POST-HARVEST HANDLING TECHNOLOGIES AND MAIZE FARMERS' INCOME IN MID-WEST UGANDA, MASINDI AND KIRYANDONGO DISTRICTS

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF BUSINESS AND MANAGEMENT IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER'S DEGREE IN BUSINESS ADMINISTRATION (PROJECT PLANNING AND MANAGEMENT) OF UGANDA TECHNOLOGY AND MANAGEMENT UNIVERSITY (UTAMU)

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DECLARATION

I, Babra Balungi, hereby declare that this dissertation titled *"Post-harvest handling technologies and maize farmers' income in Masindi and Kiryandongo districts"* is my original work and is neither a duplication of another research study nor has it been submitted to any university or institution for any award of academic qualification or publication. All existing pieces of work that were used in this research report have been accordingly acknowledged.

Signature: ………………………………….   Date: ………………………………..

APPROVAL

I have supervised this research work titled *"Post-harvest handling technologies and maize farmers' income in Masindi and Kiryandongo districts"* by Babra Balungi and I have found it worthy of submission for award of Master's Degree in Business Administration (Project Planning and Management) of Uganda Technology And Management University (UTAMU).

SUPERVISOR: PROFESSOR BENON BASHEKA (PhD, FCIPS)

Signature: ……………………………. Date: ………………………………….

DEDICATION

This dissertation is dedicated to my family, friends, course mates and workmates for the tireless efforts they put into supporting me.

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Special thanks go to the Almighty God who has given me the life and strength to accomplish this academic work. My sincere gratitude goes to my Supervisor, Prof. Benon Basheka, who has tirelessly corrected me to ensure that I deliver quality work. Special thanks also go to Dr. Jee Hyeong-Jin, together with the staff and management of KOPIA Uganda Centre.

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List of Abbreviations

ACE	Area Cooperative Enterprise
APHLIS	African Post-harvest Losses Information System
DV	Dependent Variable
EAC	East African Community
ECA	East and Central Africa
EUT	Expected Utility Theory
FAO	Food and Agriculture Organization of the United Nations
IV	Independent Variable
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MASGGA	Masindi Seed Grain Growers' Association
NGO	Non-governmental organisation
NCBA CLUSA	National Cooperative Business Association Cooperative League of United States of America
PHHS	Post-harvest handling and storage
PHHT	Post-harvest handling Technology
PHL	Post-harvest Loss
SSA	Sub-Saharan Africa
SPSS	Statistical Package for Social Scientists
UBOS	Uganda Bureau of Statistics
USAID	United States Agency for International Development
WFP	World Food Programme

ABSTRACT

This descriptive cross-sectional survey investigated the relationship between Post-harvest handling technologies and maize farmers' income in Mid-west Uganda, Masindi and Kiryandongo districts. The survey had three objectives including: determining the effect of availability of post-harvest handling technologies on maize farmers' income; establishing the role of training in post-harvest handling technologies on maize farmers' income; and, finding out the effect of adoption of post-harvest handling technologies on maize farmers' income. The study adopted mixed methods whereby a questionnaire survey, key informant interviews and document review were used to collect data. The data was collected from 151 respondents with 93.3 per cent response rate. The data was analysed using frequencies, percentages, means and standard deviations as well as correlation and regression analyses for quantitative data whereas for qualitative data, thematic analysis was used. The findings revealed: (i) a weak positive relationship between availability of post-harvest handling technologies and maize farmers' income that is not statistically significant (rho=0.013, sig=0.436); (ii) a significant moderate positive relationship between training in post-harvest handling technology and maize farmers' income (rho=0.349, sig=0.000); and (iii) a significant moderate positive relationship between adoption of post-harvest handling technology and maize farmers' income (rho=0.349, sig=0.000). According to a regression analysis, training post-harvest handling technology was the greatest contributor to maize farmers' income (Unstandardized B coefficient = 0.506). Therefore, the study calls for more investment in training of farmers in post-harvest handling technologies to increase their adoption of these technologies, hence increasing farmers' income. Future studies should explore more dimensions of post-harvest handling technology focusing on training and adoption and maize farmers' income a clear appreciation of the phenomena.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This study measured the effects of Post-Harvest Handling Technologies (PHHT) on maize farmers' income in Uganda. Post- Harvest Handling Technologies in this study was considered as the independent variable (IV) and measured in form of availability, training and adoption; while maize farmers' income was the dependent variable (DV) and measured in terms of quantity and quality of grain yield as well as the maize selling price.

In Africa, post-harvest losses (PHL) remain a persistent challenge. According to the World Resources Institute, approximately 23 per cent of available food in Sub-Saharan Africa is lost or wasted (Global knowledge Initiative, 2014: 9). Therefore, undertaking a study to measure the effects of PHHT on income among maize farmers becomes pertinent. Two million African smallholder farmers will have greater income and economic opportunities, improved resilience, and increased food and nutritional security through reduced PHL in food crop value chains by 2020 (Global Knowledge Initiative, 2014: 9).

This dissertation is arranged in five main chapters: the introduction; literature review; methodology; presentation, analysis and interpretation of findings; and, conclusions, discussion, summary and recommendations. This introductory chapter covers the background to the study, problem statement, purpose of the study, objectives of the study, research questions, research hypotheses, scope of the study, significance, justification and definition of operational terms and concepts. The background to the study is first presented.

1.1 Background of study

1.1.1 Historical Background

Maize production and consumption has been central for human survival across many countries. Maize is believed to have originated from Central America; a region which was dominated by wild maize, *Teosinte* and *Zea Mexicana* (ACDIVOCA, 2010: 2). An archaeological study of the bat caves in New Mexico revealed corncobs that were 5,600 years old by radiocarbon determination and most historians believe that corn was domesticated in the Tehuacan Valley of Mexico (Lance and Garren, 2002). In 1880, the United States grew over 62 million acres of corn. By 1900, this figure had reached approximately 95 million acres; while by 1910, it was over 100 million acres (Lance and Garren, 2002). A two-year research conducted in Honduras by Raboud *et al*. (1984) found that post-harvest damage and losses of stored maize amounted to 12.5 per cent and 8.1 per cent respectively, (averaged for the two study years) in central America. Maize is one of the main crops grown in Eastern and Central Africa (ECA) as a staple food by over 70 per cent of the population (Asea *et al*, 2014: 1). Maize was introduced in Uganda in 1861 and has since become a major part of the farming system, ranking third in importance among the main cereal crops (finger millet, sorghum and maize) grown in the country (USAID, 2010). Uganda's small-scale farmers have traditionally cultivated maize for food and for income generation.

1.1.2 Theoretical Background

This study utilized the Rational Choice Theory (RTC) and Expected Utility Theory (EUT) to understand how farmers' choices for post-harvest handling technologies affect their income. Rational Choice Theory is a framework for understanding and often formally modelling social and economic behaviour (Lawrence and Easley, 2008). Rational Choice Theory, attempts to deduce what will happen when individuals are faced with a situation such as farmers choice of post-harvest handling technologies of grains (Okoruwa, Ojo, Akintola, Ologhobo and Ewete, 2012:55). This theory was important to predict the maize farmers' behaviour in choosing the most suitable available post-harvest technologies depending on their economic status which determined the quantity and quality of the maize grain obtained.

The Expected Utility Theory, on the other hand, is founded on the fundamental assumption that a decision maker, a farmer this context, always chooses that optionof a post-harvest technology which maximizes his expected utility of wealth. Therefore farmers will always chose the technology that requires least investment (Okoruwa *et al*, 2009: 55). This theory was very important in predicting farmers' choice of selecting the appropriate technology to use, hence having a great effect on the quantity and quality of maize and affecting the selling price and income.

1.1.3 Conceptual Background

The study was founded on the conceptualization that post-harvest handling technologies affect maize farmers' income in Uganda. Post-harvest handling technology was analyzed in terms of availability, training and adoption. According to Okoruwa *et al* (2012: 55), post-harvest loss of grain which ranges from 20 to 30 per cent caused by bad practicing poor post-harvest technologies, lowers the income and standards of living of the farmers. Post-harvest handling processes of harvesting, drying, shelling, treatment and storage are very important in terms of minimizing losses not only in quality but also in quantity (Asea *et al*, 2014). Storage as one of post-harvest handling technologies offers an opportunity to improve farm incomes by storing crops and selling at premium prices when demand outstrips supply later in the post-harvest period (Florkowski and Xi-Ling, 1990); hence this proved that post-harvest technologies have a great effects on farmers income. According to the study conducted in Central America, completion of training course about post-harvest handling technologies was one of the main determinants of achieving household self-sufficiency in maize (Bokusheva et al, 2012: 1). Davis, Hands, and Maki (1997: 1) stated that decision making of adopting a given post-harvest technology depends on the risks and uncertainty involved. As quality is an important determinant of crop retail prices, effective storage is crucial to improve agricultural incomes and food security for small scale farmers (Thamaga-Chitja, 2004). There is a wide range of technologies available that, if adopted, would enable smallholders and larger producers to improve the quality and quantity of grains during post-harvest handling and storage (World Bank, 2011). Reduction in quality of grain lowers the value markets, which are usually informal, so that farmers lose the opportunity of better incomes (Rural 21, 2013:17). Kaminski and Christiaensen (2014) argued that post-harvest loss increases with higher seasonal price differences. Maize is often sold by producers in small quantities of poor quality at low prices by the majority of small-scale farmers, hence impacting on their income (PMA, 2009).

1.1.4 Contextual Background

Maize is an important crop grown in most parts of the Uganda for food, feed and income, (Asea *et al*, 2014:1). Maize being one of the major crops regionally exported was considered to be a stepping-stone towards poverty eradication (Private Sector Foundation Uganda [PSFU], 2005) but due to highpost-harvest losses, this was not achieved. The maize sub-sector is estimated to provide livelihood for about 3 million Ugandan farm households, close to 1,000 traders and over 20 exporters (UBOS, 2011). Regional maize production, however, is dominated by smallholder farmers whose production is generally characterized by small farm acreage (0.5- 5 ha) (MAAIF, 2013:1), low yields (1.0 -1.8 MT/ha) and high production costs and, consequently, low returns. Unfortunately, the quality standards of maize grain produced in Uganda is generally low and a lot is lost during the process of harvesting, transport, storage and processing. According to Roberts and Ocaya (2009), 50% of the maize produced in Uganda is sold locally to institutions, industry and retail markets, 15 per cent is lost through post-harvest losses whereas 20 per cent is retained at the household for consumption and other requirements. The major maize growing sub-regions in Uganda are Busoga (eastern) region Bunyoro (mid-western) region (MAAIF, 2013:1). Kiryandongo District has a population of 133,541 males and 134,647 females (UBOS, 2014) and the major economic activity is farming that contributes 60.61 per cent of the total population (UBOS, 2011a: 6). The highest proportion of the household grows maize at a rate of 67.2 per cent of the total households in Kiryandongo District (UBOS, 2011a: 8). Similarly, Masindi District has a population of 148,264 males and 144,687 females (UBOS, 2014) and also the major economic activity is farming that contributes 43.93% of the total population of the residents in Masindi District (UBOS, 2011b: 8). The highest proportion of the households grows maize at a rate of 32.45% of the total households in Masindi District (UBOS, 2011a: 10).

1.2 Problem Statement

Post-harvest food loss in Africa represents a multi-faceted challenge that reduces the income of approximately 470 million farmers (The Rockefeller Foundation, 2014). Furthermore, Okoruwa*et al* (2012: 55) emphasized that post-harvest loss of grain caused by practicing of poor post-harvest technologies lowers the farmers' income. The post-harvest losses represent more than 20 million metric tonnes of grain, valued at over $4b annually in Uganda which is enough to feed 48 million people (Dunford, 2015). However, according to research done by Costa (2015), training on the new post-harvest handling and storage methods and modern equipment, farmers reduced their loss levels and their incomes doubled in Uganda. Additionally, 95 per cent of all research and extension investments over the past 30 years have focused on increasing productivity and only 5 per cent directed towards reducing losses (Costa, 2014).Therefore, there is still a need to improve post-harvest handling capacity of farmers in order to improve farmers' income. There is no empirical study that has been conducted to show the relationship between post-harvest handling technologies and farmers' incomes. Okoruwa *et al* (2012) conducted a study on post-harvest grain management storage techniques and pesticides use by farmers in South-West Nigeria. However, this study did not look at other important aspects like the training background of farmers which were considered in this study and, moreover, it was conducted in a different geographical context from Uganda. Left this way, the situation will only perpetuate the situation of smallholder farmers selling their grain soon after harvest cheaply and getting less income, while later the price increases (USAID and EAGC, 2013). Therefore, there was a need to conduct a study on the effects of post-harvest handling technologies and maize farmers' incomes in Masindi and Kiryandongo districts.

1.3 Purpose of the study

The study investigated how the post-harvest handling technologies affect maize farmers' income in Mid-west Uganda, Masindi and Kiryandongo districts.

1.4 Objectives

The study was motivated by the following objectives:

i. To determine the effect of availability of post-harvest handling technologies on maize farmers' income in Masindi and Kiryandongo districts;

ii. To establish the role of training in post-harvest handling technologies on maize farmers' income in Masindi and Kiryandongo districts;

iii. To assess how the adoption of post-harvest handling technologies affects maize farmers' income in Masindi and Kiryandongo districts.

1.5 Research Questions

The study was meant to answer the following questions:

i. How does the availability of post-harvest handling technologies affect maize farmers' income in Masindi and Kiryandongo districts?
ii. How does training in post-harvest handling technologies affect maize farmers' income in Masindi and Kiryandongo districts?
iii. How does the adoption of post-harvest handling technologies affect the maize farmers' income in Kiryandongo and Masindi districts?

1.6 Research Hypotheses

The study sought to test the following hypotheses:

i. There is a significant positive relationship between availability of post-harvest handling technologies and maize farmers' income in Masindi and Kiryandongo districts.
ii. There is a significant positive relationship between training in post-harvest handling technologies and maize farmers' income in Masindi and Kiryandongo districts.
iii. There is a significant positive relationship between the adoption of post-harvest handling technologies and maize farmers' income in Masindi and Kiryandongo districts.

1.7 Conceptual Framework

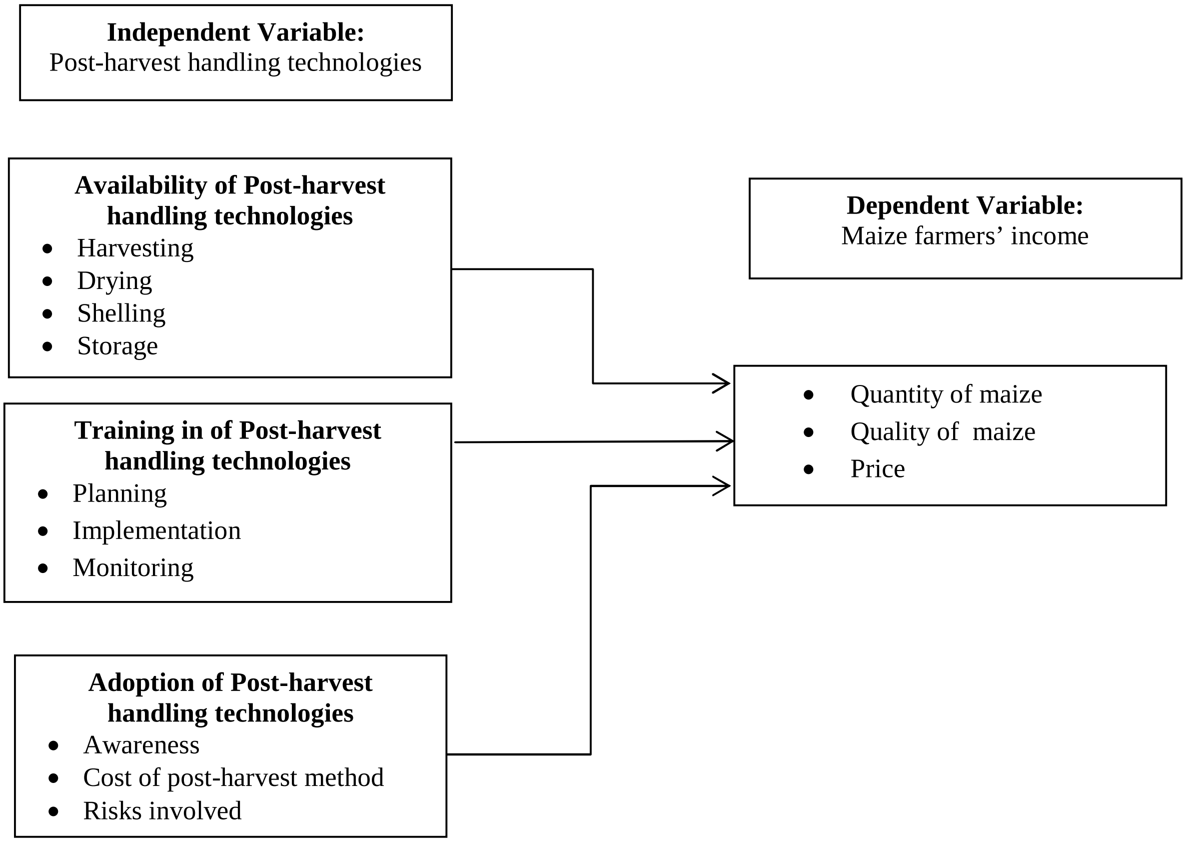

Figure 1.1 Conceptual Framework: Adopted from Okoruwo et al (2012)

Post-harvest loss of grains lowers the income and standards of living of the farmers (Okoruwo *et al*. 2012:56) due to practicing of poor post-harvest handling processes (harvesting, drying, shelling, treatment and storage) which reduces the grain not only in quality but also quantity (Asea *et al*, 2014). Bokusheva *et al* (2012: 1) in Central America found out that completion of training course about post-harvest handling technologies as one of the main determinates of achieving household self-sufficiency in maize.According to Browning, Halcli, and Webster (2000: 1) under the rational theory,people calculate the likely costs and benefits of any action before deciding what to do like the using a given post-harvest technology and Davis, Hands, and Maki (1997: 1) highlights that decision making of adopting a given post-harvest technology depends on the risks and uncertainty involved. Kaminski and Christiaensen (2014) discovered that post-harvest losses increase with higher seasonal price differences. Maize is often sold by producers in small quantities of poor quality at low prices by the majority of small-scale farmers, hence impacting negatively on their income (PMA, 2009).

1.8 Significance of the study

This study contributes to the understanding of the effects of the post-harvest handling technologies and maize farmers' income in Uganda. In addition to this, the study seeks to contribute to the greater efforts to improve post-harvest handling management as well as:

i. Helping in policy planning for future use of post-harvest handling technologies at all levels;

ii. Promoting research in post-harvest handling technologies aiming at minimizing post-harvest losses between harvesting and actual consumption;

iii. Contributing to the study of social relationships between post-harvest handling technologies and maize farmers' income;

iv. Contributing to the researchers' academic progress towards earning a Master's in Business Administration (Project Planning and Management) of Uganda Technology and Management University (UTAMU).

1.9 Justification of the study

Maize is a key staple food in Eastern and Southern Africa, with a highly seasonal production but relatively constant consumption over the year. Farmers have to store maize to bridge seasons and to protect against price fluctuations (Tefera, 2012). **S**ignificant volumes of grain in developing countries are lost after harvest, aggravating hunger and resulting in expensive inputs such as fertilizer, irrigation water, and human labour being wasted. Qualitative PHL can lead to a loss in market opportunity and nutritional value; and under certain conditions, these may pose a serious health hazard if linked to consumption of aflatoxin-contaminated grain. Food losses contribute to high food prices by removing part of the food supply from the market (World Bank *et al*, 2011:1). Poor post-harvest handling such as poor drying and improper storage conditions lead to losses due to storage pest and aflatoxin contamination (MAAIF, 2013: 1). Post-harvest losses of grains limit the potential of income of the farmers, threaten food security and exacerbate conditions of poverty among the maize farmers in the rural areas whose income stream depends on the ability to store excess farm produce and sell it later (Okoruwa *et al*, 2012:56). Therefore, this study aimed at determining the effects of post-harvest handling technologies on maize farmers' income to address the problem faced by farmers during the process of post-harvest handling.

