

**ASSESSMENT OF POST HARVEST GRAIN MANAGEMENT  
OPERATIONS AND THEIR EFFECTS ON FOOD SECURITY OF  
SMALLHOLDER HOUSEHOLDS IN KISUMU COUNTY, KENYA.**

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### **DECLARATION**

This Project is my original work and to the best of my knowledge has not been submitted for award of a degree or any other academic qualification in this or any other learning institution.

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## **ABSTRACT**

This study was aimed at assessing effects of post-harvest grain management practices on food security in Muhoroni division of Nyando sub county. The objectives of the study were ; to examine the socio economic and demographic characteristics of farmers sampled , to examine the level of access of the farmers to the sources of improved scientific post-harvest grain management technologies, and to establish the level of food security in the area of the study. The study will be significant to the government, farmers, policy makers and development partners. The theoretical frame work that guided the study was diffusion theory by Everett M. Rogers. The research design used was descriptive design and the sampling design was multi-stage cluster sampling. The study had a sample size of 120 farmers with the study population of 1200 farmers. Nyando district was purposely selected while the division was selected using simple random sampling. The tools used to gather information were structured questionnaire, in depth interview guide, and observation checklist. Primary data was gathered from interviews, observation, and structured questionnaire, while secondary data was obtained from the archives of various organizations, published and unpublished materials, books, journals, reports and magazines. The study involved both quantitative and qualitative analysis, and was analyzed using (SPSS) computer software. The study revealed that there was food insecurity in Nyando Sub County caused by post-harvest grain management practices. The government through the ministry of Agriculture should start programs aimed at teaching the farmers on proper maize storage and post-harvest handling of maize to reduce maize losses.

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Background of the study**

Various studies have demonstrated that available food in the world does not meet the demand of the world's population, and even in countries where average food consumption levels appear to be adequate, there are major disparities in food intake with portions of the population often being malnourished.

The world produces enough food to feed everyone with at least 2,720 kilocalories per day, which is well above the Food and Agriculture Organizations of the United Nations (FAO's) recommended minimum of 2250 (FAO,2003a ). Yet some 800 million people in the developing countries have inadequate access to food, fundamentally because they lack the ability to purchase enough i.e. the means to exert effective demand (Lensing 2007). Global food availability cannot be taken for granted over the long term in view of continuing population growth, increasing land scarcity, and mounting difficulties in achieving sustainable increases in food crop yields.

Sub Saharan Africa accounts for 13 percent of the population and 25 percent of the under nourished people in developing world. It is the developing region with the highest proportion, one-third of people suffering from chronic hunger. In 14 countries in the region, 35 percent or more of the population were chronically undernourished in 2001-2003. Hunger in Sub-Saharan Africa is as persistent as widespread. Between 1990-92 and

2001-2003, the number of undernourished people increased from 169 million to 206 million, and only 15 of the 39 countries were reported, to have reduced the number of under nourished. Food insecurity in Kenya occurs both in urban and rural areas and in both high potential and the Arid and Semi Arid Lands (ASAL) areas. About 51 percent of the rural and 38 percent of urban populations respectively are food insecure. It is ironic that the immediate victims of a state of food insecurity or even worse famine, have been farmers who are the producers of food. Each year hundreds of thousands of rural households who are the very producers of food are food insecure and therefore literally depend on food aid for their survival and this despites weather conditions.

Agriculture contributes 30% to the Kenya's gross domestic product (GDP) and employs more than 60% of the country's workforce (Republic of Kenya 1994). However, frequent food shortages are still experienced in Kenya. This has been attributed to pests, diseases (Republic of Kenya (1994) and post –harvest constraints among other causes. In semi arid regions, losses were reported to range between 5-7% (Songa2004). In monetary terms post-harvested losses due to insect pests have been estimated to be 1.8 million 90 kilogram bags valued at 8.1 million annually ( Likhayo et al, 2004). Despite the existence of opportunities to reduce post-harvest losses, farmers still incur substantial losses as indicated above.

According to World Bank study, post-harvest losses of food grains, are estimated to be 7-10 percent at the farm level and another 4-5 percent at market and distribution level for the system as a whole, the losses seen is up to 12-16 million tons of maize, with an

average per capita consumption of about 15kgs of food grains. These losses are enough to feed about 70 to 100 million peoples. These losses mainly rise because of improper harvesting methods, problems of threshing, storage, transportation and marketing.

FAO (2009) revealed that in Kenya, Malawi and Tanzania between 2006 and 2007, the loss to national maize due to pests was estimated to be 150-300 million dollars. A solution to the problem of inadequate food supply is often ignored, and yet very important in terms of quantity of food it can yield, and what Spurgeon (1976) and Bourine (1977) refer to as “the hidden harvest”, which means reduction of the food losses during post harvest period. It is estimated that 30 – 40% of the crops harvested in the third world countries never get to the consumer. Losses usually occur during one of the post harvest operations i.e. harvesting, handling, transportation, packaging, storage, processing and marketing). According to Salunkhe et al (1986 page 20), the attention of the World Food Day Conference in Rome in November in 1974 where he said “Another major priority must be reduced losses from inadequate storage, transport and pest control. Better methods of safe storage must be made more generally available. Many of these techniques are simple and inexpensive. Investments in these areas could have a rapid and sustainable impact on the world’s food supply.”

## **1.2 Statement of the research problem**

The consequences of food insecurity on households are physical, psychological, and social familial. It may cause hunger pangs in adult and children, fatigue(depletion) or

illness related to insufficient food. A hungry mother will give birth to an under weight baby who then faces stunted growth, illness, learning disabilities and reduced resistance to diseases. Children who do not get enough regular food will be less able physically and intellectually because of poor nutrition.

In a World Bank development report(1993), it was estimated that 40% of the cost of disease to economies of developing tropical countries was due to diseases whose susceptibility is increased by mycotoxin's consumption( Kenya Maize Development Manual).

Poisoning by aflatoxin which is highly toxic and carcinogenic mycotoxin, is responsible for frequent out breaks of food poisoning in Kenya. Between May and September(2004), there was a severe outbreak of aflatoxin poisoning in parts of Eastern and Central provinces in which 140 people are reported to have died. In 1982 several people died in Machakos after consuming aflatoxin contaminated food. (WHO 2006).

In Kenya an epidemiological association between aflatoxin consumption and primary liver cancer in certain commodities has been demonstrated . Hospital records in Chogoria, Meru district hospital, and Nembu mission hospital show a sharp increase in liver cancer attributed to aflatoxin contamination. Similar high incidence of esophageal cancer in Bomet and Keiyo Marakwet is attributed to mycotoxin consumption. In Kisumu a strong association between aflatoxin contaminated maize based weaning flour and impaired growth in children have been reported.(WHO 2009).

### **1.3 Research questions**

- (a) How do farmers' socio economic and demographic characteristics affect the adoption of post-harvest grain management technologies?
- (b) How does the level of access of the farmers to sources of management technologies, contribute to the adoption of post-harvest grain management technologies?
- (c) How do farmers' post harvest grain management operations contribute to grain losses?
- (d) What is the level of food security in the area of study?

### **1.4 Main Objectives of the Study**

To assess post harvest grain management operations and their effects on food security of smallholder households in Kisumu county, Kenya.

### **1.5 Specific Objectives**

The objectives were to:

- (a) Examine the socio- economic and demographic characteristics of farmers sampled.
- (b) Examine the level of access of the farmers to sources of post- harvest grain management technologies.
- (c) Investigate the post-harvest grain management operations and their contribution to post-harvest grain losses.
- (d) Establish the food security situation of households sampled.



### **1.6 Significance of the study**

The study is of importance to the following stakeholders:

**The government and policy makers** will benefit in the sense that the study will inform policy and development relating to food security in the country including the choice of appropriate technologies on post harvest grain management practices.

**Farmers** will be equipped with the information on how to improve their management practices in order to reduce grain losses at household level.

**Development partners** will learn about progress toward meeting Millennium Development Goals especially on hunger and poverty reduction through the adoption of improved post harvest grain management technologies.

### **1.7 Scope and limitation of the study**

The study was limited to:

- a) Examining the socio-economic and demographic characteristics of sampled the farmers.
- b) Examining the level of access of the farmers to the sources of post-harvest grain management technologies.
- c) Identifying post-harvest management technologies practiced by the sampled farmers.
- d) Establishing the food security situation of the sampled households.

## **1.8 Definition of terms**

**Aflatoxin** – Poisonous chemicals produced by certain fungi on foods.

**Food security** – Having physical and economic access to access sufficient, safe and nutritious food.

**Harvest** – Deliberate action to separate the food stuff from its growing medium.

**Shelling** - Removal of the grain from the cob.

**Winnowing** – Separation of the grain from the chaff.

**Pest** – An insect or small animal which is harmful or which damages crops.

**Grain** – Seeds from a plant, used synonymously with maize.

**Preservation** – To keep something in order to prevent it from being damaged.

**Physiological maturity** – This is when maize kernel has a maximum content of dry matter.

**Food security** – World bank summit report (1996) refined food security as existing when all people at all times have access to sufficient, safe & nutritious food that meet their dietary needs and preferences for an active and healthy life.

## **CHAPTER TWO**

### **LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK**

#### **2.1 Introduction**

The chapter captures topics on current food security status in Kenya and global insights on causes of food insecurity, grain yields and factors affecting post harvest storage. In conclusion the chapter highlights on theoretical framework on the level of food security and definition of terminologies.

#### **2.2 Global and Regional Overview of Food Security Status**

World bank summit report (1996) defined food security as existing when all people at all times have access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy needs and food preferences for an active and healthy life.

The fact that farm households lay direct claims on their own producers means that they do depend less on markets for meeting the bulk of their consumption requirements. Post harvest losses occur between the beginning and completion of harvesting. Production turn- over is mostly once a year, and at most twice, in which about 95 percent of production comes from the main season only. More- over, long gestation period is involved between planting and harvesting of crops which in addition to low productivity levels has constrained grain availability from own production. Consequently many rural house- holds run the risk of food insecurity for several seasons of a year. In other words, seasonality of food security follows food production cycles, that is a relatively higher

level of households food security during the season immediately after a harvest is followed by a longer season of food insecurity extending up-to next harvest season. The extent of food insecurity is most severe during seed preparation and sowing season, whereas seasons following harvest are those in which one could find the largest volume of available grain at household level but also at market levels, since the major marketing seasons are also those ones as far as peasant households are concerned. A study done by Gebremeskal, Jayne, and Shaffer in 1998 discovered that 79 percent of annual sales of maize takes place between January and March. Some of the factors that would attribute to such an instant disposal of food grains by farmers include cash needs such as taxes, fees, loans etc, or fear of the risk of post harvest grain loss.

Seasonal fluctuations of grain availability both at household as well as market levels and thus of the level of household food security could be related with the farmers' post-harvest grain management systems, and capacities. Smoothing out of food consumption seasonally, as well as ensuring stability in food availability in markets, thus food prices, could be determined by the extent to which there exists an efficient post-harvest grain management system not only at the household level but also at micro economic level, but unfortunately this crucial area has not received the attention it deserves. The reason probably being the often easily held assumption that what matters after all is production, and if success could be achieved at the level of production, then there would be more availability of grains both at the household and market levels etc ( Goletti and Wolff, 1999). It is interesting to note that the strategy of decreasing post-harvest losses is more economical because it requires smaller inputs per unit of the final product than a strategy

of increasing production extensively, especially in the short run (Toma, et al 1990). It is always a trend in African countries that years after a boom cropping are followed by depressed price. It has been witnessed that at macro level, the poor post –harvest grain management systems by farm households leads to the disposal of most of the grains immediately after bumpy harvests at very low prices. Lack of post-harvest grain management capacities that has surfaced both at macro (national) and micro (farm household) levels are inter- related, and they mirror the extent of what post harvest loss might be in terms of physical crop damage, quality deterioration and value depreciation. The implication on food security at national as well as household level is of paramount significance for a country such as Kenya in which food insecurity has become a structural problem. The economic review of agriculture (2007) indicates that 51% of the Kenyan population lack access to adequate food.

