CONTRIBUTION OF PURDUE IMPROVED CROP STORAGE (PICS) BAG TECHNOLOGY 1N MONITORING POST-HARVEST LOSS TRENDS & REDUCTION IN MAIZE PRODUCTION.

A CASE OF DOKOLO DISTRICT

A POSTGRADUATE DESSERTATION PRESENTED TO THE FACULTY OF AGRICULTURE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE MASTER OF SCIENCE IN MONITORING AND EVALUATION

UGANDA MARTYRS UNIVERSITY

BUSINGYE DOREEN ELIZABETH

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DEDICATION

This research work is dedicated to the almighty God who has given me strength and wisdom, my dear mother who has supported me whole heartedly Mrs. Edith Tumwebaze, Mr. Peter Mugisha thank you for your moral, technical, financial support and encouragement in my studies .This also goes to my siblings, Angela ,Christine, Sandra, Edwin and My Pastor Sande. H. David thank you for your dearly support and prayers and all my dear friends at large. Thank you all God bless

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May the Almighty Lord bless you abundantly!!

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List of Abbreviation/Acronyms

CVI:	Content Validity Index
DV	Dependent Variables
ECA:	Eastern and Central Africa
GR:	Green Revolution
HDPE:	High-Density Polyethylene
IV	Independent Variables
PHL:	Post-Harvest Loss
PICS:	Purdue Improved Crops Storage
RTC:	Rational Choice Theory
SSA:	Sub - Saharan Africa

ABSTRACT

This study sought to investigate the contribution of Purdue Improved Crop Storage (PICS) bag technology to monitoring post-harvest loss trends and post-harvest reduction in maize production using a case of Dokolo district. The study objectives were; To establish the adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District; To establish the extent of maize losses among farmers who use PICS bag technology in maize storage and maize production in Dokolo District and To compare post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it. A case study design was adopted and data collected from a sample of 198 respondents. Self-administered questionnaires, interview guide and documentary review guide were used in the study. SPSS Version 16 was used to analyse quantitative data and findings were presented in a tabular format showing frequencies, percentages, mean and standard deviation. Qualitative findings were presented in themes in a narrative form. From the study findings, it was revealed that there was a good adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District. Farmers in Dokolo district grow maize and used PICS bags in storing their produce so as to reduction of post-harvest losses in maize production every season since 2014. Challenges for the adoption include lack of awareness, being too expensive, usability, accessibility and availability of the PICS bags. To a large extent, the maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District. If bags are not tighten well in order not to allow in air and keep the maize safe away from weevils, they can be affected by pests. However, the pests die when they are stored in the PICS Bags. There are fewer post-harvest losses in maize production between farmers who adopted PICS bag technology compared to those who have ignored it. PICS Bags are pest controller bags. Never the less the farmers had a special facility for storing PICS and ordinals bags. Farmers that used PICS Bags needed nothing to do with fumigation as all their produce was safe relation compared to the ordinary Bags that needed fumigation at the store would be filled with pests allover consuming the stored maize. It was revealed quality of the maize after storage in PICS was excellent and therefore, the study recommended that government should empower households on the adoption of the Purdue Improved Crop Storage (PICS) since they are designed to store crops and reduce post-harvest losses from pests such as bruchids, also known as weevils. Since some farmers had difficulty accessing PICS bags at points that were far away from the village. Dissemination strategies should consider the different constraints men and women face accessing PICS bag distribution centres to ensure that both men and women can purchase the bags.

CHAPTER ONE: GENERAL INTRODUCTION

1.0 Introduction

This chapter introduces what the study is about, the background to the study, the statement of the problem, the study purpose, the objectives and the research questions. It also explains the scope of the study, its significance, justification, conceptual/theoretical frame work and the key definitions of the key terms and concepts.

1.1 Background

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). 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). Maize is believed to have originated from Central America; a region which was dominated by wild maize, *Teosinte* and *Zea Mexicana* (ACDI/VOCA, 2010). Archaeological remains, along with starch grain and phytolith microfossil evidence, indicate that domesticated maize was present in the Balsas River Valley by 8990–8610 cal. B.P. (Piperno et al. 2009:5021; Ranere et al. 2009:5017). Following domestication, maize spread from Mexico to Panama by about 7800–7900 cal. B.P., and to coastal Ecuador by about 8000 cal. B.P. (details of dating summarized in (Piperno 2011, Pg.458-459). Maize also reached the Colombian Andes by the eighth millennium (Piperno 2011, Pg. 458-459). Even though the productivity of early maize would have been quite low, it was clearly an important resource for hunter-gatherers transitioning to horticulture.