1.10 Scope of the study

1.10.1 Content scope

The study limited itself to PHHT as the independent variable which considered three dimensions: PHHT availability, PHHT training and PHHT adoption; whereas maize farmers' income had three dimensions as well, namely: quantity of maize, quality and selling price.

1.10.2 Geographical scope

The study was conducted around Mid-west Uganda, specifically Kiryandongo and Masindi districts as shown in *Appendix 6*. Bunyoro (mid-western) region is one of the major maize growing sub-regions in Uganda (MAAIF, 2013:1). The western region is second to the eastern region in production of maize, which is 497,745MT (UBOS and MAAIF, 2011); and due to the fact that the highest proportion of the households grows maize at a rate of 67.2% and 32.45% of the total households in Masindi and Kiryandongo districts respectively, this region was selected. One cooperative was selected each district and a representative farmers were interviewed. Warehouse operators and officials that provide technical assistance were also interviewed.

1.10.3 Time Scope

This study limited itself to the activities of different cooperatives or warehouses and farmers from 2010 to 2015. This timeframe was specifically chosen because it is easy to understand the income growth of farmers and farmers can easily remember what has happened in the past five years. Furthermore, this time was chosen on the basis that farmers are expected to have gained the experience in maize post-harvest handling technologies and benefited from using them.

1.11 Definition of operational terms and concepts

The following key concepts and terms are used with the following meanings and interpretations:

Aflatoxin: These are poisonous substances produced by fungi and make the grain unfit for consumption.

Moisture content of grain: This is a way of expressing how much water is contained within the grain.

Post-harvest damage: This is physical alteration caused by biotic or abiotic agents.

Post-harvest handling technologies: These are measures or activities done to ensure that the harvested product reaches the consumer, while fulfilling market/consumer expectations in terms of volume, quality, and other product and transaction attributes, including nutrition, food security and product safety.

Post-harvest Loss: This is the difference between total damaged and recoverable damaged grain still fit for human consumption of staple grains due to insect pests, rodents and birds.

Post-harvest period: This is between physiological maturity of a crop and the time for its final consumption.

Quality loss: This is a reduction in the quality of food grain so that its market value is reduced transaction attributes, including nutrition, food security, and product safety.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

According to Amin (2005:138), literature review involves the systematic identification, location and analysis of documents containing information related to the research problem. This chapter provides the review of literature on post-harvest handling technologies and income. It includes the theories used as well as the key concepts of the study and their interrelationships.

2.2 Theoretical Review

According to Adams (2007:28), a theory is a set of systematically interrelated concepts, definitions and propositions that are advanced to explain and predict phenomena (facts). Theory also explains how some aspect of human behaviour or performance and enables us to make predictions about their behaviours. This study employed Rational Choice Theory and Expected Utility Theory in order to describe, understand, explain and predict maize farmers' behaviours in response to post- harvest handling technologies use.

2.2.1 Rational Choice Theory

The Rational Choice Theory is an economic principle that assumes that individuals always make prudent and logical decisions that provide them with the greatest benefit or satisfaction and that are in their highest self-interest. In the context of this study, farmers are assumed to be rational in their capacity to devise, choose, and put into practice effective means to clear ends such as improving standards of living, income and maximizing profit (Okoruwa *et al*, 2009: 55).

Rational Choice Theory uses a specific and narrow definition of "rationality" simply to mean that an individual such as a farmer acts to balance costs against benefits to arrive at action that maximizes personal advantage (Milton, 1953) and the idea of this theory was invented by Max Weber in 1920. Traditional smallholder farmers have their reasons for not adopting untried technologies (Mazonde, 1993). Browning, Halcli, and Webster (2000:1) demonstrate that under the rational theory, people calculate the likely costs and benefits of any action before deciding what to do. With regard to that, farmers are believed to decide the post-harvest handling technology to use with fewer costs but with high benefits.

2.2.2 Expected Utility Theory

The principle of expected utility maximization states that a rational investor such as a farmer, when faced with a choice among a set of competing feasible investment alternatives to use, like choice post-harvest technologies, acts to select an investment which maximizes his expected utility of wealth. Therefore he always chooses the technology with less investment (Okoruwa *et al*, 2009).Expected Utility Theory (EUT) has been the basis for much decision-making theory (Okoruwa, *et al*, 2009). EUT assumes that the preferences of the decision maker comply with the axioms of ordering, continuity and independence (Starmer, 2000). Davis, Hands and Maki (1997:1) highlight that Expected Utility Theory is the way a decision maker (DM), in this context a maize farmer, chooses between risky or uncertain prospects by comparing their expected utility values, the weighted sums obtained by adding the utility values of outcomes multiplied by their respective probabilities.

The contribution of Expected Utility Theory (EUT) to the current understanding of decision making in complex situations where risk and human reactions to it are involved needs no enlargement. Maize farmers use the post-harvest handling technologies with fewer risks but with greater income maximization. Despite overwhelming evidence against its empirical validity and the proliferation of non-expected utility theories (non-EUTs) in the field of choice under risk and uncertainty, EUT remains the standard approach to the analysis of economic, social, political, and ethical problems (Liang, 2003), and hence was useful in analysing farmers' problems when they are adopting different post-harvest handling technologies.

2.3 Post-harvest Handling Technology and Maize farmers' Income

The primary role of an effective post-harvest handling system is ensuring that the harvested product reaches the consumer, while fulfilling market/consumer expectations in terms of volume, quality, and other product and transaction attributes, including nutrition, food security, and product safety. Post-harvest handling technologies include: harvesting, assembling, drying, threshing/shelling, milling, storage, packaging, transportation, and marketing (World Bank *et al*, 2011). FAO (2011) considers the post-harvest losses incurred during harvesting such as from mechanical damage and spillage and during post-harvest handling such as drying, winnowing, and storage (pests, rodents and rotting). According to the National Agricultural Research Organization (NARO), reckless handling of maize cobs or grains leads to spillage and quantitative losses on most farms in Uganda as well as loss of quality as contaminated grains or cobs are mixed with the clean ones (AGRA, 2013). The lack of suitable structures for grain storage and absence of storage management technologies often force the smallholders to sell their produce immediately after harvest (Tafera, 2010). Consequently, farmers receive low market prices for any surplus grain they may produce (Kimenju *et al,* 2009). Safe storage of maize at the farm-level is crucial, as it directly impacts on poverty alleviation, food and income security and prosperity for the smallholder farmers (Tafera, 2010). Currently, the national standard storage facilities for maize in Uganda can cater for only 550,000 metric tonnes out of 3.2 million of total production, according to the Ministry of Agriculture, 2014 projections. And as a result of the inadequate storage facilities and poor post-harvest handling practices, the country is struggling to compete in the grain market provided (Ladu, 2015).

According to the UN Food and Agriculture Organization (FAO), Sub-Saharan Africa alone loses 20 million metric tons of food each year, valued at over US$4 billion (2011). Post-harvest food loss is one of the largest contributing factors to food insecurity, under-nutrition, and hunger across the developing world, directly impacting the lives of millions of poor, smallholder farming families (Costa, 2015).

2.3.1 Availability of Post-harvest Handling Technologies and Maize farmers' income

There are many post-harvest handling technologies that can be used by maize farmers depending on the cost of the technology. Rugumamu (2009) argued that the missing link in post–harvest maize loss reduction in all the phases is the availability of appropriate technologies. Therefore this study sought to find out the relationship between availability of appropriate technologies and post-harvest loss among maize farmers. Grains can be damaged during harvesting, threshing, or transportation and by a range of pests, insects, and moulds. Improvements to storage, drying, and transportation can prevent damage and loss (Lama *et al*, 2014). Without appropriate grain storage technologies, farmers are forced to sell maize when prices are low to avoid post-harvest losses from storage pests and pathogens, thus impacting greatly on their income (Semple *et al*, 1992).

2.3.1.1 Harvesting

African producers harvest grain crops once the grain reaches physiological maturity (moisture content is 20–30 per cent). At this stage the grain is very susceptible to pest attacks. Also, unseasonal rains at this stage can dampen the crop, resulting in mould growth and the associated risk of aflatoxin or other mycotoxin contamination. Weather conditions at the time of harvest are a critical factor influencing post-harvest loss. More unstable weather conditions due to climate change, leading to damper or cloudier conditions, may therefore increase post-harvest loss (World Bank, 2011). Two key indicators of when a plant is ready to be harvested are; it changes colour from green to light brown or yellowish and moisture content at this point is 20-30 per cennt. Cereals like maize, sorghum and millet have a black layer just below the tip of the grain which determines the right time for harvest (USAID, 2013). Timing of harvest greatly affects the extent of aflatoxin contamination and the extended field drying of maize increases insect infestation and fungal contamination, hence lowering maize quality (Hell *et al*, 2008). In order for a farmer to produce quality maize, the maize cobs harvested should not get into contact with soil or water, and this can be achieved by using clean and disinfected equipments (FAO, 2016).

2.3.1.2 Drying

Drying is the systematic reduction of crop moisture down to safe levels for storage, usually 12 to 15.5 per cent moisture content. Maize is usually harvested with moisture content in the range of 18–26 per cent, which is considerably higher than the 12–14 per cent commercial standard for East Africa and is a major determinant of maize quality (ACDI/VOCA and USAID, 2011). Therefore, drying is very important to reduce the moisture level to accepted level of 13.5 per cent for the grade one EAC standards (CTA and EAGC, 2013). Most farmers in Africa, both small and large, rely almost exclusively on natural drying of crops from a combination of sunshine and movement of atmospheric air through the product, so damp weather at harvest time can be a serious cause of post-harvest losses (De Lima, 1982). Grains should be dried in such a manner that damage to the grain is minimized and moisture levels are lower than those required to support mould growth during storage (usually below 13–15 per cent). The drying post-harvest technologies for farmers to use for increasing their income include: using heavy polythene or tarpaulin or use concrete slab so as to maintain the maize quality (MAAIF, 2013) or using a crib before shelling (FAO, 2016).

The majority of the farmers in Uganda dry the maize on bare ground and lack appropriate facilities to establish whether the maize has attained the recommended moisture content for storage (Kaaya and Kyamuhangire, 2006).There are three types of drying: sun drying, solar drying and mechanical or electrical drying; and the choice of a famer to use a given method of drying depend on the cost and maize quantities. Researchers at Makerere University are currently developing a biomass-heated natural convection dryer that dramatically reduces drying time. In another example of improved drying technology, USAID's Feed the Future Initiative in Uganda is testing a mobile batch dryer. Other innovators are exploring solar drying methods and the use of plastic sheeting, concrete drying yards, raised platforms, and trays made of wire mesh or reed (Kaaya *et al*, 2010). Good drying reduces microbial activity, especially of moulds that may produce mycotoxin (such as aflatoxin) hence improving the maize quality and lowering Post-harvest Loss (CTA and EAGC, 2013).

2.3.1.3 Shelling

Shelling or threshing is a process that frees the grain from the cob, seed head or pod. This process involves the removal of maize husks to check for damage. During this process, a lot of care is needed in order to avoid breakage of grain as a way of reducing risk of pests as well as lowering post-harvest loss (USAID, EAGC, 2013). Shelling (hand-threshing) can be done with a hand-held sheller or using hands (ACDI VOCA, 2010). This process should be carefully done because it can assist in the development of insects that may actually be seen during the storage season (FAO, 2009).

Cereals, especially maize grains, can be prone to aflatoxin contamination, particularly when they come into contact with infested soil during harvesting, threshing, and drying. Therefore during this process, farmers should ensure that maize should not get into contact with soil and water (Kimatu *et al*, 2012).According to APHLIS (2013), most broken grain which comes from poor post-harvest handling are seen especially during shelling/threshing. Therefore, farmers should carefully use a method that will reduce on grain breakage in order to produce quality maize.

2.3.1.4 Storage

The principal objective in any maize grain storage system is to maintain the stored grains in good condition so as to avoid deterioration both in quantity and quality. Due to inadequate storage practices, farmers in the region including Uganda lose up to 40 per cent of their harvest to insect, pests, mould and moisture (*New Vision*, 2015). Traditionally clay-lined maize grain silos are used for storage in Africa. In each instance, subsistence farmers must take into account the difficulties of storing maize at optimal conditions and balance humidity, the moisture content of the maize, and the potential for pest infestations (Meridian Institute, 2005).Temperature and moisture content of the cereal grains are the two key features affecting the resulting quality of the grain, biochemical reactions, dry matter losses, allowable storage times and overall storage management of the grain (Lawrence and Maier, 2010).

Much as farmers do not have storage space and containers, they struggle to protect the crop from mice and other pests (AGRA, 2013). Farmers in Africa increasingly store grains in polypropylene bags, but the poor aeration in these bags may encourage fungal growth and aflatoxin production, if the grains are not dried to a safe level (Hell *et aI*, 2000). Poor condition and lack of adequate storage facilities result in significant post-harvest losses at various stages of the supply chain (World Bank, 2010).Traditionally in Uganda, maize is stored in different locally constructed storage structures such as granaries, mud-silos, tua, cribs and commercial stores or living rooms for a period of 2 to 6 months (Kaaya and Kyamuhangire, 2010).

Storage insect pests, mainly the maize weevil Sitophilus zeamais Motschulsky *(Coleoptera: Curculionidae)*, the larger grain borer, Prostephanus truncatus Horn (*Coleoptera: Bostrichidae*), angoumois grain moth Sitotroga cereallela, Oliv. (Lepidoptera: Gelechiidae) and the lesser grain weevil Sitophilus oryzae Linne (*Coleoptera: Curcu- lionidae*), cause an estimated 20-30 per cent loss of maize, thus impacting income generation as well as food security (Tafera, 2010). In many developing countries, due to inadequate handling and storage practices at the household level, within the first three months after harvest, farmers lose up to 40 per cent of their harvest to insects, pests, mould, and moisture, hence impacting significantly on maize quality (Costa, 2015). The grain should be clean and dry during storage while the storage unit should be maintained with an even, cool and dry storage environment and protected from common storage loss agents such as insect pests, rodents, moulds, birds and man (FAO, 2016)

2.3.2 Training in Post-harvest Handling Technologies

The overall goal of the PHHS training is to empower smallholder farmers to improve the quality of their cereal grains and pulses in order to help them improve their incomes from sales to higher quality markets (WFP, 2012). A study conducted in Central America discovered that completion of training course about post-harvest handling technologies was one of the main determinants of achieving household self-sufficiency in maize (Bokusheva et al, 2012: 1).

A World Food Programme (WFP) project showed that a unique combination of post-harvest management training, coupled with airtight storage equipment enables farmers to eradicate their post-harvest losses. Through training on the new post-harvest handling and storage methods and modern equipment, farmers reduced their loss levels to less than 2 percent and they were able to pay off their investments, and on average can double their incomes in Uganda (Costa, 2015).

A good training process should be moving to a more detailed presentation of a range of learning approaches, materials and processes. Advanced planning, including a training needs assessment, development of learning outcomes, design of the training programme, selection of participants including associated gender aspects, decisions on the venue and field sites are covered. These are followed by notes on evaluating, scaling out and up, and follow up of the post-harvest handling technologies learning (WFP, 2012). Rugumamu (2012: 73) argued that lack of specialized training in the post-harvest component of the crop management cycle and lack of a lead farmer/practitioner with a coordinator hinder rapid and efficient transfer of appropriate technologies.

Various methods can be used to extend information and advice either to groups or to individual farmers. Farmers learn best when taught using informal techniques. Open discussions facilitated by the extension worker enable the experiences of a group to be put forward as well as allowing those that have used a particular technology to describe it and to offer their opinions. Flip charts with prepared diagrams can be used to illustrate a message. Visual aids illustrate the problems and solutions. Posters may be used as visual aids during discussions but can be pinned up around the village to provide a permanent reminder of a message (FAO, 2009).

There is no better way to explain how something works than by showing it in operation and observing the processes involved which is well explained through demonstrations. Sometimes a decision tree can be used to analyse the problems step-by-step, giving solutions for different scenarios that the farmers may face (FAO, 2009). The goal of every trainer or extension worker's job is to ensure that the quality and quantity is not lost and this can only be achieved by revisiting the farm at intervals, talking to the farmer and collecting samples to assess the progress of any damage and quality (FAO, 2009). Improving post-harvest handling capacity of smallholder farmers not only has the potential to increase crop preservation and food volumes for consumption and trade, but also household incomes (Costa, 2015).

2.3.3Adoption of Post-harvest Technologies

The factors affecting technology adoption are assets, income, institutions, awareness, labour, and innovativeness by smallholder farmers (Muzari, 2012). The various institutional, economic, psychological and social factors are known to be important in determining the adoption of improved technologies (Adesina and Zinnah, 1993). Meinzen-Dick (2004) argues that the main factors affecting technology adoption among smallholders in Sub-Saharan Africa are assets, vulnerability and institutions. Therefore this study focused on dimension cost of the technology used in terms of its affordability to famers, the level of awareness as well as it's the risks involved.

According to Muzari (2012), technology adoption depends on whether farmers have the requisite physical (material) and abstract possessions (e.g. education). A lack of assets or enough resources limited technology adoption (Meinzen-Dick *et al*, 2004). Researchers, policy makers and development practitioners need to put more emphasis on the development of technologies with little requirements for such material and abstract possessions (Meinzen-Dick *et al*, 2004). Browning, Halcli, and Webster (2000: 1) state that people calculate the likely costs and benefits of any action before deciding which post-harvest handling technologies to use. Vulnerability factors deal with the effects of technologies on the level of exposure of farmers to economic, biophysical and social risks (Meinzen-Dick *et al*, 2004). Those technologies that have a lower risk have a greater appeal to smallholders who are naturally risk-averse (Meinzen-Dick *et al*, 2004). Davis, Hands and Maki (1997: 1) highlight that decision-making of choosing a given post-harvest technology to use depends on the risks and uncertainty involved.

A survey conducted by World Food Programme proved that 97.9 per cent of surveyed farmers achieved financial gain by utilizing new storage technologies. Farmers are able to increase their incomes as they are able to sell higher-quality grain. Therefore; training and adopting the trained technologies greatly increase farmers' income (Costa, 2015).

2.4 The Concept of Maize farmer's income

Post-harvest losses have significant nutritional, health, and financial impacts for both consumers and farmers who are largely responsible for managing post-harvest drying, cleaning, and storage (Costa, 2015).

2.4.1 Quantity and Quality of Yield

Reduction in quality of grain lowers the value markets, which are usually informal, so that farmers lose the opportunity of better incomes (Rural 21, 2013:17). USAID (2013) mentioned that maize production is characterized by low volumes and poor (inconsistent) quality that are the result of weak post-harvest handling practices and inadequate storage. Uganda lacks an authoritative price determination point (Ahmed, 2012) -- for instance a central commodity exchange or futures market -- national maize quality standards, and a legal and regulatory framework covering grain warehousing and handling operations (NRI/IITA, 2002). Temperature and moisture content of the cereal grains are the two key features affecting the resulting quality of the grain, biochemical reactions, dry matter losses, allowable storage times and overall storage management of the grain (Lawrence and Maier, 2010).Infection of maize grain by storage fungus results in discoloration, dry matter loss, chemical and nutritional changes and overall reduction of maize grain quality (Chuck-Hernández *et al*, 2012).

2.5 Empirical Studies

Suleiman *et al* (2013) conducted a research on determining the effects of deterioration parameters on storage of maize and concluded that, for the proper storage of maize grain, environmental factors such as temperature and moisture content must be controlled. These factors are the major influences of maize deterioration, because they affect molds, insects, and other pests which can result in huge losses of maize grain in a very short time. They wrapped up their research by saying that to avoid mycotoxin contamination; maize should be monitored regularly to ensure safe storage conditions. The study also concluded that in order to maintain high quality maize for both short- and long-term storage, maize must be protected from weather, growth of microorganisms, and pests. This study did not consider the farmers' knowledge or accessibility to such information and training that was considered in this study conducted.