Post harvest losses in the country have previously been estimated at 30 percent of all stored produce. However with advent of Large Grain Borer and Aflatoxin, the loss can be 100 percent depending on the severity of the outbreak (Dr Songa). Post harvest handling, storage and marketing can tremendously contribute to social economic aspects of rural communities in Kenya as stipulated in Vision 2030 (Republic of Kenya 2007). Poor households who depend entirely on food crops for their income are at greater risk of food insecurity than those who have alternative sources of income. They also risk experiencing higher mortality and malnutrition rates. Food storage at all levels result to losses reported to be around 30%.

Hunger is both a cause and effect of poverty. It holds back economic growth and limits progress in reducing poverty. The negative economic impact of hunger is dramatic, with annual losses of at least 6-10% in labour productivity and hence in gross domestic product (GDP). Poor and hungry people often face social and political exclusion. They lack access to education, health services and safe drinking water. It is particularly important that hunger reduction should be a major part of poverty reduction strategies (UN Millennium Project task force on hunger 2005).

An abstract book by ESA 2009 9<sup>th</sup> Conference European Sociological Association Mozilla Firefox sees food security as a conceptual and analytical concept used to identify households which have high and economical constraints to food consumption sociological approach inspired in theories of practice can contribute to improve this tool of measurement . Food insecurity has some consequences for the household and broader social implications (Annemarie Haemlin, Jean Habitch and Micheline Beaudry). According to the results of their study, important aspects of human development depend on food security. Some earlier studies on food insecurity in North America allude to the consequences of food include (Campbell 1991, Redimen et al 1990 and 1992, Sigman Grant and Suter 1994) on address of more specific issues such as behavioural and emotional problems in children (Kleinmen et al 1998) or household.

Indirectly, mycotoxins cause disease conditions via immunosuppression and vaccination failures. In a World Bank development report of 1993, it was estimated that 40 % of the cost of disease to economies of developing tropical countries was due to diseases whose

susceptibility is increased by mycotoxin's consumption (Kenya Maize Development Programme's Manual)

Post harvest losses occur between harvest and the moment of human consumption. This include on farm losses such as when grain is threshed, winnowed and dried as well as losses along the chain during transportation, storage and processing. In Africa on farm losses occur during storage. The potential for loss takes place throughout the grain harvesting and marketing chains. During stripping of maize from the con known as shelling, losses can occur when mechanical shelling is not followed up by hand stripping of the grains that are missed. Certain shellers sometimes damage the grain making insect penetration easier. On the farm cleaning is usually a combination of winnowing and removal by hand of heavier items such as stones. Losses can be low when the operation is done carefully but high with carelessness and wrong equipments. The main cause of loss during drying is the cracking of kernels that are eaten whole. Some grains may be lost during the drying process.

However failure to dry crops adequately can lead to much higher levels of loss than poor quality drying and may result in the entire harvest becoming inedible. Adequate drying by farmers is essential if grains are to be stored on farm and poorly dried grains for the market need to be sold quickly to enable the marketing- processing chain losses to be reduced.

Post harvest insect pests jeopardize food security through developing world. Small scale farmers who store their grains as whole ears slotted in bins in adobe rooms among the rafters of their dwelling or in the field are especially hard hit. The two most damaging species for maize are weevils and the larger grain borer. Farmers restrict weevil attacks through use of varieties with closed sturdy husks and through practices that regulate the temperature and humidity of the grain, such as sun drying or keeping ears above hearth fires. The larger grain borer can destroy an entire grain store within five months. Adult beetles also penetrate and survive in the wooden frames of highly infested stores complicating control. Traditionally clay lined maize grain silos are used for storage in Africa. In each instances subsistence farmers and agribusiness alike are faced with difficulties of storing maize at optimal conditions and balance humidity, the moisture content of the kernels and the potential for post infestations. In some parts of Africa innovative technologies for instance adaption of metals silos have been used very successfully in Central America.

Processing and drying of maize takes place in the middle of rainy season especially if the timing of the planting season and variety of the seed is not correct. While the relative humidity remains around 80% for several weeks after the harvest, it becomes difficult without additional heat to reduce the moisture content of the maize to 13-15% at which it can be stored. (FAO 1994). Many small holder farmers experience significant maize loss due to post harvest pest such as maize weevil. Although these losses are preventable they are prevalent due to lack of appropriate grain storage facilities that stop pests from contaminating grain suppliers. Bad pest infestation in Malawi have caused national grain



store losses of 40% but impact on individual farming household losses can reach 100%. This loss on household is disastrous because for many families maize is their source of income. The loss of maize results in declined food security and increased vulnerability.

### **2.3 Credit and Household Liquidity**

Price seasonality between harvest periods allows producers and traders to capture gains from grain storage investments. However, it is not always economically feasible or physically possible for small holder producers in Sub Saharan Africa to take full advantage of seasonal price increases. Most producers sale most of their stocks in the period directly after harvest because cash constrains, debts, or due to inability to protect against storage losses(Stephens and Barrett, 2009) Maize among producers is usually quite extensive. For example, Renkow et al (2004) estimate that almost 83% of Kenyan maize producer sales occur within two months of the harvest period. The timing of maize sales may vary greatly by region, how ever as Ghanian studies indicate a longer storage period of marketing small holders of 3-4 months (Mott et al 1995).

Producers commonly must buy additional maize grain at much higher prices in the lean season. Among studies of small holder farmers, between 10-19% of producers were found to be both buyers and sellers of maize in the same year. (Stephens and Barrett (2009, and Renkow et al 2004. Further Stephens and Barrett (2000) found that farmers who sold after harvest and were forced to buy in the lean season had an average loss of 29.3% on their terms of trade. The authors explain the phenomenon of sell low, buy high behaviour as a market failure from binding liquidity constraint and how rural credit

access converting non cash assets into cash may become necessary, with terms of trade losses representing a interest rate over forgone gains. Many Sub Saharan African producers face very high costs of capital, if this capital is available at all. Access to formal sectors is extremely limited and farmers draw from personal funds for agricultural expenses ( Gulde et al, (2006). This is an important factor in analyzing grain storage economics. By delaying the sale of grain until prices are higher in the lean season, producers must cover the post harvest expenses by other means. This carries a cost as these funds are removed from other possible revenue generating activities. Cash constrained households may be forced to forgo investments in insecticides and other technologies to reduce storage losses and may resort to selling early. In contrast, more cash secure households store maize for consumption, seeds, and future marketing. However scientists have attributed a recent decrease in new devastating insect infestation (Addo et al, 2002, Birkenshaw, and Hodges, 2002)

## **2.4 Post- Harvest Handling Of Grain**

In Agriculture post-harvest handling is a stage of crop production that immediately follows harvest. The instant a crop is removed from the ground or separated from its' parent plant, it begins to deteriorate. Post-harvest treatment largely determines the final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product .Sanitation is an important factor that reduces the possibility of pathogens that could be carried by fresh produce. Post-harvest sector includes all points in the value chain from production in the field to the food being placed on a plate for consumption. It includes harvesting, handling, storage, processing, transportation and

marketing. The amount of resources used and the efficiency of production depends upon the use of appropriate technologies, infrastructure, processing, marketing and transportation (Mreme and Rolle 2002).

#### **2.4.1 Factors and causes of grain losses**

The main agents or factors responsible for the losses can be grouped as:

##### **Physical factors**

- Temperature
- Moisture

##### **Biological factors**

- Insects and mites
- Birds, rodents and wildlife
- Micro organism, fungi ,moulds and bacteria

##### **Mechanical factors**

- Type and efficiency of on farm transport
- Speed and ground conditions of use

##### **Engineering factors**

- Type and efficiency of harvesting tool
- Primary processing equipment and machines
- Drying and storing structure

##### **Socio- economic and demographic factors**

- Financial status of farm household
- Storage and marketing system.

## **2.5 Post- Harvest Grain Management operations**

Some of the post-harvest grain management practices discussed below are:- harvesting, shelling, drying, transportation, winnowing and processing.

### **2.5.1 Harvesting**

One of the most important areas farmers tend to neglect is timing of the maize harvest. Many farmers do not know when to start making preparations for harvesting. The result of delayed harvesting is pest infestation and decaying of maize, especially during prolonged rains while the crop is still in the field. Farmers in Kenya and most African countries lose between 15 and 40 percent of their harvest due to these factors. If a farmer plants maize in March or early April, then it should be ready for harvesting in October, especially in warmer areas where maize matures early. This means that by September, farmers should be able to cut and stake the maize in readiness for harvesting. Some maize varieties mature early. If allowed to stay too long in the field, the maize husks tend to open, exposing the maize to weevils and rain water that is responsible for the yellow discoloration and rotting. ( Magazine for sustainable agriculture in Kenya 2007).

During harvesting the farmers cut the maize and make stakes in the field. The maize is left to dry and the cobs are removed later. During this period, the maize cobs are thrown on the ground as they remove the cobs from the husks and later picked for storage before shelling. This practice exposes the maize cobs to fungal spores in the soil and this increases the risk of aflatoxin contamination in later steps in the maize processing.

A survey conducted by the ministry of Agriculture in 2007 indicated that over 90% of small scale farmers in Eastern province dropped maize cobs on the ground during harvesting and experienced up to 30-50 percent losses. Losses at harvesting time increases when the house-holds depends entirely on hired labor.

### **2.5.2 Transportation**

Traditionally, most of the movements are handled by women and children. They carry the produce is on their heads, shoulders, their backs, hand pushed wheel barrows and carts and Pack-animals particularly donkeys and mules. The produce should be transported in clear vans to avoid both contamination and moisture in case of precipitation during transit. Wetting of dry grain during transit and storage usually results in fungal infection leading to loss of value hence affecting the marketability of the produce negatively.

The destinations are usually markets, processing, units for grains storage etc. The criteria for selecting appropriate on farm technology must take into consideration the biological, technical and socio economic feasibility of the technology.

### **2.5.3 Drying**

The main purpose of drying grain is to prevent germination, prevent growth of bacteria and fungi, and to retard considerably the development of mites and insects. It is important that the crop is properly dried to moisture levels of 12-13 percent for safe storage. Drying is solely dependent on sunshine and, hence limited to only day time and non rainy periods. One of the main problems in tropical areas is during drying because rain is usually frequent and in consequences the high relative humidity and poor insulation level.

Drying crop in the field by traditional methods fail to attain safe moisture level for storage, and also exposes the crop to field pests. Shelled maize should be dried in the sun for three to four days to prevent mould, which, which could lead to aflatoxin poisoning. Drying in the sun also kills some of the pests already in the maize.

Some of the methods used by farmers in drying grain are: staking, spreading on the bare ground or by the road side, tying maize on poles or tree branch, drying in improved natural ventilate structure, drying on a concrete cemented floor, and drying on plastic sheets.

#### **2.5.3.1 Staking or leaving maize to dry in the mother plant in the field**

In this type of drying cobs are traditionally left prior to harvesting through stoking, or left standing in the mother plant in the fields for 2-4 weeks. During stoking some losses are incurred through rodents, mainly rats and squirrels. The lose at this level is about 5 percent. Rao et al. (2001)

#### **2.5.3.2 Drying maize by spreading on the bare ground or by the road side.**

A common method involves spreading the crop on bare ground. It takes a week for drying late harvested cob but over 3 weeks to dry timely harvested crop, but it also depends upon weather conditions and the initial moisture content .Consequences of drying maize on bare ground include;-

Physical losses are experienced during gathering or cleaning. The maize is exposed to mould infestation which exposes the grain to a risk of aflatoxin contamination. Maize is also eaten by animals such as donkeys, cows sheep etc even though most people do not consider maize eaten by animals as losses. Extraneous materials and animal droppings are also experienced and this usually lowers the commercial value of maize **due** to reduction on its quality with the risk of rejection by the consumer (AGROTEC/UNP/OPS,1991).

#### **2.5.3.3 Tying maize on poles or tree branch to dry**

Maize cob in sheaths may be stringed into bunches then suspended on tree branches, or stringed above fire places in the kitchen houses in a form of stringed up cobs and left to dry. The good weather conditions is possible to dry down to 12 percent moisture and only small quantities of crop with no control on environment effect. Only small quantities of crop can be dried and with no control of environmental effect. This type of drying method exposes the crop to insect and rodent infestation and inclement weather.