Maize eventually became a dietary staple, or at least an important food resource, for prehistoric peoples inhabiting a variety of environments throughout the New World. Indeed, maize has been called "the grain that civilized the New World" (Athens et.al 2016). In 1880, the United States grew over 62 million acres of corn. They further note that, by 1900, this figure had reached approximately 95 million acres; while by 1910, it was over 100 million acres. A two-year research conducted in Honduras by Raboud and his colleagues in 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 (Bokusheva et al, 2012). Similarly, Abeleira, *et. al.,* (2008) assess postharvest bean losses in Mexico to account for 10%.

In Uganda, on-farm postharvest grain losses for maize are, on average, about 6% of quantity stored; but reach up to 100% in some cases (Kaminski and Christiaensen, 2014; anecdotal evidence). Moreover, 63% of the total postharvest grain losses by smallholder farm households are due to storage-related issues such as lack of storage, pest infestation, or poor-quality storage technologies (World Bank, 2011). Storage-related losses are important to smallholder farm households because the production of maize is largely seasonal due to rain-fed agriculture, but consumption or demand is fairly constant year-round. The inventory of produced maize is essential for income and food security as it may act as a buffer against market or supply uncertainty in the postharvest season. Thus, losing part of stored grains adversely impacts households. Postharvest loss includes the food loss across the food supply chain from harvesting of crop until its consumption (Aulakh and Regmi, 2013). Losses increase along the value chain.

Currently, the predominant storage technologies used by households are single-layer woven polypropylene bags called "kaveras" (71%); heaped-in-house, where maize is left on the cob (11%); traditional and improved granaries (8%); and private off-farm facilities (2%). The use of hermetic (airtight) technology is less than 1% in our sample. However, there are current efforts to increase the use of hermetic improved storage technology—Purdue Improved Crop Storage (PICS) bags—to mitigate postharvest grain losses. Hence, the opportunity to investigate the impacts of using the PICS technology on households' behavioural responses to maize quantity stored and duration of storage; and also, improved input and storage chemical use.

Unlike most developed countries, African subsistence farmers who do not produce and store much more than they need for consumption may be forced to choose between ensuring food availability and satisfying immediate cash needs. Immediate cash needs can arise due to unexpected healthcare expenses, birth or death in the family, and other shocks experienced by the household. Households bound by liquidity and credit constraints are likely to sell stored grains to satisfy cash needs even though they may need to replenish storage stocks at a higher price at a later date (Burke, 2014; Stephens and Barrett, 2011).

In fact, in Uganda, only about 17% of the households stored maize to sell in the lean period with the remaining storing mainly for consumption and partly for seed. Urgent need for cash and concerns about storage losses, at harvest period, are the major reasons smallholder households sell their maize immediately after harvest. These households may repurchase maize at higher prices later in the lean period. They may also be relinquishing potential increase in net income from price arbitrage. The 'sell low, buy high' attitude affects household's income and food access (Kadjo et al., 2013; Stephens and Barrett, 2011).

Uganda's small-scale farmers have traditionally cultivated maize for food and for income generation. A possible higher cost of intensification with possible higher post-harvest losses may reduce the total farm profitability for the smallholders. For this purpose, the extent and causes of post-harvest losses of smallholder farmers need to be established. Additionally, appropriate interventions must be identified for each farming system as part of a broader agriculture intensification program aiming to increase food security, nutrition and rural livelihoods. Therefore, the specific postharvest characterization of each farming system would be required.

Maize is one of the most important cereal grains grown worldwide and it is the basis for a significant portion of Sub-Saharan Africa's diet (World Bank, 2011; Kaminski and Christiansen, 2014) independently conducted studies to estimate the postharvest losses in maize crop in three SSA countries (Uganda, Tanzania, and Malawi) through comprehensive household surveys. The losses from the farm level activities were estimated in the range of 1.4% to 5.9%. Insects and pests were reported as the major cause of losses in maize during storage. Among all the biotic factors, insect pests are considered most important and cause huge losses in the grains (30%–40%) (Abass, *et al.*, 2014). However, Weevils are the primary cause of post-harvest loss in maize, particularly for hybrid varieties other than insect pests, what other elements lead to post harvest losses that in this case, PICS technology can minimize? Synthetic pesticides are expensive, may not be available in the market regularly, and may be illegally blended with other compounds (Jones et al., 2012; Njoroge, *et. al.,* 2014).