Kimatu *et al* (2012) carried out research to determine the significant role of post-harvest management in farm management, aflatoxin mitigation and food security in Sub-Saharan Africa and they concluded that proper post-harvest management, especially the use of the small-scale metal silo, contributes to better quality of grains, less pesticide usage and can accelerate agribusiness, therefore directly contributing to rural development and poverty reduction. However, he concluded that not much effort had been invested in reducing post-harvest food losses especially in staple cereals like maize and legumes, even after many studies had shown that it offered an essential way of increasing food availability and income without the need for other resources. Hence this created the need to carry out a study to supplement or confirm this finding.

Okoruwa *et al (*2009) also conducted a research on post-harvest grain management storage techniques and pesticide use by farmers in South-West Nigeria. The factors which significantly influence farmers' choice of storage techniques and pesticide use, including quantity of grain harvested, cost of pesticide and cost of investment, price of grains, gender of farmers, education, capital invested and cost of pesticides were analysed. This study focused on adaptation of agriculture technologies as a whole but the conducted study focused on other processes before adoption for instance, training of farmers in post-harvest handling technologies in relation to household income. Due to the fact that this study was conducted Nigeria with different ecological conditions, the proposed study wasconducted in Uganda and focused on understanding the effects of Post-harvest handling technology availability, adoption and training on maize farmer's income.

Kaaya and Kyamuhangire (2006) conducted a research about the effect of storage time and agro-ecological zone on mould incidence and aflatoxin contamination of maize from traders in Uganda. They found high temperature to be a major factor influencing aflatoxin contamination and fungal growth. They also revealed that temperature and water activity influence not only the rate of fungal spoilage, but also the production of Mycotoxin. This information is very important but they did not consider other aspects of post-harvest other than storage like drying, threshing and storage which was considered in the study conducted. The conducted study also focused on the training process of maize farmers which was not looked at during this study.

Kaaya *et al* (2012) carried out the research about the dynamics of fusarium and fumonisins in maize during storage using the traditional storage structures commonly used in Uganda and concluded that storage of maize in traditional storage structures for more than 4 months results in significant decrease in fumonisin levels. The Kaaya et al study only considered one post-harvest technology which is storage, but there are other technologies that can reduce maize quality like harvesting, drying and threshing which were looked at in the study conducted.

2.6. Synthesis and Gap Analysis

Most of the studies that have been conducted in Uganda have considered storage practices as the main post-harvest handling technology used; but there other practices that have a great effects on the quality and quantity of maize grain such as harvesting, drying and shelling which were considered in this study. Additionally, earlier studies conducted in Uganda and internationally have not considered the training aspects of maize farmers which were a variable under investigation in this study. The conducted study therefore sought to contribute to closing this research gap.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

Kothari (2004:8) defined research methodology as a way of systematically solving a research problem. This involves various steps that were followed by the researcher during the study. The chapter provides the research design, the study area, and the target population, sampling procedure, methods of data collection and Data Collection Instruments, Data Quality Control (Validity & Liability), measurement of the Variables and data Analysis.

3.2 Research Design

According to Kothari (2004:31), research design is a plan, a roadmap and blueprint strategy of investigation conceived so as to obtain answers to research questions. It is a procedural plan that is adopted by the researcher to answer research questions objectively, accurately and economically (Kumar,1996:74).This study utilized a cross-sectional survey design which adopted mixed methods. A cross-sectional study predominantly uses questionnaires or structured interviews for data collection with the intent of generalizing from a sample to a population (Creswell, 2003). Under the aspect of mixed methods, the researcher combined quantitative and qualitative research techniques and methods to provide the best understanding of a research problem (Creswell, 2003:12). Mixed methods employ strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problems (Creswell, 2003:18). Quantitative research employs numerical indicators to ascertain the relative size of a particular phenomenon and involves counting and measuring of events as well as performing the statistical analysis of a body of numerical data (Smith, 1988). Qualitative approaches on the other hand are concerned with expression of attitudes, opinions and feelings. They allow a researcher to solicit information that cannot be expressed in numerical format, making it possible to obtain non-numerical information about the phenomenon under study to aid establish patterns, trends and relationships from the information gathered (Mugenda and Mugenda, 1999). The quantitative method was administered by the used of questionnaire while the qualitative methods used key informant interviews and document reviews.

3.3 Study population

According to Amin (2005: 235), a target population is the population to which the researcher ultimately wants to generalize the results. The target population for this study was two hundred twenty one (221) respondents. Maize farmers from the two selected area cooperative enterprises, Nyamahasa ACE and Masindi Seed and Grain Growers' Association (MASGGA) were selected. One hundred twenty (120) maize farmers were selected from Nyamahasa ACE where five famers were selected randomly from 24 active producer organizations under this cooperative. Eighty five (85) active maize farmers that had been active for the past five years at Masindi Seed and Grain Growers' Association (MASGGA) were also selected, warehouse operators to which the cooperatives are affiliated with a population of four (4) respondents, officials that provide technical support to these cooperative in form of training with a respondents of eight (8) and two agricultural officials each from Masindi and Kiryandongo districts hence having a population of four (4) respondents as seen in table 3.1.

3.4 Sample size

A sample is a subset of a population selected to represent characteristics of a population (Nesbary, 1999). The study was conducted on representative sample of one hundred seventy eight (178) respondents. An optimum sample is one which fulfils the requirements of efficiency, representativeness, reliability and flexibility (Kothari, 2004:57). Amin (2005:238) emphasizes that a researcher must determine the sample size that will provide sufficient data to answer the research problem. A sample is important to reduce costs, time and has a high degree of accuracy (Amin, 2005: 238-239).The sampling process followed the table below.

Table 3.1 Sampling Procedure

SN	Category	Population	Sample	Sampling procedure
1	Farmers			
	a) Nyamahasa ACE (Kiryandongo district)	120	92	Random sampling
	b) Masindi Seed and Grain Growers' Association (MASGGA)	85	70	Purposive sampling
2	Warehouse operators	**4**	**4**	Purposive sampling
3	Two training officials from organizations that provide technical support to the cooperative organizations	**8**	**8**	Purposive Sampling
4	Two agricultural officials each from Masindi and Kiryandongo Districts	**4**	**4**	Purposive Sampling
	Grand Total	**221**	**178**	

The researcher conducted the study on a sample of one hundred seventy eight (178) respondents which was guided by Krejcie and Morgan's (1970) sampling table. Ninety two (92) famers were randomly selected from Nyamahasa ACE in Kiryandongo district and 70 active farmers that have been active for the past five years at Masindi Seed and Grain Growers' Association (MASGGA) were selected as well. Two officials from two organizations that provided technical support to farmers to these cooperatives were selected hence having a population of 8 respondents. Furthermore, two warehouse operators that are affiliated to these cooperatives as well as district agricultural officials were purposively selected. Additionally, two agricultural officials from each district were selected purposively hence having a sample of 4 respondents.

3.5 Sampling techniques

The study employed simple random sampling and purposive sampling techniques. Simple random sampling is where each and every item in the population has an equal chance of inclusion in the sample (Kothari, 2004:15: Amin, 2005:244). Simple random sampling was used to select farmers in the selected cooperatives and every farmer had equal chances of being selected. Purposive sampling is the deliberate selection of particular units of the population for constituting a sample which represents the universe (Kothari, 2004:15). Purposive sampling was utilized to select warehouses operators, officials providing technical support and districts agricultural leaders because these are people expected to have knowledge on the phenomenon under investigation.

3.6 Data collection methods

Data collection methods are specific approaches that the researcher applied to obtain information on the research problem (Kothari, 2004:95). The study employed both primary and secondary data collection methods explained below.

3.6.1 Primary data collection methods

Primary data is the information collected afresh and for the first time, and thus happens to be original in character (Kothari, 2004:95). The researcher used primary data collection methods by obtaining information for the directly from the respondents. Survey questionnaires were used to collect quantitative data directly from maize farmers and key informant interviews were used to collect qualitative data directly from warehouse operators and all officials from supporting organizations.

3.6.2 Secondary data collection methods

Secondary data is information gathered from already existing sources which have already been collected by someone else and which have already been passed through the statistical process (Kothari, 2004:95). This supplemented the primary methods and provided the researcher with an opportunity to gain more information about the phenomenon. The researcher reviewed the average maize production status of each farmer as well as the quality aspects. The researcher reviewed the different training materials of the organization in the different regions selected. Document reviews assist the researcher to gather information for a bottomless appreciation of the subject under investigation as well as validate the findings from the other data collection methods (Kumar, 1996).

3.7 Data collection instruments

Data collection instruments are tools that a researcher designs, tests and uses to obtain information from the intended sources (Amin, 2005: 261). The data collection tools or instruments used during this study include; questionnaires, key informants interview guide and document review checklists.

3.7.1 Survey Questionnaire

A questionnaire was used to facilitate the quantitative data collection. According to Amin (2005:269) a questionnaire is a form consisting of interrelated questions prepared by the researcher about the research problem under investigation based on the objectives of the study. This is a device used for gathering facts, opinions, perceptions, attitudes and beliefs from a large number of people at a particular time. The questionnaire was chosen to collect this type of data because it is an efficient data collection mechanism especially when the researcher knows what is required and how to measure the variables of interest (Sekaren, 2003; Creswell, 1994). It also allows the researcher to collect a lot of information over a short period of time at a low cost and free from bias of the interviewer (Kothari, 2004:101). Additionally, Kothari (2004: 100) advises that a questionnaire to be used must be prepared very carefully so that it may prove to be effective in collecting the relevant information. Questionnaires comprising both open and close-ended questions were used for data collection. Quantitative questions on the questionnaire were close-ended and ranked on a five point Likert Scale (where 1=Strongly Disagree, 2=Disagree, 3=Not Sure, 4=Agree and 5=Strongly Agree) to provide options of answers to questions that were positively formulated for clarity and consistency (Robbins, 2008: 264).

Therefore, the researcher prepared a questionnaire to collect information about the dimensions of post-harvest handling technologies and maize farmers' income.

3.7.2 Key informant interview guide

A key informant interview guide was used to get information from the key informants. Key informant interviews are qualitative, in-depth interviews of people selected for their first-hand knowledge about a topic of interest (Kumar, 1989). Key informant interview guides were devices that provided information to guide the interview process. This guide had a list of questions that were asked in relation to the themes of study specifically the independent variable (post-harvest handling technologies) and the dependent variable (Maize farmers' income).

3.7.3 Document review checklist

A document review checklist was used for carrying out the document review. This is an instrument which contained a list of all documents reviewed that were relevant to the phenomena under study. The researcher developed a list of different documents to be reviewed including documents that have information on average maize production status of maize farmers in the region as well as the quality aspects. All the documents that were related to the independent variable (post-harvest handling technologies) and the dependent variable (Maize farmers' income) were also reviewed.

3.8 Data Quality Control

Data quality controls are measures that are taken to ensure that the information to be collected represented the sample and was consistent. Quality data control or pre-testing instruments considered two aspects; validity and reliability.

3.8.1 Validity of Research Instruments

Validity is the degree to which results obtained from the analysis of data actually represent the phenomenon under study. This is the ability of the instrument to collect truthful and justifiable data (Oso and Onen, 2008). Validity also refers to the accuracy and meaningfulness that are based on the research findings. It also measures the extent to which an instrument measures what it is meant to measure (Mugenda and Mugenda, 1999). The researcher prepared research instruments and subjected them to validity tests before finally administering them on the respondents. The draft questionnaires were subjected to expert judgment to verify the validity of the questions in line with Lynn (1986) where the researcher will use the Content Validity Index (CVI).

Amin (2005: 287) asserted that: *"Content validity is the degree to which the test actually measures or is specifically related to the traits for which it was designed. It shows how adequately the instrument samples the universe of knowledge, skills, perceptions and attitudes that the respondent is expected to exhibit."*

The researcher distributed an initial draft questionnaire to five experts in post- harvest technologies in maize. The content validity was determined by having items on the instrument rated by five (5) experts. The Content Validity Index (CVI) was then determined by the formula and the workings below.

CVI	=	***Number of Items considered valid***
		Number of items on the draft questionnaire

The initial draft had 75 questions, 68 of which were found relevant to the phenomenon under study as follows:

CVI	=	***Number of items considered valid***	=	***68***	=	***0.907***
		Number of items on the draft questionnaire		***75***		

This made a CVI of 0.907 which complied with the recommended minimum CVI of 0.7 as averred by Amin (2005). All questions deemed not valid were edited accordingly per the recommendation of the experts. Consequently, 7 questions that were deemed invalid were dropped.

3.8.2 Reliability of the research instruments

Reliability is the measure of the degree to which a research instrument yields consistent results or data after repeated trails (Sekaran, 2003). Reliability also refers to the ability of the instrument(s) to collect the same data consistently under similar conditions (Amin, 2005).

Korthari (2004:33) highlighted that a good design is the one that minimises bias and maximises the reliability of the data collected and analysed. Robbins (2008:257) stated that a question is reliable if it is interpreted in the same way by those participating in a study and yield the same result repeatedly.

In order to determine the reliability of the research instruments, a pre-test of the instruments was undertaken in a similar environment using the same tools. Specifically, fourteen questionnaires were selected randomly and pre-tested to a few respondents (seven from Masindi District and seven from Kiryandongo District), in order to evaluate data collected.

In order to establish internal consistency of the data collected, Chronbach's alpha was used to correlate the scores of the responses (Amin, 2005:302). According to Cronbach (1951:297), a reliability coefficient demonstrates that the test designer was correct in expecting a certain collection of items to yield interpretable statements about individual differences.

The formula for Cronbach's Alpha to be used is follows:

$$\text{Cronbach's alpha} = \left[\frac{n}{n-1}\right]\left[\frac{SD^2 - \sum Variance}{SD^2}\right]$$

where:	*n* = *Number of items on the test* *SD* = *The Standard Deviation for the set of test scores, and* ∑*Variance = Summation of the variances of the scores for each of individual item on the test.*

The researcher used the Statistical Package for Social Scientists (SPSS for Windows V19) to calculate the Cronbach's Alpha and the results were as shown in Table 3.2:

Table 3.2: Result of the Cronbach's Alpha Reliability test

a) Case Processing Summary			
		N	%
Cases	Valid	151	100.0
	Excluded(a)	0	.0
	Total	151	100.0
a Listwise deletion based on all variables in the procedure.			

b) Reliability Statistics	
Cronbach's Alpha	N of Items
.851	38

Source: Field data, 2016

Table 3.2 above shows that the Cronbach Alpha Coefficient was 0.851, having been tested on 38 items on the questionnaires (N = 38) that was administered on one hundred fifty one (151) respondents.

If a Cronbach's Alpha is above 0.7, it shows that the tool is reliable (Sekaran, 2003). The higher the reliability coefficient, the higher the reliability of the instrument being tested (Amin, 2005:295). Cronbach's Alpha produces values n=between 0 and 1.00 with the higher value indicating a higher degree of internal consistency and reliability (Gravetter and Forzano, 2012). Therefore, having a Cronbach's Alpha of 0.851 proved that the data used for the study was reliable and consistent.

3.9 Procedure of Data Collection

A systematic procedure was followed by a researcher during data collection. The researcher obtained a letter to introduce her to farmers' cooperatives in Masindi and Kiryandongo districts from UTAMU to enable her seek the acceptance of the management and leadership of the selected cooperatives to access and interact with the proposed respondents. The researcher delivered questionnaires to respondents to whom she explained the objectives of the study and how they had been selected. She also sought their consent to participate as respondents and, finally, asked them to fill the questionnaire. Later, the researchers collected the filled questionnaires and confirmed the completeness of responses. The researcher secured appointments to conduct interviews with key informants and reviewed selected documents to search for data to support information obtained.

3.10 Data analysis

Data analysis is the process of bringing order, structure and meaning to the mass of collected data to obtain useful information. According to Amin (2005:306), data analysis includes editing, coding, computer data entry, and verification of accuracy of the data entered. Both quantitative and qualitative data were analysed following different methods of analysis as below:

3.10.1 Quantitative data analysis

The quantitative data was sorted, and edited to eliminate errors so as to ensure completeness, accuracy and uniformity. Coding was then done after editing in an attempt to reduce data from detailed to summarized and understandable forms such as tables, charts and graphs. The data was entered into the computer and analyzed using Statistical Package for the Social Sciences (SPSS). Data was analyzed using descriptive statistics such as frequencies, percentages and cross tabulations. Interpretations and implications of the generated statistical information were derived, objective by objective following the data presentation and analysis.

In order for the researcher to measure the degree of association between the independent variable (Post- harvest handling technologies) and the dependent variable (Maize famers' income) and test the hypothesis, a correlation analysis was done and the Spearman rank correlation was used.

Spearman rank correlation is the technique of determining the degree of correlation between two variables in case of ordinal data where ranks are given to the different values of the variables. The main objective of this coefficient is to determine the extent to which the two sets of ranking are similar or dissimilar (Kothari, 2004).

This is a formula used by the researcher to calculate the Spearman rank correlation

$$r^2 = \frac{6\sum d_i^2}{1- n\,(n^2-1)}$$

Where: r^2 = *Spearman rank correlation*

d_i = *the difference between the ranks for any pair of data values*

n = *number of value in each data set*

$\sum d^2$ = *the sum of the difference of the squares of the ranks for the data sets.*

The correlation coefficient ranges between -1 (perfect negative relationship) and 1 (perfect positive relationship) with 0 representing no relationship (Margolis, 2008:399).The researcher used SPSS for Windows V12 to derive Computed Variables for all dimensions of the Independent Variable and adopted the significance level of 0.05 using a one-tail test. The researcher employed for “One tail” test as opposed to the “two tail” test owing to the fact that the hypotheses had been stated in a “1 Direction” approach. A significance level, according to Mugenda and Mugenda (1999) is the probability of obtaining similar results if the study is repeated many times using different but equal random samples. For values of less than 0.05(5%), the hypotheses was accepted and the conclusion was made that there was a significant positive relationship between the dimensions independent variable (Post- harvest handling technologies) and the dependent variable (Maize farmers’ income).

Regression analysis is used when the researcher is interested in finding out whether an independent variable predicts a given dependent variable (Mugenda and Mugenda, 1999:

135).The researcher opted for regression analysis to establish which of the post-harvest handling technologies dimensions is more responsible for maize farmers' income.

3.10.2 Qualitative data analysis

Qualitative data obtained by using key informant interviews and document reviews was sorted, edited and arranged according to themes category by category, based on the study objectives. This information helped to ensure that the information given by the respondents is accurate, complete and consistent. The results of such qualitative data analysis enabled the researcher to make sense of the data (Mugenda and Mugenda, 1999:115).

3.11 Measurement of variables

The studied variables were measured at three levels: Univariate, Bivariate and Multivariate.

3.11.1 Univariate Level

At the univariate, the researcher gave a full description of a single variable and its attributes at a particular time. Hence, frequency tables and figures were used to present data and give a descriptive analysis of the variables.

3.11.2 Bivariate Level

At bivariate level, the researcher ascertained the relationship between the dimensions of the independent variable (Post- harvest handling technologies) and the dependent variable (Maize famers' income). The study variables were quantitatively measured using a Five-point Likert scale. Likert scales use fixed choice response formats and were designed to measure attitudes or opinions of respondents (Likert, 1932). The five point Likert Scale was detailed as 1=Strongly Disagree, 2=Disagree, 3=Not Sure, 4=Agree and 5=Strongly Agree. The bivariate level involved considering two variables at the same time and involved correlation of dimensions of the independent variable (Post- harvest handling technologies) and the dependent variable (Maize famers' income). The correlation measurement used to test for the hypothesis of the study and adopted a "one tail" approach due to the statement of the hypotheses at 0.05 level of significance.

3.11.3 Multivariate Level

All the dimensions of the independent variable (Post- harvest handling technologies) that were tested significant at bivariate level were analysed using a regression analysis to measure their net contribution on the dependent variable (Maize famer's income). This was a typical measurement that tries to establish relationships between the Independent variable (Post- harvest handling technologies) and the dependent variable (Maize famer's income). It was essential to determine the percentage effect or effects of each dimension the Independent variable (Post- harvest handling technologies) to the dependent variable (Maize famers' income).