#### **Disadvantage**

A main disadvantage is that only small quantities of maize can be handled during drying.

#### **2.5.3.4 Drying in improved natural ventilate structure**

On farm drying of maize in a natural ventilate structure becomes a positive small holder options specifically when more than one ton of timely harvested maize is to be handled.

The circular granary basket is very common in Africa and can be woven from a variety of materials and built by local patricians ( FAO/NRI 2010).

### **Disadvantages**

The method requires more capital, craftsman ship and some training than traditional structures.

#### **2.5.3.5 Drying on a concrete cemented floor**

Concrete cemented floor are used to dry all types of grain and also others like fruits and vegetables. The crops dried on concrete floor are not contaminated with soils, micro-organisms etc. It is versatile since many products can be dried. It uses solar energy and therefore is environmentally adequate.( FAO 2001). It is easy and simple to build and also environmentally adequate because it only uses energy for drying.

#### **2.5.3.6 Drying on plastic sheets**

The cost of drying on plastic sheets could be very high. Storage of the sheet in the off season is very difficult, especially for small scale farmers where reliable storage space is limited and protection against rodents and insects are unlikely to be achieved.

One of the most important steps a farmer needs to take after harvesting is to check the moisture is responsible for both rotting and attacks by moulds, which grow on the maize grains and produce aflatoxins. Maize if harvested early will have will have a moisture



content as high as 37%. This maize is to be dried until it attains a moisture content of 12%.

Traditionally farmers check if grains are ready for storage by:

- Putting a handful of grains and half handful of dry salt in a dry bottle or glass.
- The mixture is shaken for 2-3 minutes and allowed to settle.
- If salt sticks on the walls of the bottle, then the grains are not properly dried have not attained the lowest required moisture content.
- The grains are again dried and the test is repeated
- If there is no salt sticking on the bottle, then the grains are dry and ready for storage (The magazine for sustainable agriculture in Kenya 2007)

moisture level of 12%, which is the recommended level for long term storage. (FAO 2009).

## **2.6 Threshing/Shelling**

Maize shelling is difficult at a moisture level content above percent. At this moisture content, grain stripping efficiency is very poor with high operational energy and causing mechanical damage to kernels. A more efficient shelling is achieved when the grain has been suitable to dry 13 percent to 14 percent moisture content. Maize shelling is difficult at moisture level content above 25 percent. At this moisture content, grain stripping is very poor with high operational energy and causing mechanical damage to kernels. The method of shelling can affect the produce quality as well as predispose it to further

deterioration. Damage from these operations is proportional to moisture content of the grain and depends on the method used.

Maize for storage or consumption is prepared by shelling. Traditional shelling of maize is done by women and children. It is done by either by pressing the grain off the cob by hands, rubbing two cobs together holding one in each hand or beating the cobs in a sack with a stick. The above methods are labor intensive, time consuming and wasteful. The Use of frails to beat the grain off the cobs damages the kernel and the un-separated grain of the cob are lost with the chaff. Modern equipments not properly used also causes damage to kernels. Shelling of maize is traditionally done by women and children. Research did in Eastern, Central and Coast provinces in 2009 by FAO found that over 70% of farmers shelled their maize through physical beating. This resulted in grain cracking, exposing the grain to attack by fungi, and secondary pests reducing its quality and seed viability. Shelling by using machines that are not calibrated for the maize varieties and type (flint or dent maize), usually result in broken grains that increase the chances of fungal mycelia penetrating the maize grains and producing the aflatoxin.

### **2.6.1 Hand held shellers**

#### **Disadvantages**

Some of the disadvantages of hand shellers are that:

Low out- put (8-15 kg) 1cup a time is shelled, it is a slow process that requires a sound dry and uniform size of the cob, and a small broken or large cobs can - not be easily handled.

### **2.6.2 Small Rotary sheller**

A rotary is one of the recommended sheller that is used by farmers to shell their produce.

#### **Disadvantages**

- Significant grain damage may result from inadequate use of equipment.
- Relatively slow shelling i.e. only one cob at an equipment.

### **2.7 Winnowing/ Cleaning the grain**

Winnowing is traditionally done by dropping the grains from certain height and the natural wind eliminates the impurities. The method is tedious inefficient and causes grain losses. Winnowing is usually done because it increases the purity and market value of the grain, reduces mould and insect development and Prevents the propagation of weed seeds in the grain.

### **2.8 Storage**

The principle objective in any storage system is to maintain the stored commodity in good condition, so as to avoid deterioration both in quality and quantity. Grain can be lost over a period owing to losses, which occur during storage. Farmers are therefore forced to sell off excess produce beyond domestic requirements as quickly as possible. Improved storage structures usually prolong the duration of storage systems. Various traditional storage structures pose numerous technological design deficiencies. These deficiencies reduce the efficiency of the structures to handle and safely keep the crop for any reasonable length of time. Storage is further aggravated by the combination of high

temperatures and relative humidity's typical of many parts of the country. Not only do these conditions support the rapid multiplication of storage pests, but cause damage to crop. Storage of maize is either done in-doors or out-doors as discussed below.

### **2.8.1 Out- door storage**

- Un sheathed maize cobs are hanged on horizontal cords or creepers or poles
- Maize cobs heaped on traditional barns with or without occasional fire beneath.
- Traditional granaries, usually round with a roof thatch of grass, palm leaves or papyrus stems and raised on stone piles or on yolk poles which include basket woven, wall of mud clay and cow dung reinforced with straw and walls of mud and wattle.

### **2.8.2 Indoor Storage**

Maize cobs in sheaths are stringed and hanged above a fire place .Cobs in sheaths or un-sheathed are stored in the loft of dwelling or kitchen house. Some farmers store their maize grains in small indoor containers such as:- gourds, earthen ware, clay pots, jars, woven bags, plastic or metal tins, pails, drums etc. Maize should be turned regularly during the drying process and after wards during storage. The stored maize should be checked for any signs of pests. Maize stores should be built on a raised platform to allow for air circulation from below and sides of the store.

The type of storage material used can preserve or cause deterioration of the produce. Grains stored in polypropylene material, and with relatively high moisture content for longer than one month are likely to develop fungal infection. Natural fiber material

allows for further drying and hence appropriate for longer term storage. In the country about 80% of small scale farmers store their produce in polypropylene bags opposed to the recommended natural fiber bags (FAO 2001).

## **2.9 Pest control**

The methods that are commonly used by farmers to control pests are chemical pest control and traditional pest control.

### **2.9.1 Chemical pest control**

Chemical control of pests involves use of contact dust powder, admixtures and phosphine fumigants. These methods of pest control are unsuitable for subsistence agriculture since, most of the pesticides are either expensive, unavailable, have low shelf life, prone to user abuse, are highly toxic and farmers generally lack expertise in the handling and application of these chemicals. In such circumstances, host plant resistance and other types of control have become more appealing methods of control.(Songa and Irungu 2010).Dusting protects stored grains from attack by storage pests. However a few farmers especially the small scale farmers dust their produce as recommended. A survey conducted in eastern, central and coast provinces indicated that less than 50% of farmers dusted their produce. Out of these some used materials/ compound that were not recommended for grain preservation, under dose, poor timing and a good number did not scout for storage pests in their produce during storage as recommended. Poor dusting practices increases insect activities leading to loss of quality through damaged grains and fungal infection.(Songa and Irungu 2010).

### **2.9.2 Traditional pest control**

Some of traditional methods used by farmers to control pests include:-

- Storing in very well dried crop or re-drying when infestation is detected)
- Storage of maize in sheaths for protection by the husk
- Use of repulsive local herbs and plants to scare off the pests scare off the pests (Nim ground seed, leaves and other plant extract).
- Use of dried inert material such as sand, crushed limestone, wood ash at 1-5 percent.
- Use of abrasive ash from paddy husk mixed with the grain at 1- 0.5 percent causes dehydration in pests leading to desiccation and death.

### **2.10 Processing**

Traditionally maize is processed by de-hulling using either a stone quern or mortar and pestle. The aim is to remove the outer covering to soften the maize for cooking. Milling is also traditionally carried out using mills. The processed maize is used to make variety of traditional products such as ugali thin slurry) and porridge (thin slurries) which is the main staple for most is the main staple for most house-holds in Kenya. Traditional processing methods such as de-hulling, soaking and cooking. Maize have been reported to reduce the levels of aflatoxin by 46.6%, 28-72% and 80-93% in maize containing 10.7-270 ng/g of aflatoxin levels in Kenya (Mutungi et al,2008) The findings of this study indicate that exposure to acute aflatoxin levels is minimized during food processing and preparation. Generally, these processing techniques have been traditionally used for increasing the palatability of different food recipes but can also be promoted as strategies capable of reducing aflatoxin contamination of grains.

### **2.10.1 Posho milling**

The most common type of maize flour processing for human consumption is carried out by small scale posho millers to produce whole grain meal. Posho milling both in the urban and rural centers account for 60% of maize meal processing in Kenya. The majority of the posho millers use a simple hammer mill for processing the maize into flour.(FAO 2001).

### **2.11 Policy causes of food insecurity**

Although the government had specific policy on food security in 1981, there was hope that the goal of food self sufficiency would be met through the perseverance of broaden policies of Agriculture, as it was assumed that agricultural growth would directly translate into food self sufficiency at the national and household levels. Kenya's food policy since independence has therefore been centered on improving domestic supply of task foodstuff mainly grain crops.( Nyangito 1990).

The goal of food self sufficiently was largely attained in the early years of independence until the late seventies after which massive food shortages set in. Since then, the goal of food self sufficiency and food security has not been attained despite significant policy pronouncement to reform the sector. A number of factors that lead to food security in the country are among the policy failure in areas of agricultural pricing, marketing of inputs, distribution and extension that have introduced inefficiencies and lowering agricultural production and ability to cope with drought conditions (Nyangito 1990).

Further the poor implementation record by the government having lowered the incentives to produce by farmers. National policy documents such as seasonal paper number 2 of 1994 on food policy emphasized self efficiency in maize, beans, rice vegetables, milk, beef, and meat products with little emphasis on traditional crops such as millet and cassava.

Market liberalization policy leads to increased textures in the cotton farmer's market and therefore reducing their level income. Lack of support policy to private traders has limited their engagement in trade and therefore, they have failed to distribute food from surplus to deficit areas. In general decline in agricultural production has led to reduced food availability and decreased income which makes the country more vulnerable to food insecurity (Nyangito 1999).

The performance of the maize sub sector is key to the achievement of food security in the country as maize is a key staple food in the country. Nyangito (1997) outlines some of the key policy constraints that have hampered the sector and hence reduced domestic production of maize. These are mainly three in nature, these are: research and extension, input pricing and marketing and maize pricing. Research has failed to produce high yielding varieties for the medium potential areas, which are the largest maize producing areas in the country.



The Kenya seed company has an unfair monopoly over KARI output therefore reducing the distribution of high yielding varieties, there is no impartial institution to impact production and marketing of maize and as such limits the private sector's engagement/ investment in maize breeding. Under extension, there are recognized weaknesses in extension approaches, which have limited use of improved maize technologies by farmers. Under input pricing and marketing there is poor information flow to farmers on appropriateness and levels of use of improved inputs.

Following liberalization, high cost of inputs have made them inaccessible to farmers weaknesses in maize pricing and marketing has led to unstable domestic prices which has lowered production access of maize to consumers. Furthermore, there has been lack of support in private sector to develop and improve efficiency in maize trade. Limited private sector partnership has also hampered the achievement of food security.

FAOS / GIEWS 1999 reported that the 1999 main reason maize crop has been affected by scarcity and increasingly expensive agricultural inputs. Increase in agricultural input prices in general increased after implementation of market liberalization policies. FEWS, 1995 mentions economic reforms as a factor contributing to the increased number of people considered to be moderately involved in making food insecurity vulnerable. Although market liberalization policies had an objective of increasing the general production, they have contributed to a decline in food production in Kenya (Mbithi, 2000). This is because the policies were mainly price oriented (output and output pricing), but did not consider how price factors such as institutional framework, infrastructure and

development of private sector. Increase in real maize producer prices driving the market liberalization policies did not offer enough incentives to maize farmers to produce more because price is not the only factor attaining maize profitability.

