to produce more thus need for better storage systems. This is similar to findings of Simtowe *et al.,* (2012) who revealed a significant relationship between farm size and adoption of improved technology and stated that there was a positive correlation between farm size and adoption of improved technology.

4.7.4 Role of harvest in adoption of IMSS

The researcher was interested in knowing if the amount of maize harvested determined the nature of adoption of IMSS. In view of this, the respondents were asked to state the degree to which they agreed with the statement. Findings are presented in Table 4. 18

Table 4.18: Role of harvest on IMSS adoption

Level of agreement	Frequency	Percent
Strongly agree	77	37.7
Agree	98	48.0
Don't know	18	8.8
Disagree	9	4.4
Strongly disagree	2	1.0
Total	**204**	**100**

Findings from the study indicated that, 77(37.7%) strongly agreed, 98(48.0%) agreed, 18(8.8%) dint know, 9(4.4%) disagreed, 2(1%) strongly disagreed. This implies that most respondents (86%) at least agreed that the amount of maize harvested determines the nature of adoption of improved maize storage system, with 5% at least disagreeing that it did not. 9% of the respondents were unsure of the role of harvest on IMSS adoption. Amount of maize harvested depends on the farm size where farmers with large farm sizes are able to harvest more as compared to farmers with small farm sizes.

This is similar to findings of Simtowe *et al.*, (2012) which reported a significant relationship between farm size and adoption of improved technology and stated that there was a positive correlation between farm size and adoption of improved technology. Farmers with large farms are more likely to adopt improved storage technology unlike those with small farm sizes since having larger farms strengthens farmer's capacity to produce more, which makes them interested in preserving their produce.

4.7.5 Challenges faced by farmers on the storage systems being used

The researcher was interested in knowing the challenges farmers face by the methods of maize storage they were currently using. The respondents were asked to state some of the challenges they were facing. Findings revealed that majority stated pest and rodent attack, followed by high maintenance costs or capital requirement associated with improved systems, some also stated theft cases as a major challenge. This finding shows that most farmers still use non improved

systems which have several challenges thus continued post harvest losses. This is in line with findings by Mughogho (2009) which indicated that although relatively simple and inexpensive to construct and maintain, non- improved traditional storage systems lead to substantial post-harvest losses.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the summary of findings, conclusions, recommendations, suggestions for further studies and contributions to the body of knowledge.

5.2 Summary of Findings

The demographic characteristics that were included in the study included, gender, age, level of education of participants, number of children and number of acres used by household in planting maize. Findings from the gender of respondents revealed that females (66%) engaged more in farming as compared to men (34%). Findings revealed that majority 29.9% of the farmers were between the ages of 20-29years old showing that most of the farmers were young. The study sought to establish distribution of respondents by number of children they had and thus revealed that majority of the respondents were parents with 39% having 1-3 children. Findings from the distribution of respondents by academic qualification revealed that an overwhelming 67% of the farmers had only attained primary education.

The first objective of the study was to establish the extent to which education of farmers influences adoption of improved maize storage systems in Bungoma District. From the findings, it revealed that education influences adoption of IMSS. There is low level of formal education among farmers and hence impacting their adoption rates of IMSS. This is backed by 67% of farmers having attained up to primary level of education. Findings also reveal that there was low rate of adoption even among farmers who indicated they had knowledge. Only 38% of farmers who had knowledge adopted IMSS with 62% not adopting due to several reasons.

The second objective of the study was to determine the role of training of farmers in influencing adoption of improved maize storage systems in Bungoma District. Training, being a key element in agri-business sector's growth and development, influences one's attitude positively and boosts the individual's technical knowhow. Through training it is believed that individuals are equipped with the right skills on how to improve their storage systems. From the findings, it was found that majority of farmers within Bungoma have not been trained. For those who received training, 66% had adopted IMSS. Findings further revealed that for those who had received training, 81%

indicated that it was beneficial to them and thus contributed to increased knowledge and change of attitude while 19% indicated they had not benefited.