3.12 Ethical consideration

In conducting research, it is important to remember the power relationship in a research process and how this affects the research. The researcher had the responsibility not to abuse power, and to safeguard other participants' integrity, anonymity and generally treat all involved with respect. As one of the overarching principles of ethics, it is crucial to sound research to do no harm .This position will promote an ethical view that claims that the value of the research is not worth destroying people or communities in the process. Another consideration in the research is that participation of the respondents in the study was voluntary and was based on a conscious decision and informed consent which was a way of ensuring this. This was obtained by the researcher explaining what the study was all about, and ensuring that participants' anonymity as well as the participants' possibility of withdrawing during the research.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF ESULTS

4.1 Introduction

This study sought to determine the effect of post-harvest handling technologies on maize farmers' in Masindi and Kiryandongo districts. This chapter presents the analysis as well as interpretation of the study findings. According to Ahuja (2005:315), analysis is ordering of data into constituent parts with the objective of attaining answers to research questions while interpretation is to explain and find meaning from the answers obtained. The details of this chapter include: the response rate, results on background characteristics of the respondents and the empirical results which are all made in the form of descriptive, correlation, regression and ANOVA analysis as well as qualitative results. This study employed the mixed methods form of presentation (Sandelowski, 2003) to enhance credibility. The researcher also used graphic illustrations: tables, figures and graphs all which are presented following the research objectives.

4.2 Response rate

Response rates represent the percentage of those selected in a sample that actually provides data for analysis. Response rate also refers to the percentage of people who responded to a survey. High survey response rates help to ensure that survey results are representative of the target population (Monkey, 2009:1). A survey must have a good response rate in order to produce accurate and useful results (The University of Texas at Austin, 2016).

According to Monkey (2009:1), response rate is obtained by dividing the number of complete surveys and the number of participants contacted as seen below:

$$\frac{\textit{Number of complete surveys}}{\textit{Number of Participants contacted}} = \textit{Response rate}$$

In research surveys, Mugenda and Mugenda (2003) suggest a minimum response rate of 70 per cent whereas Amin (2005) suggests a minimum response rate of two-thirds.

The study targeted one hundred seventy eight (178) sampled respondents that included sixteen (16) interview requests, with one hundred sixty two (162) questionnaires beeing distributed, where 92 and 70 were distributed in Kiryandongo and Masindi districts respectively. Fifteen interviews were held and one hundred fifty one (151) questionnaires were properly filled and returned to the researcher making a response rate of 93.3 per cent as detailed in Table 4.1 below.

Table 4.1: Response rate

SN	Category	Target Population	Sample	Responses	Response rate
1	Farmers				
	a) Nyamahasa ACE (Kiryandongo district)	120	92	86	93.5%
	b) Masindi Seed and Grain Growers' Association (MASGGA)	85	70	65	92.9%
2	Warehouse operators	4	4	4	100%
3	Two training officials from organizations that provide technical support to the cooperative organisations	8	8	7	87.5%
4	Two agricultural officials each from Masindi and Kiryandongo districts	4	4	4	100%
	Grand Total	221	178	**166**	**93.3%**

Source: Field data 2016

Given the fact that the response rate obtained is more than 70 per cent, the researcher is confident that the survey results are representative of the target population and will produce accurate and useful results.

4.3 Background characteristics of the response

The following is the representation of the background characteristics of the respondents.

4.3.1 Respondents' sex

The study registered fifty seven (57) female respondents, making 37.7 per,cent and ninety four (94) male respondents forming 62.3 per cent as presented in figure below.

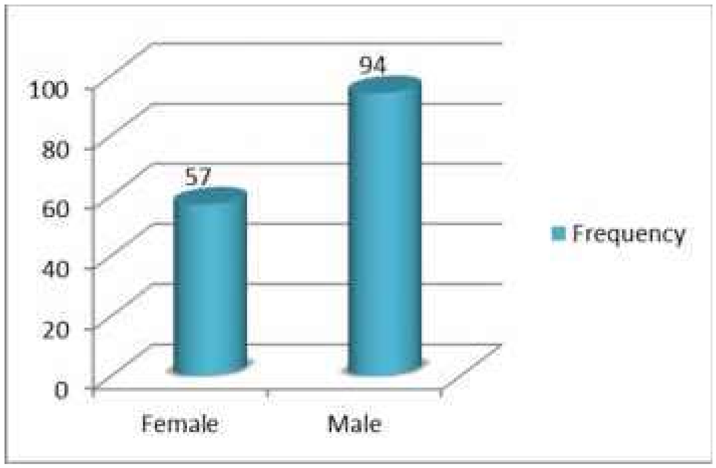

Figure 4.1: Respondents' sex: *Source: Field data, 2016*

The above findings implied there are more males than females who directly participate in maize production activities, including receiving the trainings on post-harverst handling technologies and adopting the technologies. Therefore, there is a need to encourage women to participate not only in the growing of maize but also post-harvest handling technologies.

4.3.2 Respondents' age group

The respondents were distributed across various age groups as shown in the following table.

Table 4.2: Respondents' age distribution

SN	Category	Frequency	Percent
1	18 years to 19 years old	1	.7
2	20 years to 29 years old	43	28.5
3	30 years to 39 years old	71	47.0
4	40 years to 49 years old	27	17.9
5	50 years and more	9	6.0
	Total	**151**	**100.0**

Source: Field data, 2016

From the table above, the greatest number of the respondents were aged 30 years to 39 years at a percentage of forty seven (47) followed by those aged between 20 years and 29 years at a percentage of 28.5 followed by those aged from 40 years to 49 years at a percentage of 17.9, whereas 6 per cent and 0.7 per cent were aged from 50 years and above and 18 years to 19 years respectively. The findings mean that the majority of the respondents were mature enough to provide reliable information about the effect of post-harvest technologies on their income. This increased the validity and reliability of the study results. It is in this context that improving post-harvest handling capacity for these different age groups will have a great impact to these farmers.

4.3.3 Respondents' experience in maize farming

The study was conducted on respondents with different experience in maize farming and the details are shown in the table below.

Table 4.3: Respondents' experience in maize farming

SN	Category	Frequency	Percent
1	5 years or less	7	4.6
2	6 years to 10 years	54	35.8
3	11 years to 15 years	54	35.8
4	16 years to 20 years	26	17.2
5	More than 21 years	10	6.6
	Total	**151**	**100.0**

Source: Field data, 2016

According to the table above, the greater part of respondents had more than five years of experience in maize farming. Respondents that had an experience of 6 years to 10 years and 11 years to 15 years had the same percentage of 35.5. These were followed by those who had an experience of 16 years to 20 years in maize farming at 17.2 per cent, followed by those who had an experience of more than 21 years at a percentage of 6.6 per cent and, finally, those who had an experience that was less than 5 years at 4.6 per cent. This shows that respondents had enough experience in maize farming hence giving quality responses based on their experience and this proved that most of the respondents met the study time scope of five years.

4.3.4 Respondents' location

The study was conducted in two different districts including Masindi and Kiryandongo districts in Mid-west Uganda and the figure below shows the respondents location in these two districts.

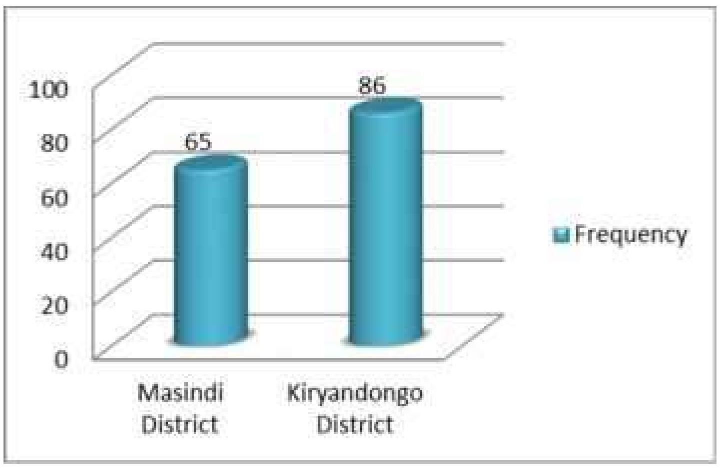

Figure 4.2: Respondent's Location. ***Source: Field data, 2016***

From the table above, there were 65 respondents from Masindi district at a percentage of 43 and 86 respondents from Kiryandongo district at a percentage of 57. This proves that the two districts were fully represented in this study.

4.3.5 Respondents' average maize acreage

The study found out the average respondent's average maize acreage per season as represented in the table below.

Table 4.4: Respondents' average maize acreage

SN	Category	Frequency	Percent
1	Less than 1 acre	2	1.3
2	1 acre up to 2 acres	10	6.6
3	More than 2 acres up to 3 acres	55	36.4
4	More than 3 acres up to 4 acres	38	25.2
5	More than 4 acres up to 5 acres	27	17.9
6	More than 5 acres	19	12.6
	Total	151	100.0

Source: Field data, 2016

According to the table above, the biggest number of the respondents had an average of between 2 acres and 3 acres under maize production per season at a percentage of 36.4. Twenty five (25.2) per cent had more than 3 acres up to 4 acres under maize production, whereas 17.9 per cent had more than 4 acres up to 5 acres under maize production although, 12.6 per cent and 1.3 per cent had more than 5 acres and less than 1 acre under maize production respectively. This projects that these respondents had enough volumes of maize that could be affected by post-harvest losses. With these volumes of maize, if they improve their quality, they can be able to sell their produce at a high price and thus increase their income.

4.3.6 Respondents' average maize production

The study went ahead to discover the average maize production per season for the respondents as seen in the figure below.

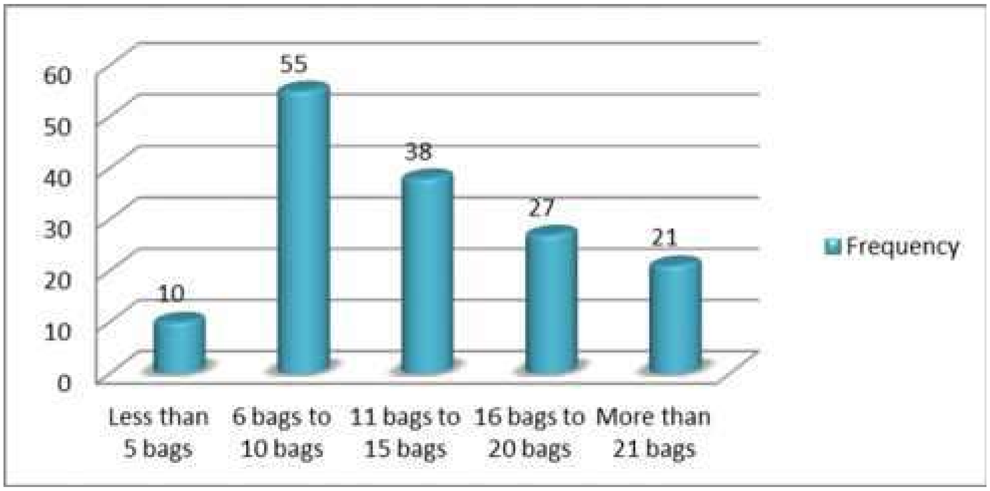

Figure 4.3: Respondent's average maize production. ***Source: Field data, 2016***

In reference to the figure above, the greatest number of respondents who had an average maize production per season between 6 bags of 100 kg each to 10 bags at 36.4 per cent followed by those who had an average maize production of 11 bags to 15 bags of 100 kg each at 25.2 per cent. Close to 18 (17.9) per cent of the respondents had an average production 16 bags of 100kgs each. Close to 14 (13.9) per cent and 6.6 per cent had an average maize production of more than 21 bags of 100 each and less than 5 bags of 100kgs respectively. This indicates that the respondents had enough maize production volumes that were easily being affected by post-harvest loss.

4.4 The effect of post-harvest handling technologies on maize farmers' income

The purpose of the study was to determine the effect of post-harvest handling technologies on maize farmer's income. This was further divided into three objectives according to which the findings are presented in the following sections.

4.4.1 Availability of post-harvest handling technologies and maize farmer's income

The first objective was to determine the effect of availability of post-harvest handling technologies on maize farmers' income in Mid-west Uganda (Masindi and Kiryandongo districts).

Some preliminary information about the availability of post-harvest handling technologies were collected on the post-harvest technologies that most affect quality and quantity of maize as well as determining whether these technologies were available in the respondents' region; and this information is represented in the figures below.

a) The post-harvest handling technologies affecting the respondents' maize quality most

This study discovered that the most post-harvest handling technologies affecting the respondents' maize quality are under the harvesting period at 54.3 per cent therefore, the trainings in post-harvest technologies should also emphasize harvesting, followed by storage at 23.2 per cent. Almost 20 (19.9) per cent of respondents emphasized that drying period was the factor affecting their maize quality while 2.6 percent said shelling was the factor affecting their maize quality as represented in the figure below.

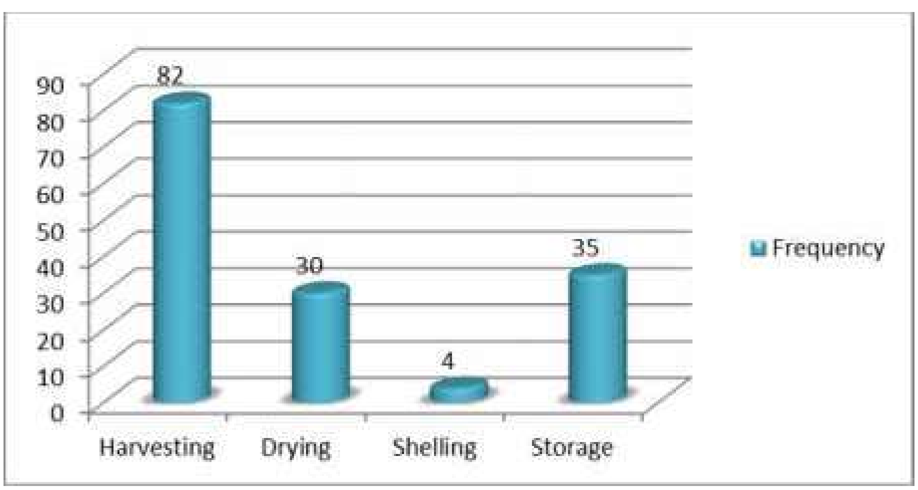

Figure 4.4: The post-harvest technologies affecting maize quality most. ***Source: Field data, 2016***

b) **The post-harvest handling technologies affecting the respondents' maize quantity most**

This study ascertained that the most post-harvest handling technologies affecting the respondents' maize quantity are under the storage period at 48.3 percent therefore, the trainings in post-harvest technologies should also focus on the storage practices followed by drying practices at 27.8 percent. The effect of harvesting practices on improving maize quantity was at 16.6 percent while shelling was at 7.3 percent as shown in the figure below.

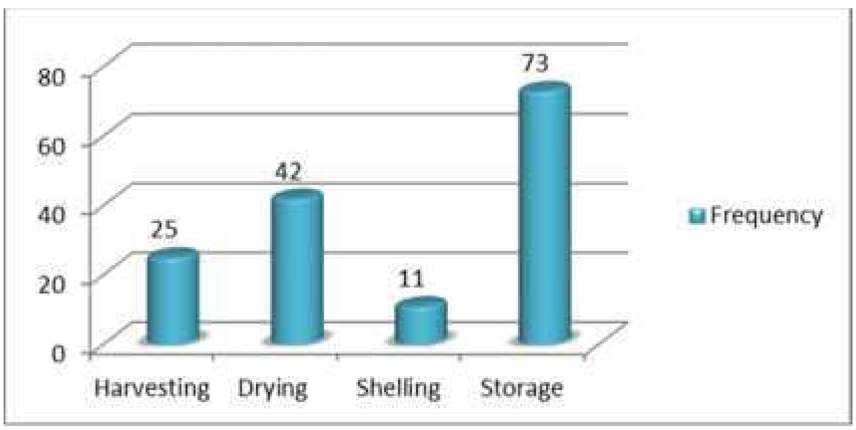

Figure 4.5: The post-harvest handling technologies affecting maize quantity most. ***Source: Field data, 2016***

The results prove that all the post-harvest handling technologies affect not only quality but also quantity. Therefore, during the process of improving farmers' capacity in post-harvest handling technologies, all processes starting from harvesting should be emphasized.

c) Overall availability of post-harvest handling technologies

The study found out whether there is post-harvest harvest handling technologies in the respondents' region as shown in the table below.

Table 4.5: Descriptive statistics for Overall availability of post-harvest handling technologies

SN	Item	SDA	DA	NS	A	SA	Mean	SD
1	There is availability of post-harvest handling technologies in the respondents' region	4 (2.6%)	15 (9.9%)	40 (26.5%)	88 (58.3%)	4 (2.6%)	3.48	0.82

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree. SD=Standard Deviation

From the table above, in general the respondents were in agreement with the idea that there was availability of post-harvest handling technologies in their region, giving a mean of 3.48; while the standard deviation proved that the responses were close to the mean. Additionally, 58.3 per cent of the respondents agreed that there were post-harvest handling technologies in their region while 26.5 per cent were not sure. Almost 10 (9.9) per cent of the respondents revealed that there were no post-harvest handling technologies in their region, while 2.6 per cent of respondents, strongly disagreed and strongly agreed to the fact that that there was post-harvest handling technologies in their region.

The study conceptualized that availability of post-harvest handling technologies had four key aspects including: harvesting, drying, shelling and storage.

4.4.1.1 Harvesting

Harvesting period is the first process of determining good quality maize and reduce post-harvest loss. On that note, to measure this, a question was asked to respondents to find out whether they avoid contacting soil and water when they are harvesting, and the results where summarised in the table below.

Table 4.6: Descriptive statistics for harvesting

SN	Item	SDA	DA	NS	A	SA	Mean	SD
1	The respondents always avoid contacting of the harvested maize with soil and water during the harvesting period	2 (1.3%)	3 (2.0%)	7 (4.6%)	110 (72.8%)	29 (19.2%)	4.07	0.66

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree. SD=Standard Deviation

According to the results in Table 4.6, commonly the greatest number of the respondents agreed that they always avoid contaminating the harvested maize with soil and water during the harvesting period, giving a mean of 4.07, while the standard deviation did not divert much from the mean. 72.8 per cent of the respondents were in agreement to the fact that they always avoid contaminating the harvested maize with soil and water during the harvesting period, followed by 19.2 per cent who strongly agreed. 4.6 per cent were not sure, while 2 per cent disagreed and 1.3 per cent strongly disagreed that they always avoid contaminating of the harvested maize with soil and water during the harvesting period.

In an interview conducted with one of warehouse operators, he said:

> "The harvesting period is very important to determine the quality of maize. If farmers harvest during the raining season, it is hard to dry maize up to the recommended moisture levels of 13.5 percent. In most cases, the maize that is harvested during August to October in this region is of poor quality because it's very difficult to reduce the moisture content to the recommended levels. For the purpose of increasing the maize quality farmers are asked to avoid contacting the harvested maize with soil and more water."

Another key informant mentioned:

> "Farmers always lack materials to use during harvesting like tarplin and polyethylene bags to avoid contacting the maize with soil and water. Farmers also find it hard to get enough labour for harvesting and lack enough money to use during this process and sometimes lack money to get a good transportation means from field to a crib."

Additionally, a district agricultural officer stated:

> "The most important thing to improve the harvesting period is the government or any development partner to provide tractors with a harvester and a trailer to take the harvested maize. Even if it's hired at relative cost, farmers can do that because it's hard for them to get enough labour. More so, farmers should be provided with a genuine tarplins to use. Someone who has a quality tarplin should open a shop in this region and

be able to sell good tarpaulin at reduced cost to farmers."

From the results above, farmers try to avoid the harvested maize to get into contact with soil and water during harvesting. This is very important to improve grain quality thus increasing their income. However, the major hindrance is lack of materials to use like quality tarplins and the weather conditions. If a farmer harvests maize during the rainy season, there are high chances of increasing its moisture content which makes it hard to dry.