The Kenya's trade policy has also tended to increase food insecurity originally based on the need to safeguard local agriculture and domestic manufacturing sector against adverse competition, the trade regime tended to unfairly tax agricultural exports thus denying the country of vital foreign exchange with which it could access food imports (Nyangito 1999). Even after the trade regime was liberalized, cheap food imports have suppressed domestic food prices and therefore food production (IBID) competing uses for land have tended to reduce the land area dedicated to food farming. The government has under invested in infrastructure that could be vital to encourage cross border trade in food commodities, which can reduce food insecurity (Ackello- Ogut et al 1997).

Until recently the high tariff regime on intra regional trade reduced the potential regional trade to help in alleviating food insecurity through food imports from the region weeks et al (1998), Mwale (1997). The ban of fresh fish exports from East African countries imposed by EU in December 1997 exhibited the effects of Hyacinth weed effects on lake victoria's fishing households.

The government currently has no policy on maize despite its importance in a Kenyan diet. The seed companies are driven a business approach that appeals to their clientele, increase in the number of bags harvested per hectare. This has been pushed by efforts of

various government policy that considers having food security as important in development of Kenya. In this regard the seed companies have concentrated their efforts on high yielding varieties which meet a partial goal of food security but have compromised on the safety. (WHO 2010).

## **2.12 Farmers Characteristics**

The aspect of agricultural technology has profoundly captured the attention of many agricultural researchers with the aim of combating food security. Agricultural technology, if properly designed and implemented, has the potential of improving and enhancement upon the level of agricultural productivity (Madukwe et al., 2000). Agwu (2001) Observed that adoption of agricultural characteristics of the farmers' inherently influence their decision to adopt agricultural technology. According to Purcell and Aderson (1997), farmers in most cases only take in new technologies when they believe that, the proposed change will benefit them totally. Furthermore, they retaliated that the rate of these adoptions would depend on individual characteristics of farmers, characteristic of the technology itself, as well the social cultural characteristics of individuals such gender of the household head, exposure, age, availability and distribution of labor, level of education, the financial strength of the agricultural farmers as well as societal members (Ibid) among others.

### **2.12.1 Gender roles and responsibilities**

Gender roles and responsibilities in terms of content and context have important implications for men and women status in the society. This is partly because gender is

socially constructed and have in assigning roles for men and women in society. Usually gender characteristics are culturally defined and stereotyped in an attempt to perpetuate beliefs and norms that society may deem necessary for its survival. Narayah and Nyamwaya (1995) in their study on socio economic causes of food insecurity found that the proportion of female headed households ranked as “ very poor” was higher than that of male headed as contracted to the large proportion of male headed households ranked rich in every district. In overall, 80% of female headed households were ranked as poor or very “poor” as compared with 58% male headed households so ranked in the entire sample. United Nations (1998) observed that gender disparities systematically disadvantages women with regard to overall economic status as well as access to basic services.

Most activities in post harvest are predominantly undertaken by women by a whole family, or by hired labor. These include harvesting, pre-processing, winnowing or cleaning of the grain, drying and pest management. Technologies used by women are largely traditional and therefore labor intensive and time consuming. In order to reduce food losses, the roles of women need to be recognized and intervention packages designed, should have a gender bias. In Africa women have found to be receptive to adoption of improved technologies that lighten and lessen their workload Nahdynd Odong (1991). Women have been considered as one of the food insecure and vulnerable groups (KF SS G 2000).

#### **2.12.2 Age of the household head**

Age is an important factor in post harvest handling of maize as it influences agronomic practices adopted by farmers (Obara 1983). It is postulated to influence agricultural technologies positively or negatively (Verva 1991, and Baidu- Forson, 1991, Lapar and Pandey, 1999, El-osta and Morehart 1999. Several other studies (e.g Savadogo et al. 1998, Neil and Lee 2001, Qaim and De Javnry 2003) have found age to influence adoption negatively. The old due to their conservative nature and risk aversion, are postulated to be reluctant to try out new technologies or innovations and stick to their old traditions, while the young are receptive to new ideas, and are energetic and known to readily adopt modern methods of farming.

#### **2.12.3 Level of education**

Education is a vital component to self reliance to farming communities. Post harvest losses will either increase or decrease with a farmer's level of education. Increased level of education will increase an adoption of the recommended improved scientific methods because it makes a farmer to make informed decision. El-osta and Morehart (1999), and Lapar and Pandery(2001).

#### **2.12.4 The size of household**

A study done by Rao et al. (2001) revealed that the post harvest losses at the harvesting level accounted for 30.5 percent of the total loss at the farm level. The loss in this stage was high because majority of farmers employed the laborers for harvesting. Singera Vadiver in 1992 also corroborated on the same. They both observed that heavy demand

for labor at the time of harvesting makes hired laborers to harvest in a hurry and some produce is left over in the plant. They also found that small sized cobs were left covered by the leaves, and were not harvested by laborers at the time of harvesting. According to them negligence during harvesting causes maximum losses at the farm level, unless supervision is strictly intensified.

### **2.13 Occupation of the household**

A cash constrained household may be forced to forgo investments in insecticides and other technologies to reduce storage losses and may resort to selling early. (Addo et al 2002).

Information is significant in ensuring that the process of adopting innovation is evident to the intended end users that determine either success or failure of the adoption of innovation. According to Serchrest et al. (2008) the development, testing and promotion of agricultural innovation require interaction between the agents of innovation and the end users. Similarly, agricultural research centers should receive feedback on performance of the innovations they introduce in the field. This implies that communication channels are immensely critical for the successful implementation and adoption of agricultural technology innovations. Hassan et al., (2010), in research paper on social economic factors influencing the level of adoption of innovation depends on the structure of the society, the standard of life, economic distribution of the innovation. Most silent information flow, which according to Hasan et al (2008) increases the distribution of innovation. In order for agricultural development to work in Africa,

governments need to take new approaches to information dissemination that emanate from a clear understanding of what the farmers' information needs are. Information is the critical factor in the decision making and farmers who know, will be more tempted to adopt innovation than the ones who do not know. Serchrest et al (.2009).

#### **2.14 Levels for post-harvest grain loss**

There is potential for losses throughout the grain harvesting and marketing chains. During stripping of maize grain from the cob, known as shelling, losses can occur when mechanical shelling is not followed up by hand stripping of the grains that are missed. Certain sellers can damage the grain, making insect penetration easier. For crops other than maize, threshing losses occur as a result of spillage, incomplete removal of the grain or by the damage to grain during threshing due to poor separation of grain from the chaff during cleaning or winnowing. Incomplete threshing usually occurs in regions with high labour costs, particularly at harvest time, when labor is too scarce and expensive to justify hand stripping after an initial mechanical thresh.

A wet season's paddy harvest may clog the screens and grain may be lost. Cleaning is essential before milling. On the farms cleaning is usually a combination of winnowing and removal by hand of heavier items such as stones. Losses can be low when the operation is done carefully but high with carelessness. With correct equipment, cleaning losses should be low in mills but grain may be separated together with dirt or alternatively, dirt may be carried forward into the

milling stages. In drying, grain that is dried in yards or on roads, as is common in parts of Asia may be partially consumed by birds and rodents, wind, either natural or from passing vehicles in the case of road drying can blow grain away.

The main cause of loss during drying is the cracking of grain kernels that are eaten whole, such as rice. Some grains may also be lost during the drying process. However failure to dry crops adequately can lead to much higher levels of loss than poor quality drying, and may result in entire harvest becoming inedible. Adequate drying by farmers is essential if grains are to be stored on – farm and poorly dried grains for the market need to be sold quickly to enable the marketing process chain to carry out adequate drying before the grains become spoilt. With high moisture content, grain is susceptible to mould, heating, discoloration and a variety of chemical changes. Ideally, most grains should be dried to acceptable levels within 2 – 3 days of harvest.

Grains are produced on seasonal basis. In many places there is only one harvest a year. Thus most production of maize, wheat, rice, sorghums, millet etc must be held in storage periods varying from a few days up to more than a year. Storage therefore plays a vital role in grain supply chains. For all grains, storage losses can be considerable but the greatest losses appear to be maize, particularly in Africa. Losses in stored grain are determined by the interaction between the grain, the storage environment and a variety of organisms.



Contamination by moulds is mainly determined by the temperature of the grain and availability of water and oxygen. Moulds can grow over a wide range of temperature is important. Maize for example can be stored for one year at a moisture level of 15% and temperature of 15°C. However, the same maize stored at 30°C will be substantially damaged by moulds within three months. Insects and mites can of course, make a significant contribution towards the deterioration of grain, through the physical damage and nutrient losses caused by their activity.

They can also influence mould coloration as carriers of mould spores, and their faecal material can be utilized as food source by moulds. In general, grains are not infested by insect below 17°C whereas mite infestation can occur between 3 and 30°C and above 12% moisture content. The metabolic activity of insects and mites causes an increase in both moisture content and temperature of the infested grain. Another important factor that can affect mould growth is the proportion of broken kernels. There is about 1700 rodents in the world, but only a few species contribute significantly to post-harvest losses. Three species are found throughout the world. These are house mouse, the black rat and the brown rat while a few other species are important in Africa and Asia. Many small holder farmers experience significant maize loss due to post-harvest pest such as maize weevil. Although these losses are preventable they are prevalent due to lack of appropriate grain storage facilities that stop pests from contamination grain supplies. Bad pest infestation in Malawi have cost national grain store loss of 40% but impact on individual farming household losses can reach 100%. This loss on household is disastrous because for many families maize is

their source of income. The loss of maize results in declined food security and increased vulnerability.

### **2.15 Ministry of Agriculture's Strategies to Curb Post-Harvest Losses**

- Training of extension staff
- Provision of moisture meters and maize shellers
- Training of farmers
- Partnering with relevant stake holders such as EAGC, COMPETE, SIDA, EU and AU.
- Encouraging value addition at farm level to transform the produce to products with a longer shelf life.

### **2.16 Theoretical Framework**

The theories used in the study were diffusion theory by Everett M. Rogers and hunger and food entitlement approach theory by Sen.

#### **2.16.1 Diffusion Theory**

Diffusion is the process by which an innovation is communicated through certain channels over time among members of social system. This is applicable in farming system when agriculturalists and researchers diffuse indigenous agricultural innovations as the adapters of innovation. Diffusion research centers on the conditions will increase or decrease the likelihood that a new idea, product or practice will be adopted by members of a given culture.

Diffusion of innovation theory predicts that media as well as inter personal contacts provide information and influence opinion and judgment. E.M Rogers (1995) argued that innovation occurs in four stages, i.e. invention, diffusion (or communication) through social system, time and consequences. The nature of networks and the roles opinion leaders play in them determined the likelihood that the innovation will be adopted. Innovation diffusion research has attempted to explain the variables that influence how and why users adopt a new information medium such as the internet.

Opinion leaders exert influence on audience behavior via their contact, but additional intermediaries called change agents and gate keepers are also included in the process of diffusion. Five adopters categories are innovators, early adopters, early majority, great majority and laggards.

### **2.16.2 Hunger and food entitlement approach**

Famine is a widespread scarcity of food caused by several factors including crop failure, population unbalance, or government policies. This phenomenon is usually accompanied or followed by regional malnutrition, starvation, epidemic and increased mortality. Conventional wisdom asserts that people who perish during famines die of starvation due to inadequate food consumption. In *Poverty and Famines*, Sen (1981, p. 47) writes about people being “plugged into starvation” when their entitlement to food collapses. In fact, frank starvation is rarely recorded as the causes of death in famine. More often, death

attributed to hunger related diseases such as diarrhoea and is explained by heightened susceptibility as lack of food undermines biological resistance to these illnesses. This is not of course incompatible with a “food entitlement decline” theory of famine. For entitlement failure to retain explanatory power however requires demonstrating association between, mortality during famines and entitlement collapse by destitution. Sen (1981) finds an association between occupation status and mortality risk during the Bengal famine of 1943 and Bangladesh famine of 1974, with low paid occupations such as landless laborers suffering the highest rates of destitution and death. But the evidence is less clear for African famines and sometimes appear to contradict Sen.