The third objective examined how cultural factors influence adoption of IMSS. Findings revealed that beliefs and norms appeared to contribute as a factor influencing the adoption of IMSS within the district with over 50% stating beliefs which hindered them from adoption. Findings from the study also indicated that majority of the respondents had various (perceptions on gender advantages to adopt IMSS, with females having the upper hand). With regards to attitude as a factor attributed to culture, findings further revealed that majority of respondents depicted a negative attitude towards IMSS, while few of the respondents had a positive attitude towards IMSS.

The last objective considered how economic status of farmers influences adoption of IMSS. From the study, it was clear that for one to adopt IMSS, money as a potential means to acquire capital was a key element to consider. This therefore led to a majority engaging in commercial farming, though on small scale, so as to afford the better systems of storage. About 50.98% of respondents indicated their interest in adopting IMSS by investing money they had earned from selling their surplus produce. For 12.75% of respondents, this was not possible due to very little income earned from crop sale.

5.3 Conclusion

The main purpose of this study was to examine socio-economic factors influencing adoption of improved maize storage systems in Bungoma district. In relation to the objectives of the study, the following conclusions were made;

The first objective was to establish the extent to which education of farmers influences adoption of improved maize storage systems in Bungoma District. This was fully met as the study showed that education influences the adoption of improved maize storage systems by farmers in the District. Findings of the study revealed that although most people had knowledge of IMSS, there was very low adoption of IMSS by the farmers within the District. This explains the low adoption rates of IMSS systems amongst the farmers in the District, owing to the low levels of their education and other factors. Additionally, there seems to be only a few types of IMSS systems being used by the farmers. None of the respondents reported using IMSS such as metal bins, shelving, and improved mud silos. This raises the need of awareness creation focused on promoting different IMSS methods that suit a farmer's needs and capacity.

Ignorance of IMSS systems and lack of technical know-how are major factors leading to the poor adoption of IMSS by farmers in the District, with over half of the farmers sampled citing these reasons as an inhibiting factor in their adoption of improved systems. Furthermore, IMSS are considered very complicated especially by farmers with limited formal education who constitute a large proportion. Findings also concluded that training influences adoption of improved maize storage systems in the District. Although very few farmers have received training on IMSS systems, those who have received training indicated that they were very beneficial to them and contributed towards a change in attitude towards improved storage systems. Training was reported to not only increase the farmers' knowledge and skills on the adoption of IMSS but also change their attitudes towards the adoption of the IMSS.

The third objective of the study was to examine how cultural factors influence adoption of improved maize storage systems in Bungoma District. Attitudes seemed to influence the adoption of IMMS by small-scale farmers in the District, with women perceived as more receptive of IMSS, while men are perceived to be more skilled and energetic to build IMMS

systems. Women are also generally considered better farm managers. Findings also indicated that beliefs influence decisions to adopt IMSS. For example, women are culturally not allowed to participate in building of granaries, putting at risk female headed households, while beliefs that chemical use in IMSS negatively affect fertility also jeopardizes the adoption of the improved systems. Still positive attitudes exist amongst the farmers with prevalent attitudes such as IMSS contributing to improved quality of stock, and that improved systems generally contribute to greater food security in the area. Friends, neighbors and relatives also play a crucial role in promoting the adoption of IMSS by farmers in the District.

Finally, the last objective of the study was to determine how economic status of farmers influence adoption of improved maize storage systems in Bungoma District. Findings concluded that income from harvest influences adoption of IMMS. Most maize farmers indicated that they rely on their produce as a source of income, suggesting the need for better storage systems. Nevertheless, income was reported to be a primary reason for adopting IMSS, with farmers indicating that they adopted the improved storage systems in order to register better quality yield and hence higher incomes. Findings further revealed that acreage also seemed to influence the adoption of improved maize storage systems, with farmers holding larger farm sizes more likely to adopt the improved systems compared to their counterparts with smaller sized maize farms.

5.4 Recommendations

The study made the following recommendations for policy action:

There needs to be a greater focus on awareness creation of IMSS to farmers as it contributes to low adoption of IMSS. This can be through sensitizing people more on IMSS, through local radio stations and barazas to promote IMSS. Awareness creation would be beneficial in promoting other IMSS methods since only two improved maize storage systems were prevalent.