For the purpose of understanding the maize farmer's practices during harvesting, a question was asked to the respondents on the characteristics the maize farmers consider to harvest and this is represented in figure below.

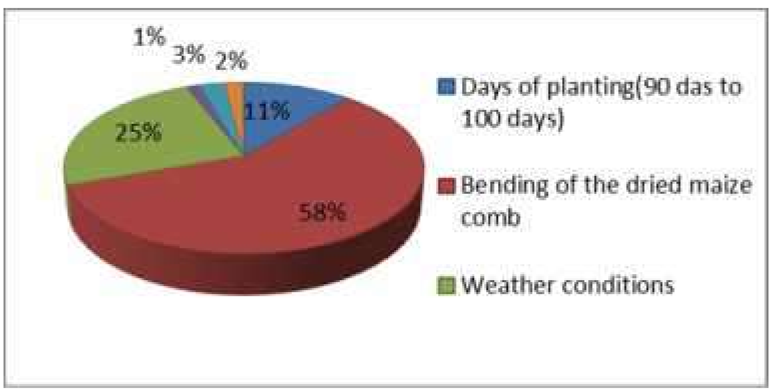

Figure 4.6: Maize characteristics considered in order to harvest maize. ***Source: Field data, 2016***

Firstly, 58 per cent of the respondents consider bending of the dried comb (maize dryness) while 25 per cent considers dry weather conditions to harvest their maize. 11 per cent considers days of planting where they harvest maize between 90 to 100 days after planting. 3 per cent consider moisture content while 2 per cent consider availability of materials to harvest like tarplins, store and crib to harvest maize and, finally, 1 per cent considers formation of a black layer on maize grain which proves that the grain is no longer receiving processed food from plant leaves.

This explains that farmers can tell when to harvest their maize. However, the optimum time of harvesting maize is when the stalks have dried and moisture of grain as about 20-17 per cent. Maize should be harvested as soon as it is dry so that it cannot be easily attacked by weevils.

4.4.1.2 Drying

Like harvesting, drying practices affect the maize quality and can cause high post-harvest loss. With regard to that, a question was asked to respondents to find out whether they find it difficult to get the desired drying methods to use and the results are summarised in the table below.

Table 4.7: Descriptive statistics for drying

SN	Item	SDA	DA	NS	A	SA	Non response	Mean	SD
1	The respondents had found it difficult to get the desired drying methods to use	9 (6.0%)	22 (14.6%)	8 (5.3%)	92 (60.9%)	19 (12.6%)	1 (0.7%)	3.64	1.16

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree. SD=Standard Deviation

According to the table above, the greatest number of the respondents agreed that they had found it difficult to get the desired drying method to use while drying maize, hence giving a mean of 3.64, whereby on the Likert scale it is close to 4, meaning agree, whereas the standard deviation did not divert much from the mean. To confirm this, 60.9 per cent of the respondents agreed that they had found it difficult to get the desired drying method to use while drying maize, while 14.6 per cent disagreed. 12.6 per cent and 6 per cent, strongly agreed and strongly disagreed respectively to the idea that they had found it difficult to get the desired drying method to use to dry maize. Lastly, 5.3 per cent were not sure while 0.7 per cent did not respond to the question.

In order to understand farmers' practices during drying of maize, a question was asked to the respondents on the type of methods they use to dry maize, and the results were summarized as below.

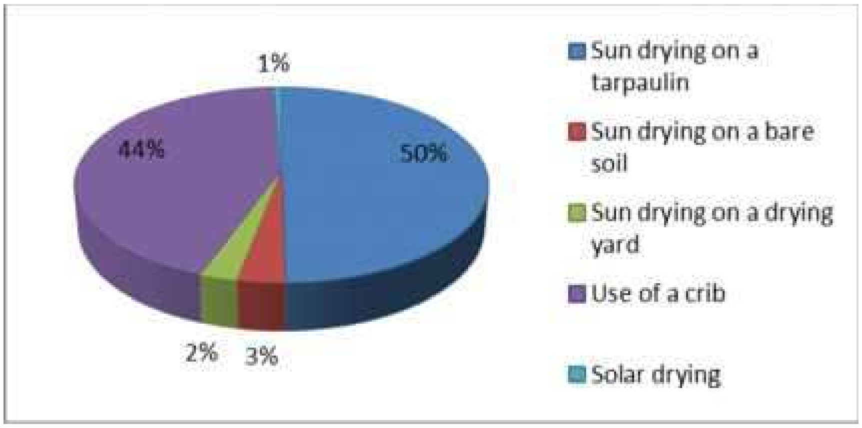

Figure 4.7: Maize drying methods used by the respondents. ***Source: Field data, 2016***

From the figure above, the majority of the respondents used the sun to dry the maize on a tarpaulin mainly for farmers from Kiryandongo district at 50 per cent while 44 per cent used a crib to dry their maize, especially those from Masindi district. Three per cent dried their maize using the sun on a bare ground which has a high impact on maize quality. Two per cent used a drying yard while one per cent used a solar drier to dry maize.

The findings were complemented by an interview with one in-charge mentioning:

> "Drying especially when farmers dry on a bare soil it leads to high post-harvest losses. Farmers in Masindi district that are under MASGGA were advised to build cribs for drying. In fact those are one the conditions put in place by the association to buy their maize. In most cases, farmers lack enough money to construct strong and big cribs. Some farmers complain about thieves and pest damage".

Another key informant was quoted saying:

> "Farmers in Kiryandongo district use tarpaulins but farmers find it very hard to get quality tarpaulins to use. Provision of artificial driers like solar and electrical driers will help a lot in reducing post-harvest loss".

From the results above, farmers from the two districts use different methods of drying. Farmers from Masindi use cribs whereas those in Kiryandongo use sun drying with tarpaulins. These methods are slow and are not effective if someone has large volumes of maize. Therefore there is a need of providing artificial driers to these two cooperatives to enable farmers dry their maize easily.

4.4.1.3 Shelling

Shelling practices can also affect greatly the maize quality and can cause high post-harvest loss. On that note, a question was posed to the respondents to find out whether they had found it difficult to shell their maize and the results are summarised as below.

Table 4.8: Descriptive statistics for shelling

SN	Item	SDA	DA	NS	A	SA	Non response	Mean	SD
1	The respondents had found it difficult to shell their maize	9 (6.0%)	22 (14.6%)	7 (4.6%)	97 (64.2%)	15 (9.9%)	1 (0.7%)	3.62	1.14

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree. SD=Standard Deviation

The results for Table 4.8, biggest number of the respondents agreed that they had found it difficult to shell maize, hence giving a mean of 3.62. Furthermore, 64.2 per cent of the respondents agreed that they had found it difficult to shell their maize while 14.6 per cent disagreed. 9.9 per cent and 6 per cent strongly agreed and strongly disagreed respectively to the idea that they had found it difficult to shell their maize. Lastly, 4.6 per cent were not sure, while 0.7 per cent did not respond to the question.

Additionally, the study went ahead to understand the type of shelling methods used and the results are represented in the figure below.

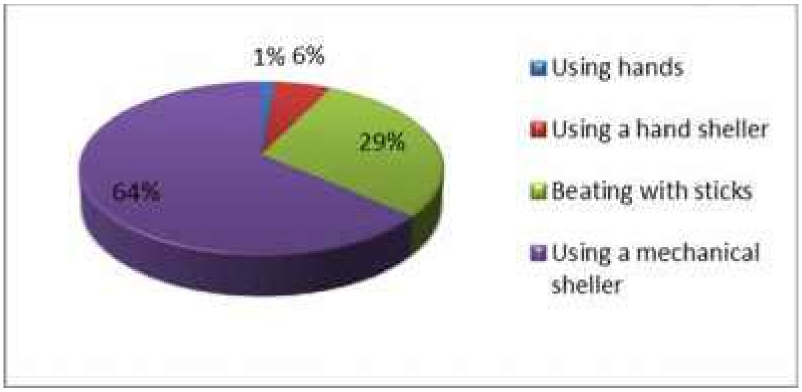

Figure 4.8: Maize shelling methods used by the respondents. ***Source: Field data, 2016***

The majority of the respondents (64 per cent) were using a mechanical sheller to shell their maize, but most of them said that it was expensive to hire a sheller and it caused grain breakage. Twenty nine per cent beat the maize combs with sticks to remove the grains. Six per cent used a mechanical sheller, while one per cent of the respondents used hands to shell their maize.

These results are complemented with by the key informant stating:

> "Farmers find it very hard to shell their maize for example farmers from Masindi district use a mechanical sheller but the cost of hiring this sheller is a bit expensive where they charge sh3,000 per to shell 100 kg and sometimes causing breaking of the maize grain. Therefore, it's important to provide a quality and cheap sheller at sub-county level".

Another key informant said:

> "Farmers in this region (region) lack quality shellers to use while shelling their maize. The shellers cause a lot of grain breakage leading to a high post-harvest loss. Therefore, there is a need for the government and other development partners to provide quality shellers that farmers can hire at a low cost".

These results show that shelling is also a major challenge to farmers. Although, they use a mechanized sheller, the cost of hiring a sheller is still high and sometimes causes grain breakage. Therefore, there is still a need to provide shellers to farmers or they can also hire them at a relatively low cost.

4.4.1.4 Storage

Storage practices greatly affect the maize quality, cause high post-harvest loss through pest damage and greatly affect the price. On that note, a question was posed to the respondents to find out whether they had found it difficult to store their maize and the results are summarized as below.

Table 4.9: Descriptive statistics for storage

SN	Item	SDA	DA	NS	A	SA	Non response	Mean	SD
1	The respondents had found it difficult to store their maize	4 (2.6%)	49 (32.5%)	3 (2.0%)	74 (49.0%)	20 (13.2%)	1 (0.7%)	3.42	1.24

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree. SD=Standard Deviation

According to Table 4.9 above, the greatest numbers of respondents were not sure that they had found it difficult to store maize with a mean of 3.42 whereas the standard deviation did not divert much from the mean. More so, 74 per cent of the respondents agreed that they had found it difficult to store their maize, while 32.5 per cent disagreed. Additionally, 13.2 per cent and 2.6 per cent respectively strongly agreed and strongly disagreed to the idea that they had found it difficult to store their maize. Lastly, 2 per cent were not sure while 0.7 per cent did not respond to the question.

One key informant said:

> "Most farmers under MASGGA do not have the stores. When their maize is shelled, it's immediately taken to the warehouse for further cleaning, drying and storage. The biggest challenge is that farmers lack money to use while storing their maize. The major problem with warehouse operators is lack of genuine fumigants where by most of them are fake causing the storage pests to develop resistance to them".

Another key informant said:

> "Most farmers in Kiryandongo district have their small stores called granaries but with little space to accommodate all the harvested maize. With a provision of village collection centre with a good store where farmers can store their maize as they are waiting for the prices to go up and sell is important. Farmers also need to be trained more in storage pest management".

The results show that farmers in different districts have different practices when it comes to storage. Farmers from Masindi have fewer problems to store maize because most store their maize immediately after harvest at MASGGA while farmers from Kiryandongo have stores. Therefore, improving storage capacity will be more effective to farmers in Kiryandongo district.

More questions were asked to respondents to understand the storage practices of farmers in Mid-west Uganda and the results to these questions were summarised in the figures below.

The type of storage bags used

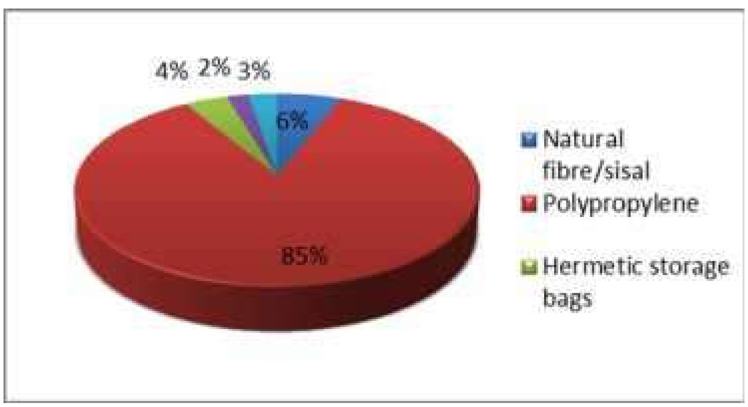

Figure 4.9: Type of storage bags used by the respondents. ***Source: Field data, 2016***

From the figure above, 85 per cent of the respondents use polypropylene as their storage bags. Six per cent of the respondents use natural fibres, while 4 per cent use hermetic storage bags. Three per cent did not respond to the question, whereas two per cent store the maize on the floor.

The study discovered that 77 per cent do not have their own store, which means that most of them take their produce directly to the warehouses immediately after shelling. Additionally, 74 per cent of the respondents have their own stores, whereby 82 per cent have a granary as their store, followed by 13.5 per cent who have hermetic stores as their storage facilities, while 6.7 per cent have cemented stores.

On a list of farmers that store maize under a warehouse receipt systems, onr key informant said"

> "Out of 289 registered members in MASGGA, on average 75 members store their maize in this warehouse because by the time farmers harvest their they are need of money so the they sell immediately at a low price but later the price increase hence farmers remaining poverty".

4.4.1.5 The relation between Availability of Post-harvest handling technologies and Maize Farmers' Income

The study sought to establish if there was a correlation between Availability of Post-harvest handling technologies and Maize Farmers' Income. This study was guided by the hypothesis which stated the; there is a significant positive relationship between availability of Post-harvest handling technologies and Maize Farmers' Income in Mid-west Uganda.

The researcher applied Spearman's Correlation and the results were as in the following table to test this hypothesis.

Table 4.10: Correlation results for availability of post-harvest technologies and maize farmers' income

			APHTCOMB	FICOM
Spearman's rho	APHTCOMB	Correlation Coefficient	1.000	.013
		Sig. (1-tailed)	.	.436
		N	151	151

Source: Field data 2016. Key: *APHTCOMB= Computed variable (Availability of PHHT) and; FICOM = Computed variable (Farmers' Income).*

The results from the table above indicated a weak positive relationship between availability of

Post-harvest handling technologies and Maize farmers' income (rho=0.013) which was not statistically significant (sig=0.436) based on a set of data from 151 respondents (N). This implies that an increase in the availability of Post-harvest handling technologies can relatively increase maize farmers' income, although the increase is not significant. Therefore, the hypothesis is accepted that there is a weak positive relationship between availability of Post-harvest handling technologies and maize farmers' income which is not significant.

These results are supplemented by the key informant who said:

> "Post-harvest technologies may be available but if farmers are not trained they cannot know them and be able to utilize them. Most farmers in this region, lack enough money to adopt these technologies."

4.4.2 Training in post-harvest handling technologies and maize farmers' income

The second objective was to establish the role of training in post-harvest handling technologies on maize farmers' income in Mid-west Uganda.

In order to increase the reliability and validity of data, a question was asked to the respondents to find out whether they have ever attended any training on post-harvest handling technologies and the results are represented in the table below.

Table 4.11: Attended the training on post-harvest handling technologies

SN		SDA	DA	NS	A	SA	Mean	SD
1	The respondents had ever received post-harvest handling training in the past five years	4 (2.6%)	0 (0.0%)	5 (3.3%)	120 (79.5%)	22 (14.6%)	4.03	0.65

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree. SD=Standard Deviation

According to the table above, it proved that most of the respondents interviewed had received training about post-harvest handling technologies, hence making a mean of 4.03 whereby likert scale shows agreement with the idea or the question asked. Additionally, the standard deviation was close to the mean. Furthermore, 79.5 per cent of respondents agreed that they had ever received post-harvest handling training in the past five years, while 14.6 per cent strongly agreed. 3.3 per cent and 2.6 per cent respectively were not sure and strongly disagreed that they have ever received training.

The study went ahead to find out organizations that provided post-harvest handling technologies and these include:

i. Masindi District Farmers' Association(MADFA),
ii. Masindi Seed and Grain Growers' Association (MASGGA),
iii. NCBA CLUSA
iv. Nyamuhasa ACE
v. Seed companies (Equator Seed, Simlow Seed)

The study conceptualized that training in post-harvest handling technologies had three factors including: planning, implementation and evaluation, and the results are represented below.

4.4.2.1 Planning

The study aimed to know how planning of the trainings was done and three questions were asked whose results are as in the table below.

Table 4.12: Descriptive statistics for planning of training in PHHT

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	There was consultation to find out the actual needs of the respondents before conducting a training	16 (10.6%)	79 (52.3%)	37 (24.5%)	18 (11.9%)	1 (0.7%)	0 (0.0%)	2.40	0.86
2	There was a planning meeting to discuss how the training should be conducted	15 (9.9%)	77 (51.0%)	41 (27.2%)	17 (11.3%)	0 (0.0%)	1 (0.7%)	2.44	0.98

3	The respondents and the training organizations agreed on the appropriate period to conduct the training	31 (20.5%)	73 (48.3%)	36 (23.8%)	10 (6.6%)	1 (0.7%)	0 (0.0%)	2.19	0.86

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR=Non response, SD=Standard Deviation

The results of table 4.12 show that the respondents disagreed to the idea that there was consultation to find out the actual needs of the respondents before conducting training, with a mean of 2.40. Furthermore, respondents disagreed that there was a planning meeting to discuss how the training should be conducted, with a mean of 2.44; while they also disagreed that they had agreed on the appropriate period to conduct the training, with a mean of 2.19 and their standard deviation was close to these means.

More so, 52.3 per cent disagreed to the idea that there was consultation to find out the actual needs of the respondents before conducting training, while 24.5 per cent of the respondents were not sure. Although, 11.9 per cent of the respondents agreed that there was consultation to find out the actual needs of the respondents before conducting training, 10.6 per cent strongly disagreed and, lastly, 0.7 per cent strongly agreed.

Furthermore, the majority (51 per cent) of the respondents disagreed that there was a planning meeting to discuss how the training should be conducted, while 27.2 per cent were not sure. 11.3 per cent and 9.9 per cent of the respondents agreed and strongly disagreed respectively to the statement that there was a planning meeting to discuss how the training should be conducted. Finally, 0.7 per cent did not respond to the statement.

Additionally, the greatest number (48.3 per cent) of the respondents disagreed that they had agreed with the training organizations on the appropriate time to conduct the training, whereas

23.8 per cent were not sure. In addition, 20.5 per cent strongly disagreed to the idea, however, 6.6 per cent agreed while 0.7 per cent strongly agreed.

In an interview with an In-charge, he said:

> "Most of these are donor funded programs where by in most case they do not involve farmers during the planning stage. However, it is important to involve farmers during this stage so that they own the program that eases the implementation stage".

The results above show that farmers are not involved during the planning stage. But involving farmers during this stage is important because the training is directed towards their needs and they will own the training right from the planning stage.

4.4.2.2 Implementation

The study sought to understand how implementation of the trainings was done and three statements were made whose results are as in the table below.

Table 4.13: Descriptive statistics for Implementation of training in PHHT

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	The farmers that were invited for the training attended	4 (2.6%)	9 (6.0%)	71 (47%)	62 (41.1%)	4 (2.6%)	1 (0.7%)	3.39	0.88
2	The venue where the training occurred was appropriate	7 (4.6%)	23 (15.2%)	23 (15.2%)	90 (59.6%)	8 (5.3%)	0 (0.0%)	3.46	0.97
3	The respondents benefited from the training on post-harvest handling technologies	5 (3.3%)	14 (9.3%)	29 (19.2%)	91 (60.3%)	12 (7.9%)	0 (0.0%)	3.60	0.89

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR=Non response, SD=Standard Deviation

The greatest number of respondents were not sure, with a mean of 3.39, that the farmers invited for the training attended. Additionally, the greatest number of respondents were not sure, with a mean of 3.46, about idea that the venue where the training occurred was appropriate. Nevertheless, the majority of the respondents agreed that they benefited from the training on post-harvest handling technologies, with a mean of 3.6 which is close to 4 on the likert scale, meaning agreement. The standard deviation did not divert much from the mean.