1.1.1 Monitoring Dokolo District

How are losses monitored in Dokolo District? Inadequate post-harvest storage exposes crop to contamination by micro-organisms, chemicals, excessive moisture, fluctuating temperature extremes, and mechanical damage. Postharvest storage loss accounts for direct physical losses and quality losses that reduce the economic value of the crop, or may make it unsuitable for human consumption. These losses can be up to 80% of the total production, the losses can be classified in two categories: direct losses, due to physical loss of commodities; and indirect losses, due to loss in quality and nutrition.

Murdock *et. al.,* (2014) have pointed out that the PICS bags' ability to create low-oxygen environments is the key to their protective nature. Contributing to this protection is the higher level of oxygen within the space between the two polyethylene liners. While a plastic membrane like the polyethylene liners can permit minimal diffusion of oxygen, this process is slow and dependent on the difference in concentrations of oxygen on either side of the membrane. Our current results show for the first time that oxygen levels in the inter-liner space can be 3–4% higher than the inner grain environment. Results show for the first time that oxygen levels in the inter-liner space can be 3–4% higher than the inner grain environment. Thus, as originally suggested this space of higher oxygen creates a buffer zone that discourages oxygen movement across both liners, as it reduces the difference in oxygen concentration on either side. The result is slower movement of the oxygen into the grain environment from the ambient air than if there were a single layer, even if that layer were thicker than typical for PICS bags (Martin et al, 2015)

The result is slower movement of the oxygen into the grain environment from the ambient air than if there were a single layer, even if that layer were thicker than typical for PICS bags. This fact establishes the value of the double-layer of HDPE as part of the triple bag configuration.

1.2 Statement of the Problem

Storage plays a vital role in the food supply chain. Maximum losses usually happen during this stage of value chain development operation. The storage losses are caused by several factors; classified into two main categories: biotic factors (insect, pest, rodents, and fungi) and abiotic factors (temperature, humidity, rain). Moisture content and temperature are the most crucial factors affecting the storage life. (Gawrysiak-Witulska; 2012) Most of the storage molds grow rapidly at temperatures of 20–40 °C and relative humidity of more than 70%. Low moisture keeps the relative humidity levels below 70% and limits the mold growth. In the traditional storage structure, temperature fluctuations due to weather changes cause moisture accumulation either at the top or bottom of the grains' bulk depending on the direction of air convection. Dependent on the conditions and environment in which farmers operate, the methods have either met the need or not. Thus, the low-cost, non-chemical grain protection triple-layer hermetic storage bag (PICS) technologies have since been introduced, to reduce losses of the stored grain, and the use of chemicals. However, evaluations on the contribution of the PICS bags technology in postharvest loss trends and the reduction of postharvest losses in maize production are elusive**.** Therefore, this study assess the contribution of PICS Bags technology in monitoring postharvest loss trends and the reduction of postharvest losses in maize production in order to compare postharvest losses in maize production with farmers who adopted the PICS bags technology to those who ignored the technology.

1.3 Objectives of the Study

1.3.1 Overall Objective

To evaluate the contribution of Purdue Improved Crops Storage (PICS) bag technology in monitoring post-harvest loss trends and reduction in maize production.

1.3.2 Specific Objectives

The specific objectives of the study include: -

1) To establish the adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District.
2) To establish the extent of maize losses among farmers who use PICS bag technology in maize storage and maize production in Dokolo District.
3) To compare post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it.

1.3.3 Research Questions

1) What is the adoption rate of the PICS bags technology in the reduction of post-harvest losses among farmers in Dokolo District?
2) To what extent have maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District ?
3) What is the difference in maize production between farmers who adopted the PICS bag technology in Dokolo District and those who don't in reducing post-harvest losses?

1.4 Scope of the Study

The scope of the study is divided into geographical, demographic, time and conceptual scope.