In addition, awareness creation would also help to reduce the negative attitudes that farmers have regarding the adoption of IMSS

More training needs to be offered to maize farmers in Bungoma District by encouraging private Agro-based sector to partner with the government in frequently holding seminars and other training sessions to encourage extension service**s** to improve their technical know-how on improved maize storage systems, especially considering a high proportion of farmers are not using IMSS due to ignorance and lack of technical know-how

There needs to be more advocacy initiatives on subsidizing the costs of agricultural products by stakeholders in order to improve the adoption of improved maize storage systems by farmers. This is especially so since the costs associated with adopting IMSS was a major challenge identified by the farmers.

There is need for maize farmers in the District to form support groups and SACCOs in order to shield them from the high costs of IMSS adoption. Member groups could be beneficial for farmers who would build IMSS systems that support more farmers hence reduce on the costs associated with IMSS construction and maintenance.

SACCOs could be beneficial in ensuring maize farmers not only collectively negotiate better prices for their products but also access financial services such as loans to support them in adopting newer, improved methods.

A more effective approach is through practical demonstration of the effectiveness of various IMSS methods. This can be done by selecting a few farmers as demo farms and providing them with the facilities for IMSS. Other farmers can be taken there for field days to see and learn how useful the facility is.

5.5 Suggestions for further study

This study did not explore certain areas that were equally important. In view of this, the study suggests the following areas for further research.

1. Access to financial services by farmers in Bungoma District and its role in the adoption of improved storage technologies.

2. The role of newer storage technologies on food security and income in Bungoma District.

5.6 Contribution to body of Knowledge

Table 5.1 Shows the contribution of the study to the body of knowledge. It highlights the gains to be realized from the study which will add knowledge to the present situation.

Table 5.1 Contribution to the Body of Knowledge

Objectives	Contribution to the body of knowledge
1. To establish the extent to which education of	The study showed that although most

farmers influences adoption of improved maize storage systems in Bungoma District	people had knowledge on IMSS, there was still low adoption, this point out need to focus on awareness creation to promote IMSS based on farmer needs and capacity.
2. To determine the role of training of farmers in influencing adoption of improved maize storage systems in Bungoma District	The study revealed that farmers should be trained on technical knowhow of IMSS since this also enhances change in attitude which increases adoption rate.
3.To determine how economic status of farmers influence adoption of improved maize storage systems in Bungoma District.	Findings from the study indicate that the income level of farmers is crucial in adoption since it enables farmers acquire better storage methods
4. To examine how cultural factors influence adoption of improved maize storage systems in Bungoma District.	Findings from the study revealed that beliefs influence decisions to adopt IMSS this shows need to educate and enlighten people on new and improved storage systems to help in change in attitude so that they are not tied to old traditions.

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APPENDICES

APPENDIX I: LETTER OF TRANSMITTAL

OLUOCH FARIDA ACHIENG,
P.O BOX 1881- 40100,
KISUMU.

To whom it may concern,

Dear Sir/ Madam,

RE: REQUESTING PERMISSION TO CONDUCT RESEARCH PROJECT STUDY

I am a second year Master of Arts in Project Planning and Management student at the University of Nairobi. As part of my course, I am required to carry out a research project study. The purpose for this letter therefore is to request for permission to carry out fieldwork which will principally involve interviewing small-scale farmers in Bungoma District. My study topic is on ***The Socio-economic Factors Influencing Adoption of Improved Maize Storage Systems in Bungoma District.*** The information provided to me will be treated with utmost confidentiality and will be used for the purpose of this study only. In case of any information or clarification, please contact the undersigned on Telephone number 0722 730 425.

Thank you very much for your co-operation.

Yours faithfully,

Oluoch Farida,

Student-UON (L50/ 83560/ 2012)

APPENDIX II: FARMERS' QUESTIONNAIRE

Introduction

The purpose of this questionnaire is to solicit the perceptions, views, opinions and experience of farmers on the socio- economic factors influencing adoption of improved maize storage systems in Bungoma District.

Instructions of Completion of the Questionnaire

Please answer the questions honestly. You are humbly requested to tick (√) in the appropriate bracket or give brief opinion where necessary.