More so, 47 per cent of respondents were not sure that the farmers that were invited for the training attended, whereas 41.1 per cent agreed to the idea. Six per cent said the farmers that were invited for the training did not attend, while 2.6 per cent strongly disagreed and also 2.6 per cent strongly agreed and finally, 0.7 per cent did not respond to the question.

Additionally, 59.6 per cent agreed to the idea that the venue where the training occurred was appropriate, while 15.2 per cent said that the venue where the training occurred was not appropriate and also 15.2 per cent were not sure that the venue where the training occurred was appropriate. Lastly, 5.3 per cent and 4.6 per cent strongly agreed and strongly disagreed to the idea respectively.

Furthermore, the majority of respondents (60.3 per cent) noted that they benefited from the training on post-harvest handling technologies, whereas 19.2 per cent were not sure; 9.3 disagreed to the idea, 7.9 per cent strongly agreed and, finally, 3.3 per cent strongly disagreed to the idea.

The study went ahead to find out the methods used during these trainings and these included demonstration, lectures and case studies. The topics covered most during these training included: harvesting and drying, grain storage systems, quality standards and grading, pest control management and agronomy.

Some related training manuals reviewed showed that:

> "Farmers are clearly showed some pictorial evidence on how to practice these post-harvest technologies on charts and some of these materials attached in appendices".

Furthermore, a key informant mentioned:

> "Most of these trainings are theoretical therefore; they should include more practical sessions with hands on the activities. Trainers should use projectors during these trainings. These trainings should be conducted nearer to farmers at least at sub-county level and increase the training time. These training should be conducted in different local languages that farmers can understand and provide more training materials like charts in local languages. Sometimes these trainings are few where more farmers in the region need these technologies, therefore; the government should invest more in training in post-harvest handling technologies so as to reduce on post-harvest loss".

The results prove that farmers prefer trainings that are near to them. If farmers are involved in the planning stage, they will definitely attend. The trainings should be conducted in the local language and provision of training material in local languages is important. More time should be allocated to these trainings and increasing on practical sessions is also important.

4.4.2.3 Evaluation

The study wanted to understand how evaluation of the trainings was done and three questions were asked whose results are as in the table below.

Table 4.14: Descriptive statistics for Evaluation of training in PHHT

SN	Item	SDA	DA	NS	A	SA	Mean	SD
1	At the end of the training, there was a discussion to evaluate and give feedback of the training had been conducted	9 (6.0%)	75 (49.7%)	44 (29.1%)	17 (11.3%)	6 (4.0%)	2.58	0.91
2	After the training, there was a team that visited the respondents to find out how they are using the technologies learnt	8 (5.3%)	53 (38.4%)	10 (6.6%)	68 (45.0%)	7 (4.6%)	3.05	1.11
3	After the training, , many farmers that were taught in the respondents' adopted the technologies that had been exposed to	9 (6.0%)	7 (4.6%)	89 (58.9%)	38 (25.2%)	8 (5.3%)	3.19	0.85

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR=Non response, SD=Standard Deviation

The results in the table above revealed that the majority of the respondents were not sure, with a mean of 2.58, about the idea that there was a discussion to evaluate and give feedback of the training had been conducted. More so, the biggest percentage of the respondents were also not sure, with a mean of 3.05, that there was a team that visited them to find out how they are using the taught technologies and, lastly, also the majority of the respondents were not sure about the idea that many farmers that were taught in my area adopted the technologies that they had been exposed to. The standard deviation of these questions was not divergent to the mean.

More so, 49.7 per cent of respondents noted that there was no discussion to evaluate and give feedback of the training conducted, while 29.1 per cent of the respondents were not sure, 11.3 per cent agreed to the idea, 6 per cent strongly disagreed and 4 per cent strongly agreed to the idea.

Additionally, 45 per cent of the respondents agreed that there was a team that visited them to find out how they were using the taught technologies while 38.4 per cent did not agree to this idea, 6.6 per cent were not sure, 5.3 per cent strongly disagreed and 4.6 per cent strongly agreed.

More so, 58.9 per cent of the respondents were not sure that many farmers that were taught in their area adopted the technologies that they had been exposed to, whereas 25.2 per cent agreed to the idea, 6 per cent strongly disagreed, 5.3 strongly agreed and 4.6 per cent revealed that many farmers did not adopt the technologies that they had been exposed to.

The findings are complemented by a response from a key informant who said:

> "Visiting farmers is important to help a farmer to use the technologies they were taught but this is an additional cost where by these trainings are funded with no budget to follow up the farmers. Very few programs have a budget for it. Sometimes when we are collecting maize from the farmers, we advise them on the

best post-harvest practices to use. More trainings and follow up visits are important in reducing post-harvest loss".

The results prove that monitoring and evaluation after the training is very important. Therefore, after the trainings, there should be an evaluation to determine the training performance. The monitoring should continue with follow-ups visits to ensure that farmers are putting into practice what they learnt and they are being assisted to adopt the technologies taught.

4.4.2.4 The relation between Training in Post-harvest handling technologies and Maize Farmers' Income

The study sought to know if there was a correlation between training in post-harvest handling technologies and Maize Farmers' Income. This study was guided by the hypothesis which stated that: there is a significant positive relationship between training in post-harvest handling technologies and Maize Farmers' Income in Mid-west Uganda.

The researcher applied Spearman's Correlation and the results were as in the following table to test this hypothesis.

Table 4.15: Correlation results for training in post-harvest handling technologies and maize farmers' income

			TPHTCOM	FICOM
Spearman's rho	TPHTCOM	Correlation Coefficient	1.000	.349(**)
		Sig. (1-tailed)	.	.000
		N	151	151

** Correlation is significant at the 0.01 level (1-tailed).

Source: Field data 2016. Key: *TPHTCOM= Computed variable (Training in PHHT) and; FICOM = Computed variable (Farmers' Income).*

The findings from the table above indicated a moderate positive relationship between training in post-harvest handling technologies and Maize farmers' income (rho=0.349) and was statistically significant (sig=0.000) based on a set of data from 151 respondents. This implies that an increase in training in post-harvest handling technologies leads to a significant increase of maize farmers' income. Therefore, the hypothesis is accepted that there is a significant moderate positive relationship between training in post-harvest handling technologies and maize farmers' income. This proves that training in post-harvesting is very important in reducing post-harvest losses.

4.4.3 Adoption of post-harvest handling technologies and maize farmer's income

The third objective was to determine the effect of adoption of post-harvest handling technologies on maize farmers' income in Masindi and Kiryandongo districts. Different questions were asked and the results are represented as below.

The study sought to find out the factor that most limits the respondents' ability to adopt these technologies.

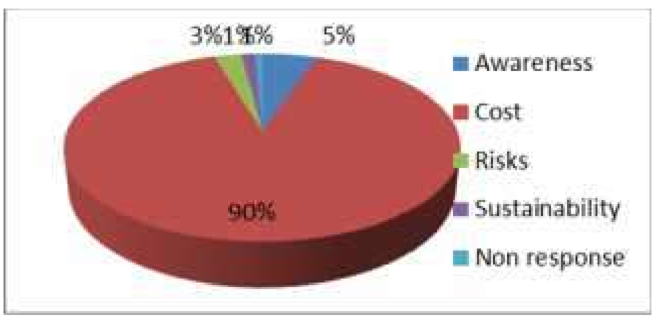

Figure 4.10: factor that most limits the respondents' ability to adopt PHHT. ***Source: Field data, 2016***

The majority of the respondents (90 per cent) pointed out that the factor that most limits their adoption is cost, while 5 per cent of the respondents revealed that awareness is the factor limiting them to adopt post-harvest handling technologies. Three per cent of the respondents said that the risks involved were what was limiting them to adopt these technologies, but one per cent said that the most limiting factor was sustainability.

The study went ahead to find out whether the respondents adopted the technologies because they saw an opportunity of improving their quantity, quality, price and income, and the results are represented in table below.

Table 4.16: Descriptive statistics for overall adoption of post-harvest handling technologies

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	The respondents adopted the technologies because they saw an opportunity of improving their quantity, quality, price and income	5 (3.3%)	6 (4.0%)	17 (11.3%)	95 (62.9%)	27 (17.9%)	1 (0.7%)	3.92	0.96

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

The biggest number of respondents agreed to the idea that they adopted the technologies because they saw an opportunity of improving their quantity, quality, price and income with a mean of 3.92, which is close to four on the likert scale; and the standard deviation was close to the mean.

The majority of respondents (62.9 per cent) agreed to the idea that they adopted the technologies because they saw an opportunity of improving his quantity, quality, price and income while 17.9 per cent strongly agreed,, 11.3 per cent were not sure, while 4 per cent and 3.3 per cent, disagreed and strongly disagreed respectively that they adopted the technologies because they saw an opportunity of improving their quantity, quality, price and income.

4.4.3.1 Awareness

The study sought to find out whether the respondents and their fellow farmers knew about these post-harvest handling technologies, questions were asked and the results were summarized in the table below.

Table 4.17: Descriptive statistics for awareness

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	There was enough information on how to use these technologies	5 (3.3%)	38 (25.2%)	63 (41.7%)	41 (27.2%)	4 (2.6%)	0 (0.0%)	3.01	0.88
2	Most of farmers in respondents' village knew the post-harvest handling technologies	9 (6.0%)	37 (24.5%)	64 (42.4%)	36 (23.8%)	3 (2.0%)	2 (1.3%)	2.99	1.13

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

The greatest number of respondents was not sure whether there was enough information on how to use these technologies and most of farmers in respondents' village knew the post-harvest handling technologies, with a mean of 3.01 and 2.99 respectively and their standard deviation was close to their mean.

Additionally, 41.7 per cent of respondents were not sure of the idea that there was enough information on how to use these technologies in the respondents' region, while 27.2 per cent were in agreement with the idea. 25.2 per cent revealed that there was not enough information on how to use these technologies, whereas 3.3 per cent strongly disagreed to the idea and, finally, 2.6 per cent strongly agreed to the idea.

Nevertheless, 42.4 per cent of the respondents were not sure about the idea that most of farmers in their village knew the post-harvest handling technologies, while 24.5 percent were in disagreement with the idea. 23.8 per cent of the respondents were in agreement with the idea, 6 per cent strongly disagreed to the idea, whereas 2 per cent of respondents strongly agreed and 1.3 per cent did not respond to the question.

According to the interview carried out, a key informant highlighted as follows:

> "Awareness is not the main reason why farmers are not adopting the post-harvest handling technologies although; it can also contribute to adoption of these technologies. Most of farmers know about the importance of using post-harvest handling technologies but their major challenge is the cost involved".

The results prove that if farmers are not aware of the importance and benefits of practicing proper post-harvest handling technologies, they cannot adopt the technologies. Therefore, without increasing the awareness about the benefits of practicing proper post-harvest technologies, they will not be able to adopt the available post-harvest technologies.

4.4.3.2 Cost

The study wanted to know whether the respondents and their fellow farmers found these post-harvest handling technologies financially affordable. Questions were asked and the results were as in the table below.

Table 4.18: Descriptive statistics for cost

SN	Item	SDA	DA	NS	A	SA	Mean	SD
1	The respondents found these technologies financially affordable	49 (32.5%)	91 (60.3%)	8 (5.3%)	3 (2.0%)	0 (0.0%)	1.77	0.64
2	The cost of using post-harvest technologies was less than the money obtained from the sale of maize for the past five years	13 (8.6%)	36 (23.8%)	71 (47.0%)	27 (17.9%)	4 (2.6%)	2.82	0.92

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, SD=Standard Deviation

The greatest numbers of respondents revealed that post-harvest handling technologies were not financially affordable to them, hence having a mean of responses as 1.77 and on a likert scale it is close to 2 which mean disagreement to the idea proposed. More so, the highest number of respondents pointed out that they were not sure that the cost of using post-harvest technologies was less than the money obtained from the sale of maize for the past five years, with a mean of 2.82 which is close to 3, meaning not sure on the Likert scale and the standard deviations were close to mean.

The majority of the respondents (60.3 per cent) were in disagreement with the idea that post-harvest handling technologies were financially affordable, and 32.5 per cent strongly disagreed. 5.3 per cent were not sure, while 2 per cent agreed that post-harvest handling technologies were financially affordable.

Furthermore, 71 per cent of the respondents were not sure that the cost of using post-harvest technologies was less than the money obtained from the sale of maize for the past five years whereas 23.8 per cent were in disagreement with the idea. 17.9 per cent and 2.6 per cent were in agreement and strong agreement respectively to the idea and lastly, 8.6 per cent of respondents strongly disagreed.

The results above prove that cost is the biggest hindrance for farmers to adopt the post-harvest technologies; therefore, there is a need to develop low-cost technologies that are financially affordable to farmers. The results show that farmers were not sure that the cost of using post-harvest technologies was less than the money obtained from the sale of maize for the past five years, therefore, encouraging farmers to store maize and sell when the price was high could help farmers to benefit from producing maize.

4.4.3.3 Risk

The study went ahead to find out whether the respondents and their fellow farmers had ever discussed about the risks, ways of controlling them and the mitigation measures. Questions were asked and the results were as in the table below.

Table 4.19: Descriptive statistics for risk

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	The respondents had ever discussed about the risks involved in using these technologies with their fellow farmers	13 (8.6%)	74 (49.0%)	40 (26.5%)	22 (14.6%)	2 (1.3%)	0 (0.0%)	2.51	0.89
2	The respondents and their fellow farmers had ever discussed ways of mitigating the risks involved in using these post-harvest technologies	10 (6.6%)	83 (55.0%)	42 (27.8%)	13 (8.6%)	3 (2%)	0 (0.0%)	2.44	0.82
3	The respondents and their fellow farmers had implemented the mitigation strategies	15 (9.9%)	90 (59.6%)	36 (23.8%)	7 (4.6%)	2 (1.3%)	1 (0.7%)	2.32	0.93

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

The greatest numbers of respondents were not sure if they had ever discussed about the risks involved in using these technologies with their fellow farmers (mean of 2.51). Additionally, the majority of respondents were in disagreement with idea that they had ever discussed ways of mitigating the risks involved in using these post-harvest technologies, with a mean of 2.44. Also, the greatest numbers of respondents were in disagreement that they had implemented the risks mitigation strategies, with a mean of 2.32. The standard deviation for these means was not divergent to them.

Furthermore, 49 per cent of respondents expressed that they had not discussed about the risks involved in using these technologies with his fellow farmers, while 26.5 per cent were not sure and 8.6 per cent strongly disagreed to the idea. 14.6 per cent and 1.3 per cent of respondents agreed and strongly agreed respectively to the proposed idea.

Furthermore, 55 per cent of respondents were in disagreement with the idea that they had ever discussed ways of mitigating the risks involved in using these post-harvest technologies, while 27.8 per cent were not sure and 6.6 per cent strongly disagreed to the idea. 8.6 per cent and 6.6 per cent of the respondents agreed and strongly agreed respectively to the idea.

Finally, 59.6 per cent of respondents had not implemented the risk mitigation strategies, while 23.8 were not sure and 9.9 per cent strongly disagreed to the idea. 4.6 per cent and 1.3 per cent of the respondents agreed and strongly agreed respectively to the idea, while 0.7 per cent did not respond the question.

The findings are complemented by an interview with a key informant who said:

> "The most factor hindering farmers to adopt post-harvest technologies is the cost involved yet most farmers are poor and cannot afford them. Additionally, provision of information through training is important in increasing post-harvest technologies adoption. Farmers need low interest loans but most banks are not willing to give loans to farmers because farming is a very risky business. Therefore, the government should increase agricultural financing and create an agricultural bank that provides farmers with low internet loans".

The results show that farmers do not know much about risk involved in using a given post-harvest technology but they are more concerned about the cost involved in using a given technology.

4.4.3.4 The relation between Adoption of Post-harvest handling technologies and Maize Farmers' Income

The study sought to find out whether there was a correlation between adoption of post-harvest handling technologies and Maize Farmers' Income. This study was guided by the hypothesis which stated that: there is a significant positive relationship between adoption of post-harvest handling technologies and Maize Farmers' Income in Mid-west Uganda.

The researcher applied Spearman's Correlation and the results were as in the following table to test this hypothesis.

Table 4.20: Correlation results for adoption of post-harvest handling technologies and maize farmers' income

			ADPHTCOM	FICOM
Spearman's rho	ADPHTCOM	Correlation Coefficient	1.000	.349(**)
		Sig. (1-tailed)	.	.000
		N	151	151

** Correlation is significant at the 0.01 level (1-tailed).
Source: Field data 2016. Key: *ADPHTCOM= Computed variable (Adoption of PHHT) and; FICOM = Computed variable (Farmers' Income).*

The findings from the table above indicated a moderate positive relationship between adoption of post-harvest handling technologies and Maize farmers' income (rho=0.349) and was statistically significant (sig=0.000) based on a set of data from 151 respondents. This implies that a rise in adoption post-harvest handling technologies leads to a significant rise in maize farmers' income. Therefore, the hypothesis was accepted that there is a significant moderate positive relationship between adoption of post-harvest handling technologies and maize farmers' income.

4.4.4 Maize farmers' income

The study conceptualized Maize farmers' Income as the Dependent Variable and this had three dimensions namely: quantity of maize, quality of maize and cost. The questions were asked to give an overview on the maize farmers' income status and the results were represented as below.

Table 4.21: Descriptive statistics for overall maize farmers' income

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	The respondent had been able to provide his family with basic needs for past five years from the sale of maize	2 (1.3%)	5 (3.3%)	6 (4.0%)	75 (49.7%)	62 (41.1%)	1 (0.7%)	4.30	0.89

2	The respondent had been able to get some properties from the saving or money obtained from the sale of maize for the past five years	6 (4.0%)	4 (2.6%)	32 (21.2%)	97 (64.2%)	12 (7.9%)	0 (0.0%)	3.70	0.82

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

The greatest numbers of respondents agreed that they had been able to provide their families with basic needs for the past five years from the sale of maize with a mean of 4.3, whereas the majority of respondents had been able to get some properties from the saving or money obtained from the sale of maize for the past five years, with a mean of 3.7. The standard deviations were close to means.

Additionally, 49.7 per cent of respondents agreed that they had been able to provide their families with basic needs for past five years from the sale of maize, while 41.1 per cent strongly agreed, 4 per cent were not sure, 3.3 per cent were in disagreement with the idea, 1.3 per cent strongly disagreed and, lastly, 0.7 per cent did not respond to the question.

The majority of respondents (64.2 per cent) were in agreement that they had been able to get some properties from the saving or money obtained from the sale of maize for the past five years and 21.2 per cent were not sure, 7.9 per cent strongly disagreed. 4 per cent and 2.6 per cent respectively strongly disagreed and disagreed to the idea.

The findings are complemented by an interview with key informant quoted below:

> "Most of the farmers in this region depend on maize farming and most of them have been able to provide the basics materials or needs to their families and some have been able to buy some small properties. This income is greatly affected by the selling price where by two months after harvesting it's around sh550 per kg and later it increases to shs800 per kg. This means that if a farmer can store their maize for a while, they will be able to earn more. The quality of maize is important to determine the price whereas higher the quantity of maize, the higher the income".

According to Masindi and Kiryandongo district local government report documents reviewed

> "The highest proportion of the households grows maize at a rate of 67.2% and 32.45% of the total households in the Kiryandongo and Masindi District respectively. Therefore, improving post-harvest handling is important to increase not only income in this region but also developing the whole region (UBOS, 2011a and UBOS, 2011b) hence lowering post-harvest loss in this region, will have a great impact on maize farmers' income".

The results prove that farmers were able to provide the basic material to their families but fewer farmers have been able to buy some properties from the sale of maize. Therefore, intervention to reduce post-harvest loss and improve the quality will help farmers to increase their income.

4.4.4.1 Quantity of maize

The study sought to understand whether availability of post-harvest handling technologies and their adoption after training had an effect on the quantity of maize produced by respondents as well as whether respondents were satisfied with the quantity of maize sold, and the results are summarized in the table below.