Geographical scope

The study is to be carried out in Dokolo District. The coordinates of the district are 01 55N, 33 10E. Dokolo District is one of the districts where the PICS bags technology intervention has been implemented and farmers trained on how to use them. This is so because Dokolo District is engaged so much in crops that need better storage that is Beans, Pigeon peas, Cowpeas, Groundnuts, Cassava, Sweet potatoes, Millet, Maize, Sorghum, Rice, Sesame, Sunflower, Soybeans and Cotton. The World Food Program (WFP) Special Operation 200617 (SO1) program in Uganda sought to train 16,600 farmers in 28 districts and offer storage technologies at a 70% subsidy.

Demographic scope

The study limited itself to collecting data or information from farmers, district officials, and technical personnel and other participants in the sector who are 18years and above, considered being adults.

Time scope

The study was carried out in a period of eleven (11) months. This started from August 2017 to December 2018.

Conceptual scope

The study was confined to the contribution of PICS technology to monitoring post-harvest loss trends in maize production in Dokolo District.

It was also limited to PICS technology usage (cost/availability, adoption) as the independent variables and maize production trends (quantity and quality of maize) as the dependent variable.

1.5 Justification

The findings of this study may help: -

To evaluate the extent at which the PICS bags have reduced post-harvest storage loses in Dokolo District, where it's not the only affected district in the country but because it was among the chosen few districts where the bags were first introduced.

Small holder farmers and manufacturers across the whole country will be able to benefit from my study, as it will create knowledge about the existence of the bags, how they have helped the people in Dokolo District hence give them a reason as to why the PICS bag is of more advantage compared to the normally used bags.

The study findings will be helpful to policy makers and advocates to enhance decisions in agricultural decisions. The strengths and weakness that will be identified during the study will guide policymakers and implementers on how PICS bags or other storage techniques can be used to reduce post-harvest storage.

This study will equip the researchers and scholars interested in the same area with research knowledge and experience that will be important in the practical world of business. The academic groups may benefit from this study by using the findings of the study to enrich their knowledge and research

1.6 Significance of the study

In recent years PICS bag technology has been in use and results are quite minimal but still growing. With over one hundred eleven (120) Districts is Uganda, PICS bags technology only chose a few of them to whom they introduced, demonstrated and trained on how to use and the importance of the triple layer PICS bags. This leaves a huge gap of for other districts unaware of the existence of the PICS bags, hence my study is to bridge the gap and by so creating awareness of the PICS bags in other districts and its importance and why one would opt for PICS bag than the normally used bags for storage.

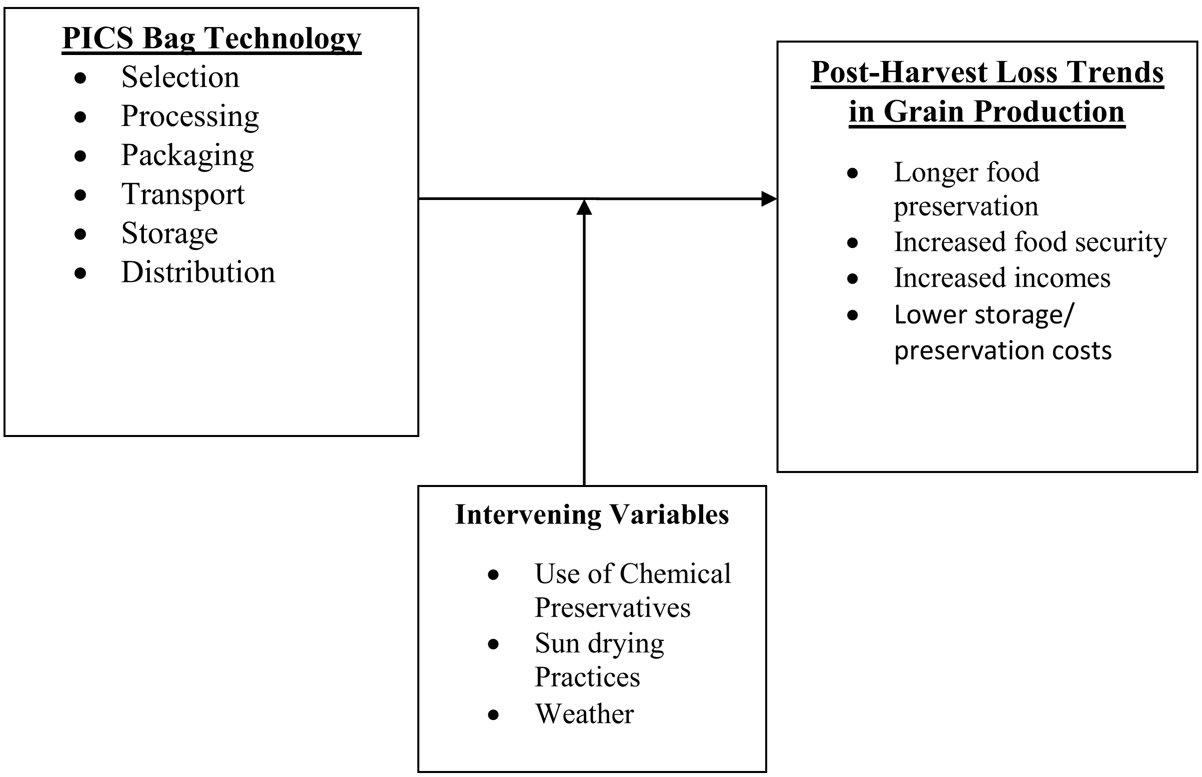
Significant volumes of grain in developing countries are lost after harvest, aggravating hunger and resulting in expensive inputs such as fertilizer, irrigation water, and human labour being wasted. Qualitative PHL can lead to a loss in market opportunity and nutritional value; and under certain conditions, 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).