SECTION 1

Demographic Characteristics

1. What is the gender of the respondent?

   (1) Male (2) Female

2. How old are you (in years)?

   (1) 20-29

   (2) 30-39

   (3) 40-49

   (4) 50-59

   (5) 60 & above

3. What is the highest level of education you have successfully completed?

   (1) Primary

   (2) High School

   (3) Vocational School/Diploma

   (4) University

   (5) Post-Graduate

   (96) None

4. How many children you have?

   (1) 0

   (2) 0-3

   (3) 4-6

   (4) 7-9

(5) 9 & above

5. How many acres of land do you have for growing maize?

   (1) 0-5

   (2) 6-10

   (3) 11-15

   (4) 16 and above

SECTION II

Education and Adoption of Improved Maize Storage System

6. Which traditional maize storage system do you currently use/used to use?

   (1) Traditional Granary

   (2) Sacks

   (3) Sisal Baskets/Kiondos

   (4) Airtight Plastic Bags

   (5) Plastic Containers

   (96) Other, Specify……

7. Are you aware of improved maize storage systems?

   (1) Yes

   (2) No If No, skip to 11

8. If yes, where/ how did you learn about adoption of improved maize storage systems?

   (1) Extension Officers

   (2) Exhibition

   (3) Seminars

   (4) Baraza

(96) Other specify …….…….

9. Have you adopted improved systems of storing maize?

(1) Yes (2) No (Skip to 13)

10. If yes, which of the following maize storage systems do you commonly use?

(1) Improved granary

(2) Metal bin

(3) Shelving

(4) Improved mud silo

(5) Other, Specify……..

11. What are some of the reasons why you have not adopted improved systems of storing maize?

(1) Ignorance

(2) Expensive

(3) Lack of knowhow

(4) Norms/ Beliefs

(5) Other specify……..

SECTION III

Training and Adoption of Improved Maize Storage Systems

12. Have you been trained on how to make, use and maintain improved maize storage systems?

(1) Yes (2) No If No, skip to 15

13. How long ago did you undertake the training?

(1) 1-4 Months ago

(2) 5-8 Months ago

(3) 9-12 Months ago

14a. Did you benefit from the training on adoption of improved maize storage system?

(1) Yes (2) No

14b.) If Yes, briefly explain…….

……..

……

14c.) Indicate your degree of agreement/ disagreement with the following statements

Item	**Construct**	**1. Strongly Agree (1)**	**2.Agree (2)**	**3. Don't Know(3)**	**4.Disagree (4)**	**5.Strongly Disagree(5)**
i)	Training increased my knowledge and skills on adoption of improved maize storage system					
ii)	Training changed my attitude towards adoption of improved maize storage systems.					

SECTION IV

Cultural Factors and Adoption of Improved Maize Storage Systems

15a) Do you have gender preferences when it comes to adoption of maize storage systems?

(1) Yes (2) No

b) If yes, explain your gender perceptions

……

……

……

16). Name norms or beliefs that influence your choice on adoption of improved maize storage systems.....

.....

.....

17). Explain how your attitude influences adoption of improved maize storage system?

……

……

……..

SECTION V

Economic Status of Farmers and Adoption of Improved Maize Storage Systems

18a) Do you earn income from farming?

Yes (1) No (2)

b) Does the income earned from farming influence adoption of improved maize storage system? Yes (1) No (2)

c) If Yes/ No, briefly explain…….....

……

……

19. Does the number of acres of land you have influence your adoption of improved maize storage system? (1) Yes (2) No

19b. Indicate your level of agreement to the following statement:

The amount of maize harvested determines the nature of adoption of improved maize storage system.