Table 4.22: Descriptive statistics for maize quantity

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	The respondents' maize quantity for home consumption and for sale increased because of easily available these technologies.	3 (2.0%)	32 (21.2%)	57 (37.7%)	50 (33.1%)	8 (5.3%)	1 (0.7%)	3.23	1.01
2	The respondents' maize quantity for home consumption and for sale increased because of easily adopting these technologies after the training	3 (2.0%)	5 (3.3%)	27 (17.9%)	105 (69.5%)	11 (7.3%)	0 (0.0%)	3.77	0.72
3	The respondents were satisfied with the quantity of maize they sold in a season for the past five years	2 (1.3%)	72 (47.7%)	36 (23.8%)	41 (27.2%)	0 (0.0%)	0 (0.0%)	2.77	0.87

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

Most respondents were not sure to the idea that their maize quantity for home consumption and for sale increased because of easily available technologies with a mean of 3.23. Furthermore, the majority of the respondents revealed that they were in agreement with the idea that their maize quantity for home consumption and for sale increased because of easily adopting these technologies after the training, with a mean of 3.77 which is close to 4, meaning agreement on a Likert scale. However, the greatest number of respondents pointed out that they were not sure to the idea that they were satisfied with the quantity of maize they sold in a season for the past five years with a mean of 2.77 and their standard deviation was not divergent to their mean.

Furthermore, 37.7 per cent of respondents were not sure of the idea that their maize quantity for home consumption and for sale increased because of easily available technologies, while 33.1 per cent were in agreement with idea and 5.3 per cent strongly agreed. 21.2 per cent and 2 per cent of respondents disagreed and strongly disagreed respectively with the idea.

The majority of respondents (69.5 per cent) revealed that their maize quantity for home consumption and for sale increased because of easily adopting these technologies after the training, whereas 17.9 per cent were not sure and 2 per cent strongly agreed. 7.3 per cent and 3.3 per cent respectively disagreed and strongly disagreed with the idea.

More so, 47.7 per cent pointed out that they were not satisfied with the quantity of maize they sold in a season for the past five years, while 23.8 per,cent were not sure and 1.3 per cent strongly disagreed with the idea. But, 27.2 percent were in agreement with the idea.

This information was confirmed by interviews conducted where a key informant said:

> “The average maize production in Masindi District is 1,500 kg which is small hence leading to little income generation”.

Another key informant revealed:

> "The average production of maize in Kiryandongo district is 600kg and this little and the only way to increase the farmer's income is through storing the maize up to when the price has increased".

However, the greatest number of were not satisfied with the amount of maize they sell per season. Therefore, improving post-harvest handling technologies will help not only to improve the quality but also increase on the quality, hence increasing the amount of maize sold.

4.4.4.2 Quality of maize

The study wanted to understand whether availability of post-harvest handling technologies and adoption after training have an effect on the quality of maize produced by respondents as well as whether respondents' quality is good or not, and the results are summarized in the table below.

Table 4.23: Descriptive statistics for maize quality

SN	Item	SDA	DA	NS	A	SA	NR	Mean	SD
1	The respondents' maize quality for home consumption and for sale increased because of easily available these technologies.	2 (1.3%)	20 (13.2%)	74 (49.0%)	46 (30.5%)	9 (6.0%)	0 (0.0%)	3.26	0.81
2	The respondents' maize quality for home consumption and for sale increased because of easily adopting these technologies after the training	1 (0.7%)	7 (4.6%)	27 (17.9%)	106 (70.2%)	10 (6.6%)	0 (0.0%)	3.77	0.67
3	The respondents' customers had never complained about the their maize quality sold	29 (19.2%)	105 (69.5%)	7 (4.6%)	10 (6.6%)	0 (0.0%)	0 (0.0%)	1.99	0.71
4	The respondents' customers had never complained about the high moisture content	31 (20.5%)	100 (66.2%)	9 (6.0%)	10 (6.6%)	1 (0.7%)	0 (0.0%)	2.01	0.77
5	There weren't broken maize in the respondent's sales	20 (13.2%)	99 (65.6%)	18 (11.9%)	13 (8.6%)	0 (0.0%)	1 (0.7%)	2.21	0.94

6	There weren't diseased maize in the respondent's sales	12 (7.9%)	90 (59.6%)	36 (23.8%)	12 (7.9%)	0 (0.0%)	1 (0.7%)	2.36	0.91
7	There weren't stones or soil in the respondent's sales	15 (9.9%)	79 (52.3%)	41 (27.2%)	14 (9.3%)	0 (0.0%)	2 (1.3%)	2.45	1.09

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

The majority of the respondents were not sure whether their maize quality for home consumption and for sale increased because of easily available technologies, hence having a mean of 3.26. Additionally, the greatest number of respondents were in agreement with idea that their maize quality for home consumption and for sale increased because of easily adopting these technologies after the training, thus having a mean of 3.77. Furthermore, the highest number of respondents pointed out that their customers had ever complained about their maize quality and had also complained about the high moisture content, hence having a mean of 1.99 and 2.01 respectively. The majority of respondents had broken maize, diseased maize and sand or soil in their maize, thus having a mean of 2.21, 2.36 and 2.45 respectively. The standard deviations were close to these means.

Only 30.5 per cent were in agreement with the idea that their maize quality for home consumption and for sale increased because of easily available technologies, whereas 70.2 per cent were in agreement with the idea that that their maize quality for home consumption and for sale increased because of easily adopting these technologies after the training. More so, 69.5 per cent of the respondents were in disagreement with idea that their customers had never complained about the quality of maize sold, while 66.2 per cent of the respondents disagreed that their customers had ever complained about the high moisture content. The majority of respondents revealed that they had broken maize, diseased maize and sand or soil in their maize with percentages of 65.6, 59.6 and 52.3 respectively.

A key informant was quoted saying:

> "There are mainly two seasons in the year namely from March to July while harvesting in August and from September to December while harvesting in January. The quality of the maize during these two seasons is different whereby for the first season the quality is poor because during the harvesting time there some raining intervals therefore, this is the season where farmers need material like tarplins, ready transport to carry their produce from the gardens to crib as well as ready labour. Most farmers need some assistance in acquiring these materials. As warehouse operators we try to encourage farmers to use all possible methods to improve their quality so that they can get a higher price from their produce".

The results above prove that the maize produced in this region has quality issues. Therefore, improving farmers' capacity in post-harvest handling will definitely enable farmers in this region to improve on the quality of maize produced.

4.4.4.3 Price

The study went ahead understand whether the respondents are satisfied with the price received from their sales and payments were timely as well as knowing whether the total cost involved in the post-harvest handling of maize, and whether the respondents have benefited for the past five years. The results are shown in the table below.

Table 4.24: Descriptive statistics for price

SN	Item	SDA	DA	NS	A	SA	Mean	SD
1	The respondents' were not satisfied with the price received from their sales	2 (1.3%)	12 (7.9%)	9 (6.0%)	72 (47.7%)	56 (37.1%)	4.11	0.93
2	The respondents' payment for the maize sale is not timely	5 (3.3%)	9 (6.0%)	20 (13.2%)	93 (61.6%)	24 (15.9%)	3.81	0.89

3	According to the respondents' total cost involved in the maize post-harvest handling, they had benefited for the past five years	2 (1.3%)	17 (11.3%)	80 (53.0%)	47 (31.1%)	5 (3.3%)	3.24	0.75

Source: Field data, 2016. Key: SDA=Strongly Disagree, DA=Disagree, NS=Not Sure, A=Agree and SA=Strongly Agree, NR= Non Response, SD=Standard Deviation

The greatest numbers of respondents were in agreement with the idea that they were not satisfied with the price received from their sales, with a mean of 4.11. With a mean of 3.81, it means that the majority of the respondents were in agreement with the idea that their payment for the maize sale was not timely, and with a mean of 3.24, most of the respondents were sure that based on the total cost involved in the maize post-harvest handling, they had benefited for the past five years while their standard deviation was close to these means.

The greatest number of the respondents (47.7per cent), were in agreement with the idea that they were not satisfied with the price received from their sales, and 37.1per cent strongly agreed with the idea. 7.9 per cent and 1.3 per cent disagreed and strongly disagreed respectively with the idea, whereas 6 per cent were not sure.

The majority of the respondents (61.6 per cent) revealed that their payment for maize sale was not timely, while 15.9 per cent strongly agreed with the idea proposed and 13.2 per cent were not sure. Six per cent and 5.3 per cent disagreed and strongly disagreed respectively with the idea.

Lastly, 80 per cent of the respondents were not sure that based on the total cost involved in the maize post-harvest handling, they had benefited for the past five years, while 31.1 per cent were in agreement with the idea as well as 3.3 per cent strongly agreed with the idea. 11.3 per cent and 1.3 per cent disagreed and strongly disagreed respectively with the idea.

The findings are complemented by an interview with a key informant and said:

> "According to the total cost invested in production of maize per acre is approximately sh600, 000 while if the farmer sell immediately after harvest, he or she will get approximately sh500, 000 per acre hence making a loss. Some farmers are forced to sell their maize immediately after harvesting because they don't have appropriate stores and have immediate needs so they cannot wait up when the price increase hence this greatly affects their income".

The results show that if there are no interventions done to help farmers to practice proper post-harvest technologies, they will not benefit from maize farming. Therefore, there is need to encourage farmers to harvest, dry, shell, store their maize, wait till when the price is high and sell so that they can get a higher price.

4.4.5 Regression analysis

Regression analysis has been defined by Kothari (2004) as a technique that consists of determining the statistical relationship between two or more variables (p.143). Regression analysis aids in predicting the value of the dependent variable, using one or more independent variables. This analysis assisted the researcher to know which independent variable contributes most to the dependent variable and the results are summarised in the table below.

Table 4.25: Regression analysis results

a) Variables Entered/Removed (b)

Model	Variables Entered	Variables Removed	Method
1	ADPHTCOM, APHTCOMB, TPHTCOM(a)	.	Enter

a All requested variables entered.
b Dependent Variable: FICOM

b)Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.546(a)	.298	.284	5.168

a Predictors: (Constant), ADPHTCOM, APHTCOMB, TPHTCOM

c) ANOVA(b)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1670.484	3	556.828	20.847	.000(a)
	Residual	3926.350	147	26.710		
	Total	5596.834	150			

a Predictors: (Constant), ADPHTCOM, APHTCOMB, TPHTCOM
b Dependent Variable: FICOM

d) Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	30.229	3.689		8.193	.000
	APHTCOMB	-.123	.150	-.057	-.821	.413
	TPHTCOM	.506	.089	.466	5.694	.000
	ADPHTCOM	.167	.109	.125	1.530	.128

a Dependent Variable: FICOM

Source: Field data, 2016. Key: APHTCOMB = Computed variable (Availability of PHHT); TPHTCOM= computed variable (Training in PHHT); ADPHT= Computed variable (Adoption of PHHT), and; FICOM= Computed variable (Maize farmers' Income).

a) The "Variables Entered" column in Part (a) shows that the regression model considered the computed variables for availability of post-harvest technology handling (APHTCOMB), training of post-harvest technologies (TPHTCOM) and adoption of post-harvest handling technologies (ADPHTCOM) as the predictor variables and Maize farmers' income (FICOM) as the Dependent variable. Under the variables removed, nothing or zero is indicated implying and confirming that all variables in the model have been used in the regression calculation procedure. The result "Enter" under the Method column showed that each independent/predictor variable was entered in the normal way.

b) Part (b) of a regression analysis table, indicates a correlation coefficient (R= 0.546) which suggested a strong positive correlation between post-harvest handling technologies and maize farmers' income. Furthermore, part (b) shows the R Square of 0.298 implied that the Independent Variable (PHHT) in this model and under the conditions of this study accounted for 29.8 per cent of the variation in the Dependent Variable (Maize farmer's income). Additionally, part (b) shows the Adjusted R Square of 0.284. The adjusted R Square is an adjustment of the R square that penalizes the addition of unnecessary predictors to the model. Therefore, this meant that the Independent Variable (PHHT) in this model and under the conditions of this study accounted for 28.4 per cent of the variation in the Dependent Variable (Maize farmers' income).

c) In the ANOVA table (part c), the significance level of 0.000 disclosed that the model used was significantly able to predict the dependent variable (since it was less than 0.05) and confirmed that Independent and Dependent variables had a correlation which was in agreement with prior correlation results. The significance level of 0.000 suggested a linear relationship between PHHT and Maize farmer's Income in Mid-west Uganda. This implicated that, overall, the model used was a good fit for the data used in the study on PHHT and Maize farmer's Income in Mid-west Uganda. More so, the ANOVA table (part c) showed a value of F at 20.847 suggested the margin of error of the model. Hence, this implied that there was 79.153 per cent chance that the relationship between PHHT and Maize farmer's Income is not due to chance.

d) In the coefficient table, part (d), the Unstandardized B coefficients showed a negative influence of availability of PHHT (APHTCOMB) on Maize farmers' income after having a coefficient of -0.123 at a significance level of 0.413 and a significant t value of -0.821

which was below the acceptable lowest t value of 2. Additionally, there was a positive influence of training of PHHT (TPHTCOM) on maize farmers' income having had a coefficient of 0.506 at a significance level of 0.000 a significant t value of 5.694 which was above the lowest t value of 2 and, lastly, there was a positive influence of adoption of PHHT (ADPHTCOM) on maize farmers' income having had a coefficient of 0.167 at a significance level of 0.128 and an insignificant t value of 1.530 which was below the acceptable minimum of 2. This meant that training and adoption of PHHT positively influenced maize farmers' income whereas, training of PHHT influences significantly maize farmer's income. More so, availability of PHHT influences negatively maize farmer's income and the influence is not statistically significant.

The above Unstandardized B coefficients (part d) implied that for every unit increase in availability of PHHT (APHTCOMB), a decrease of 0.12 is expected in maize farmers' income; for every unit increase in training of PHHT (TPHTCOM), an increase of 0.51 is assumed in maize farmers' income; and for every unit increase in adoption of PHHT (ADPHTCOM), an increase of 0.16 is believed to result into maize farmers' income, assuming that all the other conditions of the study remain constant.

The results in the Coefficients table (part d) show the actual contribution of each dimensions of the Independent Variable (PHHT) to the Dependent variable (Maize farmers' income). These results revealed that training in PHHT (TPHTCOM) was the most significant contributor to maize farmer's income under consideration (Sig =0.000 and an Unstandardized B Coefficient of 0.506) followed by adoption of PHHT (ADPHTCOM) (Sig =0.128 and an Unstandardized B Coefficient of 0.167) but was not significant and finally, availability of PHHT was not significant (Sig = 0.413 which is more than 0.05 together with a negative Unstandardized B coefficient = -0.123). This meant training of PHHT is the most important dimension to increase maize farmers' income in Mid-west Uganda, given the same conditions and context of the study.

CHAPTER FIVE
SUMMARY, DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study aimed at determining how post-harvest handling technologies (PHHT) affect Maize farmers' income in Mid-west Uganda (Masindi and Kiryandongo districts). This chapter presents the discussion of findings in chapter four and in the context of the study. It presents discussion, conclusions and recommendations for improving post-harvest handling technologies (PHHT) so as to realize Maize farmers' income in Mid-west Uganda (Masindi and Kiryandongo districts).

5.2 Summary of findings

The study found out that there is positive correlation between post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda (Masindi and Kiryandongo districts). Nevertheless, the dimensions of post-harvest handling technologies (PHHT) had different correlations with maize farmers' income. For the first objective, there was a weak positive and not statistically significant correlation between availability of PHHT and maize farmers' income. For the second objective, there was a moderate positive that was statistically significant correlation between training of PHHT and maize farmers' income, and lastly, for the third objective, there was a moderate positive and statistically significant correlation between adoption of PHHT and maize farmers' income.

5.2.1 Availability of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

The study recognized a weak positive correlation between availability of PHHT and Maize farmers' Income (rho=0.013) and this was not statistically significant (sig =0.436). This meant that every unit increase in availability of PHHT would lead to a smaller increase in maize farmers' income but this increase is not significant.

5.2.2 Training in post-harvest handling technologies (PHHT) and Maize farmers' income in the mid-west Uganda

The study recognized a moderate positive relationship between training in PHHT and maize farmers' income (rho=0.349) that was statistically significant (Sig = 0.000). This meant that a unit improvement in the conditions for training in PHHT would result into a bigger unit increase in Maize farmers' income in Mid-west Uganda, specifically in Masindi and Kiryandongo districts and the increase will be significant.

5.2.3 Adoption of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

The study recognized a moderate positive relationship between the adoption of PHHT and maize farmers' income (rho=0.349) that was statistically significant (Sig = 0.000). This meant that a unit improvement in the conditions for adoption of PHHT would result into more unit increase in Maize farmers' income in Mid-west Uganda, specifically in Masindi and Kiryandongo districts and the increase will be significant.

5.3 Discussion of Findings

Following is the discussion of the study findings:

5.3.1 Availability of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

The study findings showed that there is a weak positive relationship between availability of Post-harvest handling technologies and maize farmers' income which is not statistically significant.

This means that despite the availability of these technologies, if there is no awareness through trainings, farmers cannot adopt them and will thus have less effect on their income. However, the results show that there is positive relationship between availability of post-harvest technologies and maize farmers' income.

These results are in line with Semple *et al* (1992) who discovered that a farmer without an appropriate grain storage technology is forced to sell maize when prices are low to avoid post-harvest losses from storage pests and pathogens, thus impacting greatly on their income. However, improvements to storage, drying, and transportation can prevent damage and loss (Lama, *et al*, 2014). Additionally, the results were in line with Costa (2014:15) who discovered that smallholder a farmer harvesting maize in Uganda in December 2013 would normally attempt to sell the bulk of his crop within a few weeks of harvest to minimise the expected losses. This farmer selling maize in the early weeks of January 2014 would have received somewhere in the range of UGX 480 and UGX 520 per kg. By utilizing the new storage technology and taking his crop to market three months later (April 2014) he received somewhere in the range of UGX 760 and UGX 820. This represented a potential of 64 per cent gain in household income for this family.

Asea *et al* (2014:1) revealed that post-harvest handling processes of harvesting, drying, shelling, treatment and storage are very important in terms of minimizing losses not only in quality but also in quantity whereby the higher the quality and quantity, the higher income that will be generated. However, without telling the farmers the importance of these post-harvest handling technologies, maize farmers' adoption will be low, hence impacting on their income. Florkowski and Xi-Ling (1990) emphasized that storage is one of post-harvest handling technology that offer an opportunity to improve farm incomes by storing crops and selling at premium prices when demand outstrips supply later in the post-harvest period hence this proved that post-harvest technologies have a great effects on farmers' income. Therefore, even if these technologies are available to the farmer, without adopting or utilizing them, they have less effect on their income.

5.3.2 Training in post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

The study established that there is a significant moderate positive relationship between training in post-harvest handling technologies and maize farmers' income that is statistically significant. This means that training in post-harvest technologies is very important in increasing maize farmers' income. Unfortunately, Costa (2014:3) pointed out that about 95 per cent of all research investments over the past 30 years have focused on increasing productivity and only five per cent directed towards reducing losses following harvest, which calls for the government and all development partners to intensify the trainings in post-harvest handling technologies so as to save post-harvest loss of 20 million metric tonnes of grain in Uganda, valued at over $4b annually (Dunford, 2015:1).

These results confirmed that improving post-harvest handling capacity of smallholder farmers not only has the potential to increase food volumes for consumption and trade, but also household incomes (Costa, 2015:3). Additionally, the results were similar with finding by Bokusheva *et al* (2012: 1) in Central America which revealed that completion of training course about post-harvest handling technologies as one of the main determinants of achieving household self-sufficiency in maize. Improving post-harvest handling capacity of smallholder farmers through training them not only has the potential to increase crop preservation and food volumes for consumption and trade, and household incomes (Costa, 2015).

A regression analysis coefficient results also showed that training in post-harvest handling technologies (TPHTCOM) is the most significant contributor to maize farmers' income (Sig =0.000 and an Unstandardized B Coefficient of 0.506). This is because as farmers attend these trainings, there are high chances that they will utilize the technologies and thus improve their maize quality and quantity as well as reduce post-harvest loss, and hence increase their income.