Poor post-harvest handling such as poor drying and improper storage conditions lead to losses due to storage pest and aflatoxin contamination (MAAIF, 2013**).** These 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). 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.

1.8 Conceptual Framework

The Conceptual Framework between independent and dependent variables can be expressed as follows: The research model below was used to investigate the between the usage PICS technology and post-harvest loss trends in grain production. Harvesting

Independent Variables (IV) **Dependent Variable (DV)**



The conceptual framework describes the relationship between the independent variable and the dependent variable. In this conceptual framework, Contribution of PICS Bag Technology is the independent variable while Post-harvest Loss Reduction in Grain Production is the dependent variable. Contribution of PICS Bag technology is seen through longer food preservation, increased food security, increased incomes and Lower storage/preservation costs. On the other hand Post-harvest Loss Reduction in Grain Production is considered as the dependent variable as seen by Harvesting, Selection, Processing, Packaging, Transport, Storage and Distribution.

However the intervening that influence the relationship between the independent and dependent variable include use of Chemical Preservatives, Sun drying Practices and Weather

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter includes a review of the available literature on the rate of adoption of Purdue Improved Crop Storage (PICS) Technology among farmers, the trends in the use of chemicals for grain preservation among farmers plus the contribution of the Purdue Improved Crop Storage (PICS) Technology to grain production, the farmers and other related parties. We have reviewed literature that has been studied and published in books, newspapers and peer reviewed journals. The literature reviewed is then synthesized in order to summaries what is already known about these two variables and identify the study gaps.

2.1 Theories Related to Production

This study utilized the Rational Choice Theory (RTC) to understand how farmers' choices for post-harvest handling technologies affect their income.

2.1.1 Rational Choice Theory

Rational Choice Theory is an economic principle which assumes that individuals always make prudent and logical decisions which provide them with the greatest benefit or satisfaction and which are in their highest self-interest. Most mainstream economic assumptions and theories are based on rational choice theory. Rational Choice Theory is a framework for understanding and often formally modelling social and economic behaviour **(**Lawrence and Easley, 2008; Kei, 2009)**.**

The 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, *et al*., 2009). 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 (Asensio & Matas, 2008). There are a few assumptions made by rational choice theorists. Ogu (2013) in his journal noted three assumptions made by rational choice theorists. These assumptions include:

Individualism

It is individuals (in this case farmers) who ultimately take actions. Individuals (farmers), as actors in the agricultural value chain or agricultural sector and everywhere, behave and act always as rational beings, self-calculating, self-interested and self-maximizing, these individual's (farmer's) economic actions are the ultimate source of larger economic outcomes. From this first overarching assumption derives the four other major assumptions summarized below.

Optimality

Individuals (farmers) choose their actions optimally, given their individual preferences as well as the opportunities or constraints with which the individual faced. He went on to say that 'optimality' is defined as taking place when no other course of economic action would be preferred by the individual over the course of action the individual has chosen. This does not mean that the course of action that the actor adopts is the best in terms of some objective, and outside judgment (Piperno, 2011). The rational choice theory, therefore assumes, according to Kei, that individuals (farmers) "do the best they can, given their circumstances as they see them".