(1) Strongly Agree (2) Agree (3) Neutral (4) Disagree (5) Strongly Disagree

20. What are some of the challenges facing the methods of storage you are currently using?

……

……

Thank you for taking your time to participate in this study

APPENDIX III- Table for Sample Size Determination

Size of Population	Sample Size (n)	Precision (e) of:		
	± 3%	± 5%	± 7%	± 10%
500	A	222	145	83
600	A	240	152	86
700	A	255	158	88
800	A	267	163	89
900	A	277	166	90
1000	A	286	169	91
2000	714	333	185	95
3000	811	353	191	97
4000	870	364	194	98
5000	909	370	196	98
6000	938	375	197	98
7000	959	378	198	99
8000	976	381	199	99
9000	989	383	200	99
10000	1000	385	200	99
15000	1034	390	201	99
20000	1053	392	204	100
25000	1064	394	204	100
50000	1087	397	204	100
100000	**1099**	**398**	**204**	**100**
>100000	1111	400	204	100

Source: Glenn, D. Israel (2009).

APPENDIX IV: LETTER FROM UNIVERSITY

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
KISUMU CAMPUS

The Secretary
National Council for Science and Technology
P.O Box 30623-00100
NAIROBI, KENYA

28th June, 2014

Dear Sir/Madam,

RE: OLUOCH FARIDA ACHIENG'- REG NO: L50/83560/2012

This is to inform you that **Oluoch Farida Achieng'** named above is a student in the University of Nairobi, College of Education and External Studies, School of Continuing and Distance Education, Kisumu Campus.

The purpose of this letter is to inform you that **Farida** has successfully completed her course work and Examinations in the programme, has developed Research Project Proposal and submitted before the School Board of Examiners which she successfully defended and made corrections as required by the School Board of Examiners.

The research title approved by the School Board of Examiners is***: "Socio-Economic Factors Influencing Adoption of Improved Maize Storage Systems in Bungoma District, Kenya".*** The research project is part of the pre-requisite of the course and therefore, we would appreciate if the student is issued with a research permit to enable her collect data and write a report. Research project reflect integration of practice and demonstrate writing skills and publishing ability. It also demonstrates the learners' readiness to advance knowledge and practice in the world of business.

We hope to receive positive response so that the student can move to the field to collect data as soon as she gets the permit.

Yours Faithfully

UNIVERSITY OF NAIROBI
28 JUN 2014

Dr. Raphael O. Nyonje, PhD
SENIOR LECTURER & RESIDENT LECTURER
DEPARTMENT OF EXTRA-MURAL STUDIES
KISUMU CAMPUS

APPENDIX V: RESEARCH AUTHORIZATION LETTER

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:
24th July, 2014

NACOSTI/P/14/4498/2492

Farida Achieng Oluoch
University of Nairobi
P.O.Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Socio-economic factors influencing adoption of improved maize storage systems in Bungoma District,"*** I am pleased to inform you that you have been authorized to undertake research in **Bungoma County** for a period ending **9th September, 2014.**

You are advised to report to **the County Commissioner and the County Director of Education, Bungoma County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: SECRETARY/CEO

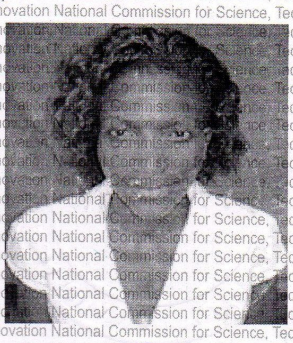
Copy to:

The County Commissioner
The County Director of Education
Bungoma County.

APPENDIX VI: RESEARCH CLEARANCE PERMIT

THIS IS TO CERTIFY THAT:
MISS. FARIDA ACHIENG OLUOCH
of UNIVERSITY OF NAIROBI, 1881-40100 KISUMU,has been permitted to conduct research in *Bungoma County*
on the topic: *SOCIO-ECONOMIC FACTORS INFLUENCING ADOPTION OF IMPROVED MAIZE STORAGE SYSTEMS IN BUNGOMA DISTRICT*
for the period ending:
9th September,2014

Permit No : NACOSTI/P/14/4498/2492
Date Of Issue : 24th July,2014
Fee Recieved :Ksh 1,000



.....
Applicant's Signature

.....
Secretary
National Commission for Science, Technology & Innovation

CONDITIONS

1. **You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit**
2. **Government Officers will not be interviewed without prior appointment.**
3. **No questionnaire will be used unless it has been approved.**
4. **Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.**
5. **You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.**
6. **The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice**

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 2351

CONDITIONS: see back page

APPENDIX VII: MAP BUNGOMA COUNTY