5.3.3 Adoption of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

The study established that there is a significant moderate positive relationship between adoption post-harvest handling technologies and maize farmers' income that is statistically significant. This means that adoption of post-harvest technologies affects greatly farmers' income.

According to Browning, Halcli, and Webster (2000: 1) under the rational theory, people calculate the likely costs and benefits of any action before deciding what to do like using a given post-harvest technology. This study revealed that the major hindrance for farmers not to adopt these post-harvest handling technologies is the costs involved, thus this was in agreement with this theory whereby farmers first calculate the cost benefit analysis before adopting the taught technologies.

Furthermore, the study findings were in agreement with a survey conducted by world food programme proved that 97.9 per cent of surveyed farmers achieved a financial gain by utilizing new storage technologies. Farmers are able to increase their incomes as they are able to sell higher-quality grain. Therefore, training and adopting the trained technologies will increase farmer's income (Costa, 2015:3). The results of this study were in agreement with Kaaya *et al* (2010:967) who revealed that there are three types of drying; sun drying, solar drying and mechanical or electrical drying in Uganda and the choice for a famer to use a given method of drying depend on the cost and maize quantities. These results proved that lack of assets or enough resources limited technology adoption (Meinzen-Dick *et al*, 2004).

Post-harvest food loss in Africa represents a multi-faceted challenge that reduces the income of approximately 470 million farmers (The Rockefeller Foundation, 2014). However, if farmers adopt post-harvest handling technologies, they would lower post- harvest loss and increasing income.

5.4 Conclusions

The study was based on the conceptualization that post-harvest handling technologies (PHHT) affects maize farmers' income. Post-harvest handling technologies (PHHT) had three dimensions including: availability of post-harvest handling technologies (PHHT), training in post-harvest handling technologies (PHHT) and adoption of post-harvest handling technologies (PHHT). Based on the findings, below are the conclusions made.

5.4.1 Availability of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

Based on the finding, it is concluded that there is a weak positive correlation between availability of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda that is not statistically significant. This means that even if there availability of post-harvest handling technology, it has less effect on maize farmers' income.

5.4.2 Training in post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

From the results, it is concluded that there is significant moderate positive correlation between training in post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda. Increasing the training of post-harvest technologies through improving the farmers' capacity will greatly increase maize farmers' income that is statistically significant.

5.4.3 Adoption of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda

Basing on the findings, it is concluded that there is a significant moderate positive correlation between adoption of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda. This means that improving the farmers' capacity in post-harvest handling technologies, will lead to significant adoption of post-harvest handling technologies, hence having a high effect on maize farmers income. It is concluded that training in post-harvest handling technologies will increase adoption of post-harvest handling technologies, hence increasing farmers' income.

According to the results of the regression analysis results, training of post-harvest handling technologies (PHHT) was the greatest significant contributor to Maize farmers' income in Mid-west Uganda followed by adoption of post-harvest handling technologies (PHHT) and lastly availability of post-harvest handling technologies (PHHT).

5.5 Recommendations

Based on the findings of the study, the following recommendations are made:

i. There should be provision to farmers with materials to use or hire at a relatively cheap cost, for instance polyethylene, tarpaulins, tractors with harvesters and trailers, shellers, artificial driers using solar or other electricity, store and village collection centres with all these quality equipment to use.

ii. The trainings should be conducted nearer to the farmers maybe at sub-county level, provision of enough training materials like charts in local languages, use of more local languages during the trainings so that farmers can easily understand, increase on the time allocated for these trainings and more practical sessions during the trainings, involvement of some farmers during the planning stage so that the trainings are directed towards the actual farmers' needs and, lastly, increase the farmers' visits so that as advise them more on how to use these technologies.

iii. Research should focus on developing low-cost options that farmers can use as well as providing low interest loans from banks.

iv. Farmers should form strong cooperatives that can easily access agricultural financing and be able to hire the post-harvest equipment at a low cost.

v. Efforts should be made towards increasing awareness of the importance of post-harvest handling technologies so that post-harvest losses are reduced in Uganda from 20 million metric tonnes of grain, valued at over $4b annually, and increase farmers' income.

5.7 Contributions of the Study

The study on post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda has:

i. Contributed to a clearer understanding of the theory and practice of post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda.

ii. Contributed to improving the relevance, efficiency and effectiveness of policy framework and practices of post-harvest handling practices.
iii. Contributed to more appreciation and understanding the problem of post-harvest loss and the challenges faced while trying to reduce the post-harvest losses and the recommendations.
iv. Enhanced knowledge and the importance of training in post-harvest handling technologies to maize farmers.
v. Contributed to the management practices required to reduce post-harvest losses.

5.7 Limitations of the Study

This study on post-harvest handling technologies (PHHT) and Maize farmers' income in Mid-west Uganda had the following limitations:

The study limited itself to two main concepts of post-harvest handling technologies (PHHT) and Maize farmers' income. Under the two concepts, only availability of PHHT, training in PHHT and adoption of PHHT were the dimensions of PHHT, whereas quantity, quality and price were the dimensions of maize farmer' income; but there are many factors that contribute to maize farmers' income.

Secondly, the study limited itself mostly to farmers that have been farming for the past five years, but there are other stakeholders that were not considered and generalization in other situations with other categories of respondents may not be warranted.

Finally, the study was limited to interviewing, administering of questionnaire and document review. Whereas combining these beefed up the findings as well as the validity and reliability, it is important to note that there are other methods that may also be used to understand the phenomena.

5.8 Areas for Further Research

Based on the findings and limitations of this study, the researcher hereby makes the following comments and recommendations.

i. The regression analysis provided an Adjusted R^2 of 0.284 which meant that using the model under the study, post-harvest accounts for 28.4 per cent of maize farmers' income in Mid-west Uganda. Thus more studies with additional dimensions and indicators for both PHHT and Maize farmers' income should be conducted to enhance understanding of the phenomena, especially training and adoption of post-harvest handling technologies.
ii. The study was conducted only using 151 respondents; therefore more researches should be conducted with a higher sample size.
iii. More research should be conducted to understand how weather conditions affect the rate of post-harvest loss in form of quality and quantity.

5.9 Summary of the Chapter

This chapter was an effort to summarize the study. It has provided a discussion of the results by making cross-references with the literature that was reviewed by the researcher and has as well provided personal opinions of the researcher. It has also drawn conclusions and made practical recommendations on the basis of the findings and their interpretations, as well as suggested areas for further research studies to ensure more understanding of the phenomena.

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APPENDICES

Appendix 1: Certificate of Proof from the Language editor

MUKOTANI RUGYENDO

P.O. BOX 31178

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TEL: 0701707093

18 August 2016

CERTIFICATE OF PROOF THAT DISSERTATION HAS BEEN EDITED

This is to certify that the Master's Degree dissertation entitled, **Post-Harvest Handling Technologies and Maize Farmers' Income in Mid-west Uganda, Masindi and Kiryandongo Districts by Babra Balungi**, has been reviewed and corrected in order to ensure clarity of expression and consistency regarding key style aspects like general grammar, sentence construction, logical flow, tenses especially in relation to writing reports and presenting findings , punctuation, elimination of wordiness, citation and referencing.

Mukotani Rugyendo

Professional Editor

Appendix 2: Questionnaire

Questionnaire for determining the effect of Post-harvest handling Technology on Maize farmers' income in Kiryandongo and Masindi Districts

A. Introduction

You are humbly chosen to participate in a study to determine the effects of post-harvest handling technologies on maize farmers' income. The study is purely for academic reasons and you are kindly requested to honestly fill this questionnaire by providing your true answers to all questions. The study will assist the researcher in the process of earning the Master's degree of Business Administration (Project Planning and Management) at Uganda Technology and Management University. There is no pledged compensation for participating in this study. However, your thoughts will certainly contribute to the body of knowledge of post-harvest handling technologies. At all stages of the study, there will be no mention of your personal identity details. You are kindly requested to answer the questions as instructed and for more information feel free to contact:

Babra Balungi, KOPIA Uganda Center

Telephone: +256 771 844 101

Email: bbalungi@gmail.com

B. Respondents' Background Information						
1	Respondent's Sex *(please tick orcircle)* 1= Female 2= Male					
2	Respondents' age group *(pleasetick orcircle)* 1. (18years – 19 years) 2. (20 – 29 years old)3. (30 – 39years old) 4. (40 – 49 years old) 5.(50 years ormore)					
3	Years of Experience spent in Maize Farming *(please tick or circle your answer)* 1. (5years or less)2. (6 –10years)3. (11 - 15years) 4. (16 – 20)years 5.(21 years ormore)					
4	Location of respondents *(please circle your answer)*	1. Masindi District 2. Kiryandongo District				
5	What is your maize acreage (acres) per season? *(please tick or circle your answer)* 1. Less than 1 2. 1 up to 2 3. More than 2 up to 3 4. More than 3 up to 4 5. More than 4 up to 5 6. More than 5					
6	What is your average production per season? 1. Less than 5bags (@100kg)2. 6 bags –10bags3. 11 bags – 15 bags 4. 16 bags – 20 bags 5.21 bags or more					
	C. Availability of Post-harvest handling technologies					
Apply where Appropriate, using the scale of**(1= StronglyDisagree, 2=Disagree,3= Not sure, 4= Agree,5= StronglyAgree)**, please tick orcircle youranswer to indicate the extentto which you agree with the following statements.						
7	What are the most post- harvest handling technologies that you need to improve your maize quality? (circle any applicable numbers) 1. Harvesting 2. Drying 3. Shelling 4. Storing					
8	What are the most post- harvest handling technologies that you need to improve your quantity? (Circle any applicable numbers). 1. Harvesting 2. Drying 3. Shelling 4. Storing					
9	There is availability of post-harvest handling technologies in this region	1	2	3	4	5
10	What characteristics do you consider to harvest 1…………………………………………………………………………………………… 2……………………………………………………………………………………………					

11	I always avoid contact of the harvest maize with the soil and water	1	2	3	4	5
12	What challenges do you find in harvesting your maize …… ………………………………………………………………………………………..					
13	How would you like to be helped to improve the harvesting of your maize …… ……………………………………………………………………………………….					
14	What are the methods you useto dry your maize?*(please tick or circle your answer/s)* 1. Sun drying on a tarplin 2. Sun drying on bare soil 3. Sun drying on a drying yard 4. Use of a crib 5. Solar drying 6. Electric drying 6. Others (Please specify)					
15	I have found it hard to get the desired drying method to use	1	2	3	4	5
16	What challenges do you find in drying your maize …… ……………………………………………………………………………………………………….					
17	How would you like to be helped to improve the drying of your maize …… ……………………………………………………………………………………………………….					
18	I have found it difficult to shell maize	1	2	3	4	5
19	What method are you using to shell your maize? *(please tick or circle your answer/s)* 1. Using hands 2. Using a hand Sheller 3. Beating with sticks 4. Using a mechanical Sheller 5. Others (Please specify)					
20	What challenges do you find in shelling your maize …… ………………………………………………………………………………………………………..					
21	How would you like to be helped to improve the shelling of your maize …… ……………………………………………………………………………………….					
22	I have found it hard to store my maize properly	1	2	3	4	5
23	What type of storage bags do you use? *(please tick or circle your answer)* 1. Natural fibre/ Sisal 2. Polypropylene (PP) 3. Hermetic storage bags 4. Others (Please specify)					
24	Do you have a store? 1. Yes 2. No					
25	If "yes" to the question 24 above, which type of store do you have? *(please tick or circle your answer)* 1. Mud Silo 2. Granary 3. Metallic silo 4. Cemented store 5. Hemertic storage 6. Others (Please specify)					
26	What challenges do you find in storing your maize …… ……………………………………………………………………………………………………….					
27	How would you like to be helped to improve the storing of your maize …… ……					
	D. Training in Post-harvest handling technologies					
28	I have ever received a post-harvest handling technology training in the past five years and my fellow farmers	1	2	3	4	5
29	Name only two organisations that trained you on post-harvest handling technologies? 1…………………………………………………………………………………………………					

	2……………………………………………………………………………………………………….					
30	There was consultation to find out our actual training needs	1	2	3	4	5
31	There was a planning meeting to discuss how the training will be implemented	1	2	3	4	5
32	We agreed on the appropriate period to have the training	1	2	3	4	5
33	The farmers that were invited for the workshop came	1	2	3	4	5
34	The venue where the training occurred was appropriate	1	2	3	4	5
35	What methods were used during the training?*(please tick or circle your answer)* 1. Demonstrations 2.Case studies. 3. Lectures 4. Others (Please specify)					
36	What was/were the topic or topics that you were trained in? *(please tick or circle your answer)* 1. Harvesting and drying2. Grain storage systems/facilities 3. Quality standards and grading 4. Pest control and management 5. Others (Please specify)					
37	I benefited from the training of post-harvest technology use	1	2	3	4	5
38	At the end of the training, there was discussion to evaluate and give feedback of how the training had been conducted	1	2	3	4	5
39	After the training, there was a team that visited me to find out how I am implementing the technologies learnt and the problem faced	1	2	3	4	5
40	After the training many farmers that were taught in my area adopted the technologies that they had been exposed to	1	2	3	4	5
41	What challenges do you find in attending trainings in Post-harvest handling technologies …… ………………………………………………………………………………………..					
42	How would you like these trainings to be conducted …… ……………………………………………………………………………………….					
	E. Adoption of Post-harvest handling technologies					
43	What is the factor most limits your ability to use these technologies? *(please tick or circle your answer)* 1. Awareness 2. Costs 3. Risks 4. Sustainability 5. Others (Please specify)					
44	There is enough information on how to use these technologies	1	2	3	4	5
45	Most of farmers in my village know the post-harvest technologies of maize	1	2	3	4	5
46	I find these technologies financially affordable to me	1	2	3	4	5
47	The cost of using post-harvest technologies is less than the amount I obtain from the sale of maize after five years	1	2	3	4	5
48	I have ever discussed about the risks involved in using post-harvest technologies with my fellow farmers	1	2	3	4	5
49	We have ever discussed about ways of controlling or mitigating the risks involved in using post-harvest technologies	1	2	3	4	5
50	I have implemented the ways of controlling the risks involved in these technologies with my fellow farmers	1	2	3	4	5
51	I am using these technologies because I saw an opportunity of improving my quantity, quality, price and income	1	2	3	4	5

52	What challenges do you find in adopting these technologies ……… …………………………………………………………………………………………………..					
53	How would you like to be helped to adopt these technologies ……… ………………………………………………………………………………………………….					
F. Farmers' Income						
54	Because of easy availability of these technologies, the quantity of my maize available for home consumption and for sale increased	1	2	3	4	5
55	Because of adopting or using these technologies after being trained, the quantity of my maize available for home consumption and for sale increased	1	2	3	4	5
56	I am satisfied with the amount of maize that I sell per season for the past five years	1	2	3	4	5
57	Because of easy availability of post-harvest handling technologies, the quality of my maize improved	1	2	3	4	5
58	Because of adopting or using post-harvest handling technologies after being trained, the quality of my maize improved	1	2	3	4	5
59	My customers have ever complained about the quality of maize that I sell	1	2	3	4	5
60	My customers have ever complained about the high levels of moisture content	1	2	3	4	5
61	There is broken maize in my sold maize	1	2	3	4	5
62	There is diseased maize in my sold maize	1	2	3	4	5
63	There are stones or soil in the maize I sell to customers	1	2	3	4	5
64	I am not satisfied with the price I receive from the sale of my maize	1	2	3	4	5
65	The payment for the sale of maize is not timely	1	2	3	4	5
66	Based on the total cost invested in the post-harvest handling of maize, I have benefited for the past five years	1	2	3	4	5
67	I have been able to provide my family with basic needs for past five years from the sale of maize	1	2	3	4	5
68	I have been able to get some properties from the savings or money obtained from the maize sale for the past five years	1	2	3	4	5

Thank you very much for your valuable time and contribution unto the study. Please be assured that the information will be used for academic purposes only.

End

Appendix 3: Interviewguide for interviewing key informants

Interview Guide for determining the effect of Post-harvest handling Technology on Maize farmers' income in Kiryandongo and Masindi Districts

You are humbly chosen to participate in a study to determine the effects of post-harvest handling technologies on maize farmers' income. The study is purely for academic reasons and you are kindly requested to honestly fill this questionnaire by providing your true answers to all questions. The study will assist the researcher in the process of earning the Master's degree of Business Administration (Project Planning and Management) at Uganda Technology and Management University. There is no pledged compensation for participating in this study. However, your thoughts will certainly contribute to the body of knowledge of post-harvest handling technologies. At all stages of the study, there will be no mention of your personal identity details. You are kindly requested to answer the questions as instructed and for more information feel free to contact

Babra Balungi, KOPIA Uganda Center
Telephone: +256 771 844 101
Email: bbalungi@gmail.com

Questions

A. Introduction to the interview

1. Name of interviewer
2. Name of the interviewee
3. Location
4. Highlighting confidentiality and anonymity
5. Assuring respondent that s/he could drop the interview at any stage s/he felt
6. Request for consent to interview

B. Post-harvest Handling technologies

1. What do you think is most important post- harvest stage that leads to the highest losses and lowers farmer's income? Please explain your answer
   ……………………………………………………………………………………………………
   ………………………………………………………………………………
2. In your opinion, do you think are these post-harvest handling technologies easily available to farmers? Please explain your answer
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………...........
3. In your opinion, is the current training on post-harvest handling technologies effective? What can be done to make it more effective?
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………
4. Are the farmers adopting the post harvesting handling technologies? Yes/No, explain your answer please

…………………………………………………………………………………………………
…………………………………………………………………………..
5. What do you think is the most limiting factor for adopting of post-harvest technologies?
…………………………………………………………………………………………………
…………………………………………………………………………..
6. What challenges do farmers face in adopting post-harvest technologies?
…………………………………………………………………………………………………
…………………………………………………………………………….
7. What recommendations can you suggest to enable farmers adopt the post-harvest technologies?
…………………………………………………………………………………………………
……………………………………………………………………………………………

C. Income

1. What do you think is the average production quantity of maize per farmer in a season?
…………………………………………………………………………………………………
2. Is the quality of maize sold in this region good? Please explain your answer
…………………………………………………………………………………………………
…………………………………………………………………………………………...
3. What do you think is the most significant factor/parameter that is reducing the quality of maize?
…………………………………………………………………………………………………
4. Suggest possible ways to improve the quality of maize in this area
…………………………………………………………………………………………………
……………………………………………………………………………..
5. What is the average selling price per kg of maize in this district and how does the maize price change between harvesting and 2 to 3 months after harvest?
…………………………………………………………………………………………………
……………………………………………………………………………..
6. Do you think maize farmers are able to provide the basic needs to their family or to buy a property from the sale of maize?
…………………………………………………………………………………………………
…………………………………………………………………………

Thank you very much for your valuable time and contribution to the study .Please be assured that the information will be used for academic purposes only.

End

Appendix 4: Draft document review checklist

Review the following sample documents to ascertain the elements of post-harvest handling technologies therein.

1. Cooperatives or warehouses records on the averages prices, quantity and quality
2. Maize production of Kiryandongo and Masindi district
3. Organisations training materials
4. EAC maize grain standards
5. Related documents to my study

Appendix 5: Work plan and time frame

Activity	**Duration**	**End Date**
Proposal writing and Approval	2 months	January 2016
Data collection	2 month	April 2016
Data analysis	1 month	May 2016
Report writing	1 month	June 2016
Submission of final Dissertation	2 month	August 2016

Appendix 6: The Sampling table

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—N=Populationsize.S=Samplesize. Source:KrejcieandMorgan (1970.p.608).

Appendix 7: Example of maize cribs for drying maize

Appendix 8: Some training materials used


MAIZE IS MONEY: KEEP IT CLEAN
GOOD PRACTICES
STANDARD IMPACTED
BAD PRACTICES


MAIZE IS MONEY: DRY IT PROPERLY
GOOD PRACTICES
STANDARD IMPACTED
BAD PRACTICES

Appendix 9: Map of Uganda showing Masindi and Kiryandongo districts

KEY

Districts used in the study on the effect of post-harvest handling technologies on maize farmers' income.

Mid-West Uganda