Structures

That structures and norms that dictate a single course of action are merely special cases of rational choice theory. In other words, the range of choices in other circumstances differs from choices in a strong structural circumstance, where there may be only one choice. Although these structures may be damaging to the rational choice model, individuals will often find a way to exercise action optimally, hence the rational choice model may not necessarily show harmony, consensus, or equality in courses of action. Again, Asensio & Matas, (2008) argued that structures, may not be optimal from the viewpoint of an individual with few resources, however, the rational choice approach will attempt to explain is how this situation emerges and is maintained through rational choices.

Self-regarding interest

This assumption states that the actions of the individual (a farmer) are concerned entirely with his or her own welfare. Ogu (2013) noted that in as much as this is a key assumption in the rational choice approach, is not as essential to the approach as the assumption on optimality. He also noted that various types of group sentiments could exist, such as cooperation, unselfishness, charity, which initially may seem to be contrary to individual optimality. Rational choice theorist may argue that these sentiments can be incorporated into the rational choice model by observing that such sentiments may ultimately be aimed at pursuing some form of self-interest. For instance, Burke, (2014) argued that charity movements or efforts could ultimately be aimed at making an individual feel good or could be a means of raising one's social esteem in the eyes of others.

Rationality

This appears the most predominant assumption of the rational choice theory. All individuals, according to this assumption act in ways that would benefit them more; every individual is most like to undertake courses of actions that they perceive to be the best possible option and one that would immensely be to their own advantage.

2.1.2 Criticisms of the Rational Choice Theory

Several critique and scholars have identified certain shortfalls of the rational choice approach. Aside, some of the disagreements that have been associated with accepting the basic assumptions of the approach, there are a number of other weaknesses that have been attributed with the rational choice theory (Costa, 2014). Some of these weaknesses are:

Problems associated with inadequate information and uncertainty, this may make it difficult for individuals (in this case, farmers) to make rational decisions as a result, they may rely on other ways of making decisions (Young, 2016).

Human social action and interactions are complex, and many of the theories examined earlier may provide better guides to how these take place.

Theorists of rational choice argue that macro level structures and institutions can be explained from the models of individual (farmer) social action. But there are problems of aggregation of individual (farmer) to societal level phenomena. These same difficulties exist in well-developed economic models.

Norms and habits may guide much action, and once these take root people (in this case, farmers) may not question them but use them to pursue meaningful social action.

One problem of RCT is that some theorists argue that almost everything humans do is rational, even philanthropy and self-sacrifice. Young, (2016) argued that by expanding to include all forms of action as rational, action that is non-rational or irrational becomes part of the model. By including every possible form of action in rational choice, it is not clear how the standards of what is rational and what is not are constructed.

2.1.3 Applicability RCT

As with any other sociological theory or method of analysis, RCT should be evaluated on the basis of its ability to help us explain and understand the social world. There is no doubt that each of us is an individual, and if a theory developed from this point of view can help explain aspects of social interaction and social systems, then it has worthwhile aspects to it. In addition, in our society much social action is explicitly rational and is undertaken by individuals – purchase of consumer durables, choice of a career, and perhaps even choice of a lover or spouse (Ahmad and Emeka, 2014). Where the choices are not always entirely conscious and rational, it is possible that RCT models may help explain much social action.

2.1 Adoption Rate of the Purdue Improved Crop Storage (PICS) Technology

Many ideas have come up to explain how global food production can be increased using the basic resources to grow more food efficiently. Some scientists like Norman Borlaug advocated for adoption of the "Green Revolution" in increasing food production. The Green revolution has been considered the most successful introduction of newly developed high-yielding varieties of grain (wheat, rice, and others) in third world countries. Norman Borlaug in 1970 received the Nobel peace prize for his work in breeding the first high-yielding wheat varieties. According to Blaustein (2008), says that the Green Revolution that brought advances in crop genetics to Asia and Latin America completely by passed the African continent. Africa's smallholder farmers finally joined the movement in 2006, when Bill and Melinda Gates Foundation joined the

Rockefeller Foundation to create the Alliance for a Green revolution in Africa. Its goal is to develop 100 new crop varieties in 5 years, so that within 20 years farmers will double or triple their yields.