A person's “entitlement set” is the full range of goods and services that he or she can acquire by converting his or her endowments (assets and resources, including labor power) through “exchange entitlement mappings”. In the context of poverty and famine, the entitlement approach aims comprehensively to describe all legal sources of food which Sen (1981, p.2) reduces to four categories: “production based on entitlement” (buying food), own labor entitlement (working for food) and “inheritance and transfer entitlement”(being given food by others). Individuals face starvation if their full entitlement set does not provide them with adequate food for subsistence. Famine scales this up: Occupationally or geographically related groups of people face famine if they simultaneously experience catastrophic declines in their entitlements.

Perhaps the most valuable contribution of the entitlement approach to famine theorizing is that it shifts the analytical focus away from a fixation on food supplies. The Malthusian logic of “too many people, too little food” and on the inability of groups of people to acquire food. Food insecurity affects people who cannot access to adequate food( eg because of poverty) irrespective of food availability. A famine can occur even if food supplies are adequate and markets are functioning well. This is crucial insight. As Sen emphasized that there is no technical reason for markets to meet subsistence needs and no moral or legal reason why they should. An equally important insight, and one that has generated much confusion and controversy in the literature, is that famine can be caused by “exchange entitlement decline” (adverse shifts in the exchange value of endowments for food, e.g falling wages or livestock prices, rising food prices, rising food prices) as well as by “direct entitlement decline”( loss of food crops to poor post harvest crop management).

### **2.16.3 The relationship between of the diffusion theory and the food entitlement approach theory with the topic**

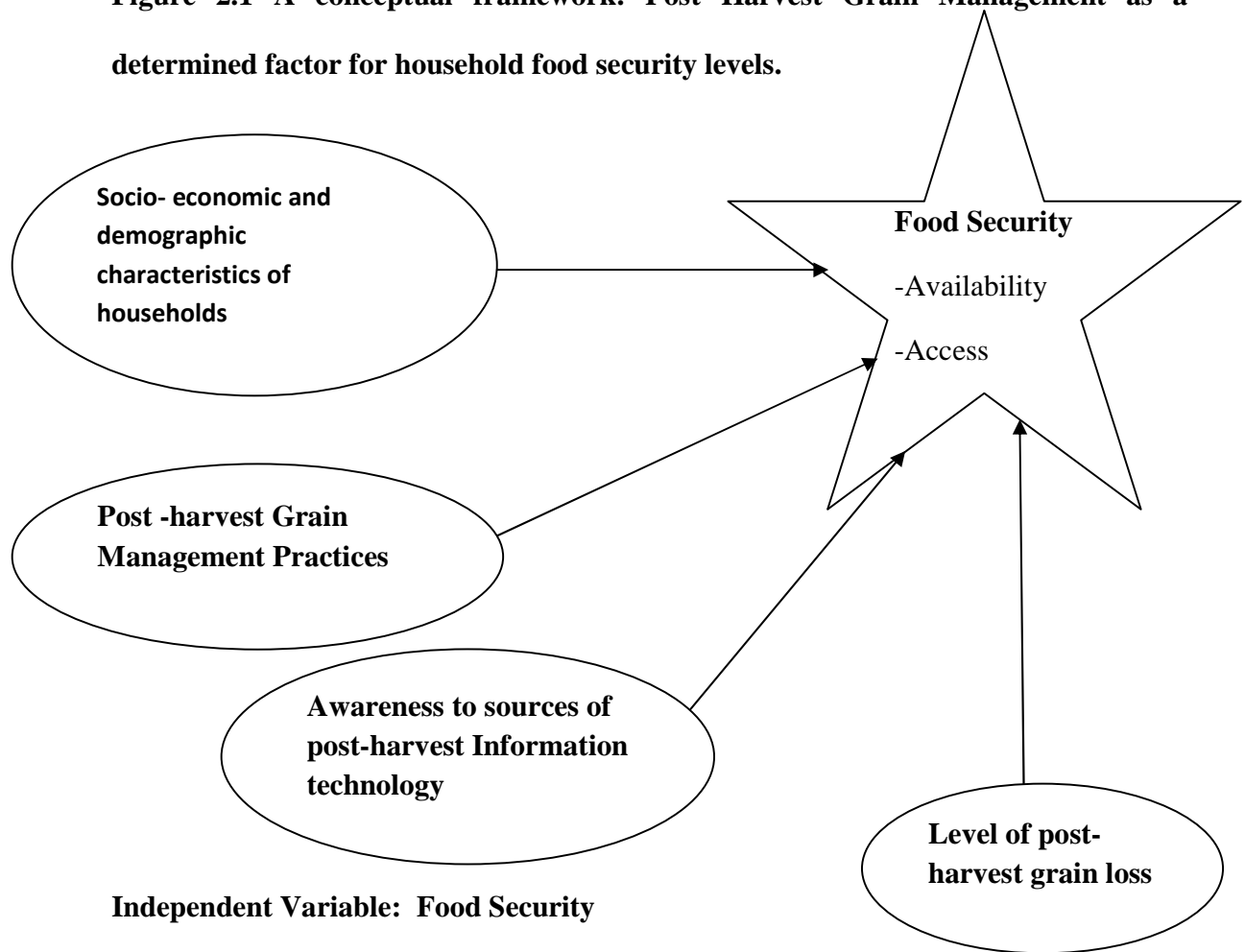
Based on the theories food insecurity continues to take place because of the losses obtained during the farm management practices ( eg harvesting, shelling, transportation, processing and storage)

-The post harvest grain management technologies from agriculturists and researchers diffuse the technologies to farmers through a media.

-Diffusion of technologies will either increase or decrease the likelihood of the information being adopted by the farmers.

-Diffusion of innovation theory predicts that media and interpersonal contacts will provide information and influence opinion and judgment of adoption of post harvest grain management technologies.

**Figure 2.1 A conceptual framework: Post Harvest Grain Management as a determined factor for household food security levels.**



**Dependent Variable: Post- Harvest Grain Management**

## **2.17 Operational definitions of variables**

### **Dependent variables**

Dependent variable is the variable that the researcher is interested in explaining and predicting (Singleton 1988: 72)

### **Independent Variables**

Independent variable is the variable

**Food Security** - Refers to amount of yield of maize obtained by the farmers and for how many months it lasts per household consumption.

-It also refers to sufficiency of income of a household to enable it buy food if it is not producing enough.

### **Socio- economic and demographic factors of farmers**

**The age of a farmer** - The age of a farmer refers to the number of years she or he has lived in this world. It is categorized as < 18 years as under age, 19- 39 years as young adults, 40- 60 years as middle age and > 60 years as old age. Age can relate negatively or positively to adoption of new technologies. An assumption is that the young may be more conservative and less open to new ideas.

-Another assumption is that farmers who are more elderly, are more experienced and acquaintance with new technologies and hence are expected to have higher ability to use innovations more effectively.

**Farm size** - Refers to total acreage of land per household and is categorized as < 3 acres, 4-5 acres and > 6 acres. The assumption is that farmers with larger farms are likely to practice better post- harvest management, than those with smaller farms.

-Large farms are indicators of wealth, and perhaps a proxy for social status and influence within a community. An assumption is that it is positively related to the adoption of post harvest crop management.

**Number of dependants** - Household size refers to a number of persons living together in one house. The family size can be ambiguous. An assumption is that it may hinder an adoption where farmers are very poor, and financial resources are used for other family commitment with little left for purchase of other things meant for adoption of new technologies Rao et al (2001).

-Another assumption is that a household size can be an incentive to new technologies as they may provide labor at the crucial time when labor is required most. Availability of labour can be an incentive to an adoption of recommended post- harvest technologies. Rao et al (2001).

**Main occupation** - An occupation refers to non farm income that a person does to earn an income. An assumption is that non- farm employment is positively related to adoption of technologies as it will provide finance required for adoption of post- harvest technologies.

**Gender of households** - Gender male or female headed households can have different adoption rates. Assumption is that adoption of new technologies can be both positive or negative depending on who makes decisions in the family.



**Years of schooling** - This refers to a number of years spent in school and is categorized as none, lower primary (1-4) years, upper primary (5-8) years, secondary (9-12) and college 13 years and above. The assumption is that farmers who are more educated will have, the higher adoption rate of post harvest technologies.

**Level of post- harvest storage loss** - Level of post- harvest storage loss refers to the magnitude of losses in the entire post harvest system for maize. The assumption is that losses will depend on post- harvest operations during harvesting, drying, transportation, packaging, processing and marketing. The level of loss will be measured in 90 kg bag lost after harvesting.

**Level of awareness to sources of information technologies** - This refers to post harvest information that a farmer requires in order to reduce the post- harvest storage losses. Assumption is that access to information will improve the adaptability of post harvest technology and hence will reduce grain losses.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Introduction**

This chapter describes the methodology used in the study. The chapter is divided into 5 sections. The first section discusses the study site. The second and the third sections describe study design and sampling methods. Data collection procedures and methods of analysis described in section four and five respectively.

#### **3.2 Site selection and description**

##### **Area of study**

The study was done in Muhoroni division of Nyando sub-county. Nyando district is a fairly new district in Kenya which broke away from Kisumu County in Nyanza province. The sub county is named after the Nyando river. It's capital is in a small town called Awasi located 30 km east of the provincial capital in Kisumu (district).

Nyando is among the twelve sub counties that make up Kisumu County. It has a geographical coverage of 1,168.4 km<sup>2</sup> and is divided into five administrative divisions which are:- Upper Nyakach, Lower Nyakach, Nyando, Miwani and Muhoroni. It has a population of approximately 357,393 (2009 census) with about 75% of the people residing in the rural areas. The ratio of males to females is 100:104. The youth are 21% of the population. The settlement patterns are mainly determined by the potential of the area; Upper Nyakach division has the highest population density with nearly 368 persons

per km<sup>2</sup> while Muhoroni division is a high potential sugar-belt region and is also the largest division in the district covering 334.8km<sup>2</sup> the average density of the district is 284.6 people per km<sup>2</sup> with an annual growth rate of 3.4%. Muhoroni, the division where the research was conducted hosts a town council. It has a household of 16,137 and about 15,011 living within the town centre making a total population of 31,148 (2009 census). Muhoroni has a railway station along Nairobi – Kisumu Railway. A town is located fifty (50) km east of Kisumu, the provincial capital and Chemelil a smaller town is located 10 km west of Muhoroni.

The overall poverty incidence in the district is approximately 61% compared to urban areas where it stands at 72%. Poor agricultural technology, lack of proper storage, poor and inaccessible roads, frequent floods that disrupt economic activities etc are some of the main factors perpetuating poverty in the district. Nyando district is a food deficit zone despite being considered 99% cultivable. This is partly due to unreliable rainfall. The zone produced 33,892 MT of cereals in 2010 as compared to its annual cereal demand of 51,465 MT. This means own production can only take the district for seven months and hence the reliance in inter county trade with neighboring high potential counties. For the households it means reliance on the markets for a significant share of food eaten. Over 60% of cereals consumed at household level are sourced from markets. The main crops grown in the district are maize, beans, sorghum, rice and sugarcane.

### **3.3 Research Design**

Research design used was descriptive research. Descriptive design deals with compilation and presentation of data in various forms. Descriptive research was used because the results of the study were to be displayed and information passed from which conclusions were drawn and decisions made.

#### **3.3.1 Sample Design and Sample Size**

Sampling is part of statistical practice concerned with the selection of individual observations, intended to yield some knowledge about a population of concern, especially for the purpose of statistical inference (Mugenda 1999).

Sample size, the central limit theorem is a significant result which depends on a sample size. It states that as the size of a sample of independent observations, sampling frame has a property that can identify every single element and include any in the sample. The sampling frame must be a representative of the population. A sample size of 10% of the total target population is accepted (Mugenda 1999). A target population of 1200 farmers would require a sample size of 120 farmers.

#### **3.3.2 Sampling design**

(a) To determine the sample size from each group, multi-stage cluster sampling design was used. Multi-stage cluster sampling design is a type of design which is used where population is large and scattered. A multi-stage cluster sampling was used because it gave all the households in the selected sub-locations an equal chance of being selected.

(b) The 3 locations of the division (Koru, Fort Ternan and God Abuoro) were sampled into 6 sub locations which were:- Tamu, Munara, Ochoria, Kandege, Owaga and God Nyithindo.

(c) Maize farmers from the sampled sub-location were listed then assigned numbers making a total target population of 1200. Depending on the total number of farmers in the sampled sub location, 10% of farmers were randomly selected from these sub-locations, making a sample size of total of 120 farmers.

**Table 3.1: Sample Sizes**

<b>Sub Locations</b>	<b>No. of households</b>	<b>Sample Size</b>
Tamu	240	24
Munara	230	23
Ochoria	140	14
Kandege	150	15
Owaga	190	19
God Nyithndo	250	25
<b>Total</b>	<b>1200</b>	<b>120</b>

*(Data source: District Agricultural office 2012)*

### **3.4 Type and sources of data**

Both primary and secondary data were collected for the study.

### **Primary data**

Primary data were collected using, surveys, semi structured interviews schedule, direct observation and a structured questionnaire which was pre tested amongst farmers in Muhoroni division.

### **Secondary data**

Secondary data is data that is collected from a source that has already been published in any form ( Farshaw 2000: 156) in the topic of the study. Secondary data for this study was obtained from the archives of various organizations such as the ministry of Agriculture, District Commissioner's office, published and unpublished materials, books, journals, reports and magazines.

### **3.5 Selection of key informants**

Purposive selection was done to all the informants that were thought to be relevant to the research topic. They included District Commissioner, Divisional agricultural officer, Divisional agricultural extension officer, 2 Chiefs, Field Extension Officer and 2 Agro chemical traders in the division. A total of 8 key informants were selected for the study.

### **3.6 Selection of research site and sub-sites**

Nyando Sub County was purposely selected for the study due to its proximity to the researcher, and Muhoroni division was randomly selected. The sub county has 2 divisions called Muhoroni and Miwani. The Sub- county has a poverty level of 61% despite having two planting seasons annually (short rains and long rains). The researcher therefore

wanted to find out if post harvest grain management practices had any effects on food insecurity among households in the district.

### **3.7 Data collection tools**

- **structured Questionnaire** : Administered to maize farmers in Muhoroni division in order to collect primary data on effects of post harvest grain management practices on food security.

-**Interview Schedule** : Used to collect data from the key informants.

-**Observation Checklist** : Used to collect information through field survey.

### **3.8 Data collection procedure**

Before the actual data collection exercise, preliminary survey was undertaken both in the field and also to the relevant departments. The purpose for this was the researcher to familiarize herself with the study areas, and also make appointment with the identified persons in the study. The researcher then administered all the questionnaires by herself.

On the appointment, days the researcher distributed the questionnaires to the sampled respondents who were learned for them to fill them by themselves but always availed herself for any consultation or clarification. Those respondents who were not learned were assisted by the researcher and whenever there was a language barrier, the researcher got assistance from the interpreters. In cases where the respondents were absent, the researcher got a replacement from the sampling frame through simple random sampling. The key informants were interviewed personally using the interview schedule. The

researcher used the observation checklist and entered all the relevant information in the note book which was analyzed later.

### **3.9 Data analysis**

The study involved both qualitative and quantitative analysis of data. Data cleaning was done to determine inaccurate, omitted, inconsistency and missing data. After editing, the data was coded, analyzed and examined critically in order to make inferences. Data was analyzed using SPSS, computer software. For qualitative data, focus was placed on the particular meanings of what participants said. Thematic and content analysis were employed in the analysis of this data taking on both descriptive and analytical explanations.

### **3.10 Validity and Reliability**

According to Orodho and Kombo, (2002) validity determines the extent to which the reach truly measures the aspects it intends to measure, or how truthful the research results are. The researcher combined both closed questions and open ended questions. Reliability concerns the extent to which the results are consistent over time and provide an accurate representation of the population under study. This is done to find out whether it is possible to obtain a similar result using the same methodology. This consistency was tested by the farmer giving out a few questionnaires to some farmers outside the sampling frame in order to test the uniformity of the responses.



### **3.11 Challenges encountered**

- Language barrier- This was encountered by having interpreters
- Change of appointments by some of the department heads and key informants in the division. This was caused by them either being absent or having tight schedules. This led to prolonged time spent in the field.
- Some participants were reluctant to give information on some issues and had to be explained to the aim of the study.
- Bad weather during rainy seasons made movement to the interior places almost made movement almost impossible during the study, due to the nature of black cotton soil in most parts of the division.

### **3.12 Gaps in addressing post-harvest grain management**

- Post harvest grain management had a gap
- Farmers education level had a gap
- Farmers access to sources of information had a gap.

## **CHAPTER FOUR**

### **DATA PRESENTATION AND ANALYSIS**

#### **4.1 Introduction**

This section of the chapter presents the major findings, data analysis and the presentation in terms of frequencies and percentages based on the socio-economic and demographic characteristics of the respondents, the level of access to the sources of post-harvest grain management technologies, and post-harvest grain management practices and their contribution to grain losses and the level of food security.

#### **4.2 Socio- economic and demographic characteristics of the respondents**

The researcher's first objective was to sought the socio-economic and demographic characteristics of the farmers' and their effects on adoption of post-harvest grain management technologies. She therefore asked the respondents questions that were related to their gender, age, number of years in school, land family size and the main occupation of the family head and their responses were as indicated in table 4.1 below:

**Table 4.1 - Distribution of respondents according to their socio economic**

**Characteristics**

<b>Variables</b>	<b>Number</b>	<b>Percentage</b>
<b>1 Gender</b>		
Male	80	66.7
Female	40	33.3
<b>Total</b>	<b>120</b>	<b>100</b>
<b>2 Age of family head</b>		
<40	20	16.7
40-50	30	25
50-60	40	33.3
>60	30	25
<b>Total</b>	<b>120</b>	<b>100</b>
<b>3 Occupation of the respondents</b>		
Farmers	70	58.3
Employed	30	25
Business	20	16.7
<b>Total</b>	<b>120</b>	<b>100</b>
<b>4 Level of education</b>		
None	20	16.7
1-8	30	25
9-12	40	33.3
>12	30	25
<b>Total</b>	<b>120</b>	<b>100</b>

#### **4.2.1 Gender of the house-hold head**

Female headed households are more susceptible to instant sales than male headed ones. This may be ascribed to fewer options available to female headed sources of income. Due to social inequalities women are often disproportionately vulnerable to hunger. Although they are responsible for the bulk of food production, more than 80 percent in Africa, they continue to be bypassed by most agricultural programs.( UN millennium project Tusk Force On Hunger,(2005).

The study on the gender of the respondents revealed that majority ( 67%) of the respondents were headed by male while the remaining (33%) by female. Out of the households headed by women, 70% were food insecure. The finding shows that gender of the household head was directly related to the adoption of post-harvest grain management operations.

#### **4.2.2 Age of the family head**

Data shows that of the 120 respondents interviewed, 20 (16.7%) were less than 40 years, 30 (25%) were between the age of 40 and 50, 40 (33.3%) were between the age of 50 and 60 and the remaining 30 (25%) were above 60 years of age. This shows that majority of the respondents involved in farming were relatively young. According to Savado et al (1998), Neill and Lee (2001), Quim and Javnry (2003) in their study found that age influences adoption of technologies negatively. The results indicated that with the increase in age of the farmer, post-harvest losses decreased because of the farmers

experience at the field level about post harvest practice. Age was directly related to the adoption of post harvest grain management operations.

#### **4.2.3 Occupation of the family head**

Rural house-holds are engaged in diversified activities to meet their economic needs. It was therefore found necessary to investigate the respondents main occupation as respondents who had diversified occupation had other sources of funds and so were in a better position to provide for funds required for post- harvest management technologies. As indicated in table 1 above, the majority 70 (58.3%) of house-hold heads were farmers and the remaining 50 (41.7%) were engaged in other activities such as formal employment, and different types of businesses. The study revealed that occupation of household head and farming were significantly related. Farmers whose households engaged entirely on farming experienced higher level of grain losses than those who had diversified occupation. The finding revealed that (40%) of farmers who did have diversified activities increased the household's vulnerability to food insecurity as they sold most of their produce soon after harvesting at low costs in order to meet households' financial needs. The results revealed that occupation of the household head was directly related to the adoption of post-harvest management technologies. Diversification of occupation is therefore necessary for the reduction of post-harvest losses.

#### **4.2.4 The family size**

The pressure on households triggered by larger family size to meet non grain purchased consumption needs tends to induce farmers to instant crop sales. The researcher was therefore compelled to enquire from the households the number of dependants they had and findings revealed that majority 72 ( 60%) of the household had the dependants more than 5, while 48 (40% ) had less than 5 dependants. The numbers were inclusive of both the respondent's own children and their dependants. The researcher found it necessary to study the number of the dependants as a large number of the dependants was expected to reduce post-harvest losses. The study revealed that (55%) of households who had more than 5 dependants also experienced grain losses. The results indicate that the family size of the household and the adoption of post-harvest technologies were not significantly related.

#### **4.2.5 Level of education of the family head**

Education level has a major implication in adoption of improved scientific technologies and innovations as low level of education limits the farmers' level of adoption as it increases the managerial skills of a farmer. The researcher therefore asked the respondents to state their level of education. The results on the level of education showed that the majority 70 (58.3%) of the household heads had 9 years and above of education, while the remaining 50(41.7%) between 0- 9 years of education. The average of 9 years and above in school for this sample suggests that the respondents were fairly educated, and therefore were in a position to understand the need to adopt post-harvest management technologies. The finding found that out of those who had less than 9 years

in school, the level of adoption of post-harvest technologies was about (10%) as compared to (40%) of those who had 9 and above years in school. The study therefore suggests that an additional education to the household heads who had less than 9 years in school was necessary as it will increase the chances of adoption of post harvest grain management technologies. The study findings concurs with the study by Ervin & Ervin, and Lapar & Pandey (1999) who found that exposure to education improves an individual's ability to make informed decisions and choices. The study revealed that as the level of education of the farmer increased the level of losses also decreased. This is an evident that the level of education and crop losses were significantly related.

#### **4.3 The level of access of the farmers' to sources of post-harvest grain management technologies.**

The second objective of this study was to examine the level of access of the farmers to sources of post-harvest grain management technologies. Information is a critical factor in decision making and those who know are tempted to adopt the information, than those who don't know (Serchrest et al, 2009). The researcher therefore wanted to know whether or not the respondents were aware of the sources of post-harvest management technologies or not. Their responses were that the majority (33.3%) said the information they had was from agro chemical shop venders in the area. The information from the agro chemical shop venders was mainly on the right varieties for the area and the chemicals suitable for various pests and diseases. The (20%) of these farmers said that they adopted the information they received. The remaining (10.3%) said that even though they had the information they did not adopt it because of lack of funds. The (25%) of the

interviewed farmers said that the information they had was from the media. The information was on the recommended harvesting and drying methods, and also on the steps they were supposed to take to ensure that the environment around the stores and inside the stores were kept clean to keep away the pests. The (15%) of these farmers said they adopted the information and were practicing it while the remaining (10%), said that they had not started practicing but because they had the information, they would practice it in the next planting season. The (16.7%) of farmers said that they got the information from their neighbors.

According to the study, the type of information they received from neighbors was on chemicals for the control of storage pests. Out of these farmers, (11%) of them said the information they got did not help them and were still experiencing losses due to storage pests. If asked further, they said that the information they got was only on the type of chemical the neighbor was using to control storage pests with no proper technical training on the other logistics like the recommended dosage of the chemical and the methodology. Finally the remaining (25%) of farmers said the information they had was from the extension officers, agricultural shows and field days. The study revealed that the information they received from agricultural shows and field days was on the recommended crop protection techniques which included safe use of chemicals, monitoring of the moisture level, harvesting, drying, threshing and storage techniques. The (18%) of these farmers adopted the knowledge and reduced post harvest losses in their farms.



**Table 4.2: Distribution of respondents according to the level of access to the sources of post- harvest grain management technologies.**

<b>Source of information</b>	<b>Number</b>	<b>Percentage</b>
1 Extension officers	10	8.3
2 Agricultural shows/ Field days	20	16.7
3 Neighbors	30	16.7
4 Media	20	25
5 Agro chemical shop venders	40	33.3
<b>Total</b>	<b>120</b>	<b>100</b>

#### **4.3.1 Post-harvest grain management operations**

Post-harvest grain management operations discussed below are harvesting, transportation, drying, storage and threshing/shelling. The researcher wanted to know if the farmer's post- harvest management operations had any effect on crop losses.

**Table 4.3: Distribution according to post-harvest grain management operations**

<b>Variable</b>	<b>Number</b>	<b>Percentage</b>
<b>1. Harvesting</b>		
Harvesting and putting them in containers	20	16.7
Cutting maize stalks and hipping them at a place then remove the husks later.	40	33.3
Harvesting by throwing on the ground	60	50
<b>Total</b>	<b>120</b>	<b>100</b>
<b>2. Transportation</b>		
Tractor	40	33.3
Wheelbarrows	30	25
Head	24	20
Donkeys	16	13.3
Hired vehicles	10	8.4
<b>Total</b>	<b>120</b>	<b>100</b>
<b>3. Drying of maize</b>		
Drying in improved cribs	10	8.4
Spreading on bare ground	30	25
Staking	40	33.3
spreading on concrete/plastic sheets	40	33.3
<b>Total</b>	<b>120</b>	<b>100</b>
<b>4. Storage</b>		
Granary	0	0
Crib	50	41.7
House	70	58.3
<b>Total</b>	<b>120</b>	<b>100</b>

#### **4.3.1.1 Harvesting**

Due to heavy demand for labor at the time of harvesting some farmers were forced to employ laborers to assist. Hired labor usually harvest in a hurry, neglecting corn in plants, causing the highest losses at the field level unless strict supervision is practiced. According to results, lost (10%) of their maize due to negligence by the hired labor. The study on farmers' harvesting practice revealed that the majority (50%) of farmers interviewed said that they harvested their grain by throwing it on the ground, (33.3%) by cutting the maize stalks and hipping them at strategic points then removed the husks later, and the minority (16.7%) harvested their maize by putting them directly in harvesting containers. This practice since was hygienic, was not popular because it was considered to be slow and time consuming. Harvesting maize and throwing it on the ground, as shown in the picture (plates 6 and 16) and cutting maize stalks and hipping them on the ground and collecting them later exposed the grain to pests and diseases as shown in (plates 7, 10,11 and 12). The losses are usually due to pests and diseases.

#### **4.3.1.2 Transportation**

The research on the type of transportation used in post- harvesting grain management practices established that the majority(33.3%), wheelbarrows (25%) head (20%), donkeys (16%) and hired labor (10%) of the transportation was done by bullock cart and tractor Some other means of transport were bicycles, head, and hired vehicles, wheel barrows and pack animals (donkeys). The choice of transport system used depended on factors such as the socio-economic factors of the farmer, level of the zone, amount of production of the crop, distance, infrastructure, availability of animals, ways, roads

trucks, cars etc to transport the harvested produce. The level of losses depended on the type of transportation system used. These losses were in terms of quality and quantity.

#### **4.3.2.3 Drying**

Farmers were asked to state type of methods they used for drying, and their responses were that the majority (33.3%) , dried by stooking (appendix v ) and leaving the maize standing in the field until it dried, (41.7%) on concrete grounds and plastic sheets, and the minority (25%) dried maize by spreading it on bare grounds. Drying maize on bare grounds exposed the grain to soil contamination, domestic animals and bad weather infection, causing both quality and quantity losses. The study supported the findings by FAO( 2008) which also found that maize dried on bare grounds exposed it to fungal infection. Farmers when asked if they knew how to test for moisture content in maize, (60%) said that they did not know and only (40%) they knew how to do it using traditional methods (appendix ix). Out of those farmers who knew how to text maize for moisture content only (15%) tested their maize before storage meaning that the remaining farmers stored their maize with very high moisture content that exposed it to moulds and fungal attacks.

#### **4.3.2.4 Storage**

Data in table below summarizes the storage facilities in the area of the study. Farmers were asked to state where they stored their maize after harvesting and their responses were that the majority (70%) stored their maize in the living room, and (50%) stored their maize in cribs. The use of traditional granaries was not popular among the interviewed

farmers due to the issue of insecurity in the area. Most farmers were not using insecticides to control storage pests exposing their maize to storage pests like in (plates 13 and 14). Storage Losses (plate 11) caused by leaking roofs made maize to have mould infection rendering it unfit for human consumption (plate 8), The broken stores exposed maize to be exposed to rodents attack making it not safe for human consumption. Due to insecurity, farmers shifted from storing their maize from granaries to living rooms. However due to human activity in the living rooms relative humidity is usually high, predisposing the grain to both storage pests and fungal attack.

#### **4.3.2.5 Threshing / Shelling and cleaning**

The average losses resulting from threshing/shelling were about 10%. The losses were in terms of broken grains because majority of farmers threshed their produce by beating in bags. Grains were also by leaving grains over in the threshed corns, and also due to scattering of grains in the threshing yards. Losses were less where manual shelling was used and highest where power shelling was used. The results supported the findings by Patil et al (2000).

#### **4.3.2.6 Packaging**

In this study, grains were mainly packed in gunny bags. Losses during packaging was about 5 % of the total loss at the farm level. The grains were packed in old and torn gunny bags. This caused losses especially during transportation to different destinations. The gunny bags which were used by some farmers were torn and so spilled the maize causing losses. Some farmers also stored their maize gunny bags made of polypropylene

material. Polypropylene material has very high moisture content that if used longer than one month are likely to develop fungal infection (plate8). The study results found that packaging and level of losses were significantly related and training on packaging would reduce the post-harvest grain losses.

#### **4.4 The Household Security Situation**

The fourth objective of the study was to establish the food security situation of households sampled.

The household security situation was arrived at by screening the respondents to ascertain any level of food insecurity or any signs of hunger. The indicators were classified along the four dimensions of food security: availability, access, utilization, and stability.

For instance:

- Their main staple food.
- The source of food consumed in their households(Access)
- Whether or not, they were forced to eat food that was not of their choice(Food preference)
- Whether all the members of the household always had enough food(Quantity)
- The number of meals the family members had per day ie breakfast, lunch super
- The types of food consumed in the household (Nutritious food or a balanced diet).
- Whether or not the family members were forced to eat maize that was infected by pests and diseases (Quality)

- Further, to test food security level in the household, Household Food Insecurity Access Scale (HFIAS) score was used. This is an approach used to estimate the prevalence of food insecurity in the United States annually.
- The method is based on the idea that the experience of food insecurity (access) cause predictable reactions and responses that can be captured and quantified through a survey and summarized in a scale.
- HFIAS score is a continuous measure of the degree of food insecurity (access) in the household in the last one year.
- Scores were converted to a 0-10 metric by dividing individual household score with the maximum household score (18) and multiplying by ten. The resulting score should be used to categorize households based on the classification scale below.

**Table 4.4: Households categorized according to HFIAS scores**

Up to 2.32	Up to 4.56	Up to 6.53	Up to 10
Food secure	Food Insecure		
	Food insecurity without Hunger	(Less Severe) “Moderate”	(More Severe) “Severe”

- The higher the score, the more food insecurity (access) the household experienced.
- The lower the score, the less food insecurity (access) a household experienced.
- **Calculation of HFIAS =  $\frac{\text{Sum of HFIAS Scores in the sample}}{\text{Number of households in the sample}}$**

**Number of households in the sample**

- The lower the score, the less food insecurity (access) a household experienced.
- **Calculation of HFIAS =  $\frac{\text{Sum of HFIAS Scores in the sample}}{\text{Number of households in the sample}}$**

**Number of households in the sample**

$$\text{Average HFIAS} = \frac{1450}{120} = 12.08$$

120

An average HFIAS of 12.08 means that (52%) majority of the households had a score of  $12.08 \times 10 / 18 = 6.71$  and would therefore be classified as **severely food insecure with hunger** based on the classification scale. This is because, from the illustration above, any



score beyond 6.71 implies a severe food insecurity with hunger in the homestead. From the results, it is evident that the people of Nyando sub county of Kisumu county were food insecure.

## **CHAPTER FIVE**

### **THE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

#### **5.1 Introduction**

This chapter consists of the summary of the research findings, the conclusions, recommendations, and suggestions for further research.

#### **5.2 Summary**

According to the research findings, post-harvest grain management practices had effects on food security in Nyando Sub County, causing losses in terms of quantity and quality of the grain.

Socio-economic and demographic characteristics (gender, age, occupation and level of education of the households head), farmers' access to sources of information contributed, and Post-harvest grain management operations (harvesting, means of transportation, drying, storage, threshing and winnowing) had effects on grain losses.

#### **5.3 Conclusions**

The study on assessment of post-harvest grain management and its effects on post harvest grain management losses, concluded on the following:

-If losses are not managed, keeping maize for selling after some period of time is risky due to price fluctuation and storage losses.

-Repairs and monitoring of farm grain structure in order to reduce the losses is poor leading to losses due to rots, insects and rats

-There is significant grain loss, in quantity, occurring at on farm and in grain stores. This has caused frustration and anger to farmers because they lose considerable amount of grain each year.

-There is opportunity in long term maize storage, but farmers and traders will continue to face constraints including uncertain returns from storage as a result of future price unpredictability, limited working capital to construct / repair storage structures, in addition physical grain losses contribute to the losses too. Programs designed to eliminate these constraints can encourage farmers and traders to increase efficiency in maize storage in post harvest seasons.

#### **5.4 Recommendations**

-Seed companies in the country needs to make sure that seeds are sold on time at the beginning of the planting season to avoid post-harvest losses

-The government through the ministry of Agriculture should start programs aimed at teaching the farmers on proper maize storage and post-harvest handling of maize to reduce maize losses.

-National cereals and Produce Board (NCPB) needs to motivate farmers by paying them on time to reduce post-harvest losses of maize on the side of farmers.

### **5.5 Suggestions for further research**

Further studies are necessary to inform policy on credit and saving options on credit and saving options including options for introducing grain ware- house receipt system, traditional methods of grain treatment (effectiveness, economy, health issues etc) and non- farm linkages and scope for the development of agro processing industries including those small scale farmer managed grain processing technologies.. The study revealed that most households mould infected maize to make local brews, and also fed their livestock and chicken which is not recommended, (FAO 2005). It would be necessary to study health issues related to it.

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## **APPENDICES**

### **APPENDIX 1: INTERVIEW SCHEDULE**

#### **Semi structured questionnaire & Structured questionnaire**

Dear respondent , I am a Master's student from the university of Nairobi and I am conducting a Study titled “**POST HARVEST GRAIN MANAGEMENT AND ITS EFFECTS ON FOOD SECURITY IN KISUMU COUNTY , KENYA**”. You are among a group of farmers Who have been randomly selected for the study. Kindly answer the questions as honestly and Openly as possible. Your name and the information you provide will be held in strictest confidence and will not appear on any documents or publications unless with your express permission .Thank you in advance for agreeing to participate in the study.

#### **SECTION 1: Farmer's Personal Characteristics**

(a) Sex.....

(b) Age (Year).....

(c)Marital Status.....Single/ Divorced / Married/ Widowed

(d) How many years have you spent at school?.....



(e) How many children do you have ? .....

(f)How many are dependants/ relatives relying on your support ?.....

(g) Occupation ( self ).....

(h) Spouse(s) .....

(i) Status of respondent (1) Head (2) Wife (3) Son / Daughter ( 4 ) Relative

(5)Laborer

(j) For how long have you been farming this land ?.....

## **SECTION 2: FOOD SECURITY**

(a) What is the main source of food consumed in your household?

(b) Due to lack of food, are you at times forced to eat food of your choice and preference?

(c) Due to shortage of food, are you and your family forced to eat food that is infected with either pests or diseases?

(d) Do you and family members always have enough food every day?

(e) How many meals do you and your family have every day?

(f) What are types of food consumed in your family (breakfast, lunch and super) have every day?

## 2. Post-Harvest Grain management operations

<b>Harvesting</b>		
<b>Mode of transportation-</b> By bicycle , motor vehicle, head ,donkey, others (specify)		
<b>Processing -</b> By hand, shelling machine, putting in a bag and hitting, Others (specify)		
<b>Drying –</b> Tying and leaving on farms, On the ground ,others (specify)		

(c) How long (weeks) did you dry your maize after harvesting? .....

.....

(d) Where do you store your maize ?.....

(i) Poured on floor

(ii) Granary

(iii) House

(iv) Store

(v) Other (specify).....

(f) Do you own the structure that you store your grain in ? Yes /No.....

(i) In which form do you store the maize?

(ii) On cob without sheath

(iii) On cob with sheath

(iv) Shelled

(g) Can you please explain why you store it in the above method .....

.....

(h) What problems do you face while storing your maize?

(i) Storage space

(ii) Storage containers

(iii) Storage pests

(iv) Other (specify)

(i) Do you experience crop losses by pests during storage ? Yes No

(j) Yes what proportion of the grain did you lose to these pests?

(i) 1-2 (90 kg bags )

(ii) 3-4 (90 kg bags)

(iii) > 5 bags ( 90 kg bags )

(k) What did you do to the infected grain?

(l) In which ways did you control the insect pests?

(i) Insecticide (specify)

(ii) Ash

(iii ) Other (specify).....

(m) Which of the following practices did you carry out?

(i) Storing the new grain in separate storage structures from the old ones

(ii) Repairing the storage structures to prevent leakage

(iii) Cleaning the surrounding to keep pests and rodents away

(iv) Others (Specify)

If you did not carry them out why?.....

.....

(n) Do you experience any crop loss due to bad weather during

harvesting? Yes/No .....

(o) If Yes What do you do to reduce the loss?.....

.....

What do you do with the affected grain ?.....

.....

(p) Which months do you normally sell your maize?.....

.....

(q) What means of transport do you use to transport your maize from  
home (or storage) to the market?

(i) Head

(ii) Motor vehicle

(iii) Other (specify )

(r) Do you sell all your maize at once ? Yes / No

(s) If Yes give reasons why?.....

.....

## **5. Farmers' access to sources of information technology**

Have you been in contact with the following sources of information over the past three  
years?

**Source of Information****Type of information**

Visited by agricultural extension workers	
Visited Agricultural extension office	
Attended a Agricultural show	
-Farm magazine (specify)	
Farm radio broadcast ( specify)	
Visited and learnt from neighbor	
You have been a contact farmer (specify)	

Comments if any .....

.....

**THE END: THANK FOR YOUR TIME**

## **APPENDIX II: CHECKLIST FOR KEY INFORMANT**

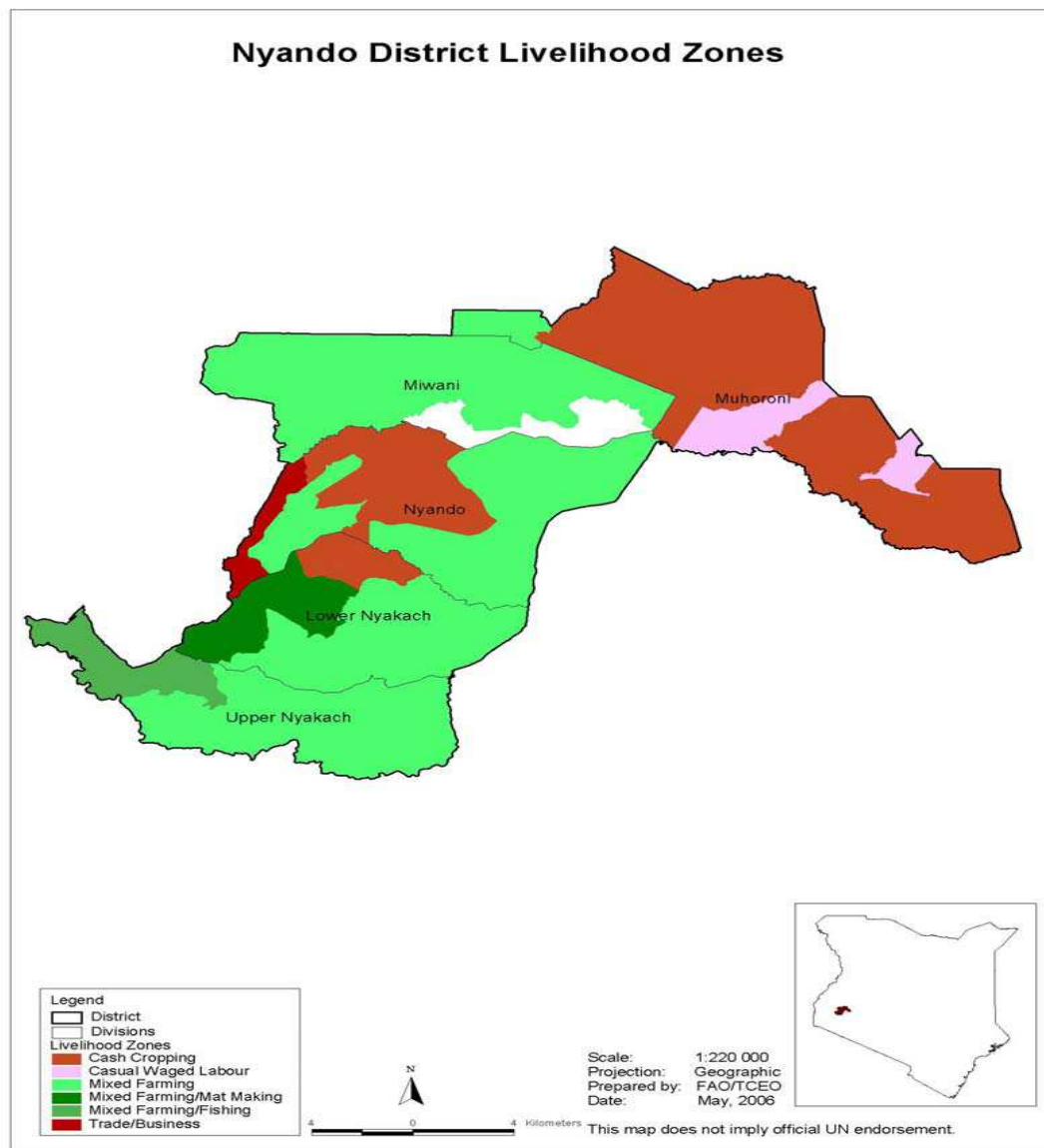
- (1) A complete list of all varieties of maize grown in the division.
- (2) Reasons for cultivating traditional/recommended varieties of maize – details on how the cultivated varieties contribute to post harvest grain losses and hence household food security.
- (3) Types of chemicals available in the agro chemical shops and the percentage of chemicals that were sold to farmers during the last two seasons.
- (4) Factors that hinders or encourages the adoption of post harvest grain management technologies. (getting details of both traditional and traditional technologies) that work for/or against the recommended technologies.
- (5) The strategies made by the ministry of Agriculture to reduce post harvest grain losses.
- (6) The government policies on post harvest grain management.

### **APPENDIX III: OBSERVATION CHECKLIST**

- (1) Marketing behaviour of households during harvesting period of maize.
- (2) Post harvest grain management practices during processes such as harvesting transportation, drying, shelling and storage.
- (3) Market prices at different times of the year.
- (4) The presence of storage structures such as stores and cribs.
- (5) The average sizes of land in the area.
- (6) The lively hood of households in the area of the study.



## APPENDIX 4: NYANDO DISTRICT LIVELIHOOD ZONES



## **ANNEXES**

### **PLATE 1: DRYING OF MAIZE IN THE FIELD BY STOOKING**



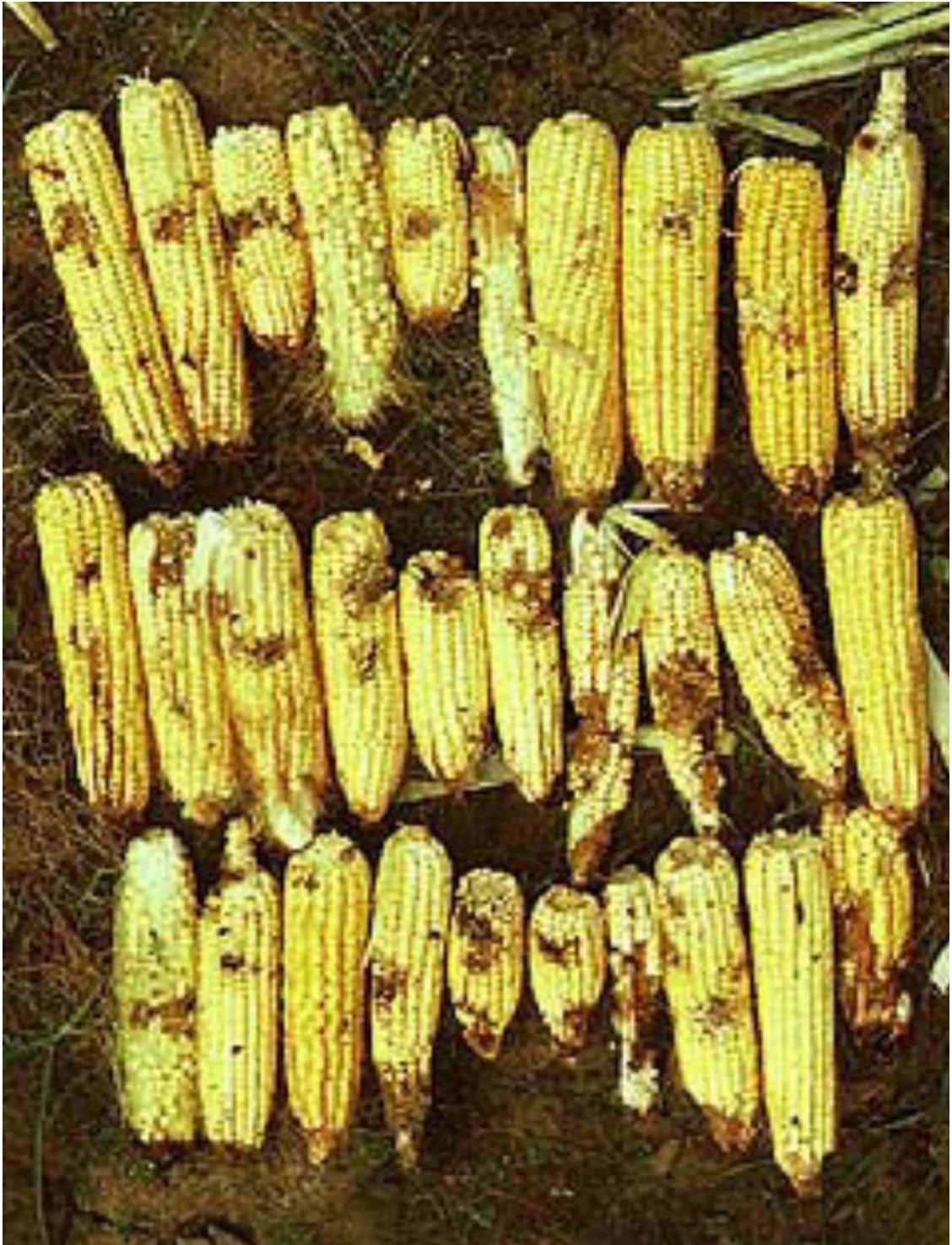
## **PLATE 2: HARVESTING OF MAIZE**

**Harvesting of maize during harvesting exposes maize to fungal contamination.**





**PLATE 3: MAIZE DESTROYED BY RODENTS**



**PLATE 4: MOULD INFECTED MAIZE SEEDS DUE TO POOR STORAGE**



**PLATE 5: TRADITIONAL WAY OF TESTING FOR MOISTURE CONTENT IN  
MAIZE**





**PLATE 6: MAIZE INFECTED BY MOULDS IN THE FIELD DUE TO LATE  
HARVESTING**



**PLATE 7: MAIZE INFECTED WITH PESTS.**





**PLATE 8: CATERPILLAR DESTROYING A MAIZE COB**



**PLATE 9: A MAIZE WEEVIL**



**PLATE 9: RED FLOUR BEETLE**



**PLATE 10: HARVESTING OF MAIZE**



**PLATE 11: COLLECTION OF MAIZE AFTER HARVESTING**