Today, the term "Green Revolution" refers to almost any package of modern agricultural technologies introduced in the Third World. This approach of the Green Revolution has, however, created a number of controversies with skeptics like Raj Patel (2011), seeing the system as a cause of social upheavals in peasant culture. They argue that the views of the Green Revolution have not only failed to improve the lot of the poor, but have also caused ecological problems. Pingali (2012) says that at the same time, the GR also spurred its share of unintended negative consequences, often not because of the technology itself but rather, because of the policies that were used to promote rapid intensification of agricultural systems and increase food supplies. Some areas were left behind, and even where it successfully increased agricultural productivity, the Green Revolution (GR) was not always the panacea for solving the myriad of poverty, food security, and nutrition problems facing poor societies.

Pingali (2012) also noted that poverty and food insecurity still persist despite the Green Revolution success. There is a large econometric literature that uses cross-country or time series data to estimate the relationship between agricultural productivity growth and poverty. These studies generally find high poverty reduction elasticities for agricultural productivity growth.

The Green Revolution (GR) strategy for food crop productivity growth was explicitly based on the premise that, given appropriate institutional mechanisms, technology spillovers across political and agro-climatic boundaries could be captured. However, neither private firms nor national governments had sufficient incentive to invest in all of the research and development of such international public goods. Private firms operating through markets have limited interest in public goods, because they do not have the capacity to capture much of the benefit through proprietary claims; also, because of the global, non-rival nature of the research products, no single nation has the incentive to invest public resources in this type of research. Therefore, whereas, some people recommend for Green Revolution to increase food production, others advocate for organic appropriate technologies (Pingali, 2012).

Schools of Thought on Food Production

Two main schools of thought on food production have been popular since the 1940s (Watuleke, 2015). The first school of thought- proposes that modern technologies provide an effective way of ending hunger. This school of thought is represented by several points of view. They include;

Modern technology is the best method of food production; Science and technology offer particular advantages to agricultural modernization; New technologies can promote positive social and political change and Technology can have a beneficial effect on the environment.

It is at this school of thought that approaches like the Green Revolution is based.

The second school of thought argues to the contrary. It agrees that food production is a key ingredient in ending hunger. However, it promotes different agricultural methods. For example, it advocates for use of more organic methods of production than do “Green Revolution” technologies, ones that do not depend upon the intensive use of energy, chemicals or pesticides. The proponents of this alternative school of thought of agricultural production contend that it has the merit of being ecologically sound, sustainable over a long period of time, and potential as productive as more mechanized forms of farming (Watuleke, 2015).

In my point of view, much as there is increased adoption of agricultural technology in Uganda, given the poverty conditions of many smallholder farmers in the country, the adoption of the second school of thought would be more efficient. Farmers only need to be trained in how they can use locally available resources to boost production. For example, during field work, I found out that many smallholders could not afford pesticides or artificial fertilizers, they were however, mixing different shrubs and with hot pepper and animal urine as pesticides and urea and it was working for them. Others were using organic and compost manure to add nutrients to their gardens. This is particularly important given the changing trends and shifts in the understanding of food security with focus narrowing down on individuals and households as the key units of analysis.

The Changing Trends in Food Security

It should be acknowledged that the subject of food security has kept changing in the past as a result of the emergence of global development as well as the dynamic nature of food problems around the world. Hart (2009) even the thinking about food security has also gradually shifted away from issues of global and national food supply to concerns of household and individual access to food. He goes on to say that there is, however, an issue of the swinging pendulum between food supply and food consumption, implying a debate on whether the main focus of food security should be put on food production and supply or, accessibility to food and consumption. Details on this subject will be discussed further in the next sections of this report where we shall look at the non-agricultural population and its food consumption demands. This has led to what we may call an evolution of food security concerns.

The PICS technology consists of two 80-micron thick high-density polyethylene bags supported by an outer woven polypropylene bag16. The bags sell for approximately USD2.50 and can be reused several times before they are damaged beyond the point of repair. The sealed triple-layer crop storage bags were developed by Professor Larry Murdock and his team at Purdue University in West Africa in the 1980s to assist in combatting insect infestations, specifically from bruchids (a kind of beetle).

Though the technology was introduced primarily for the storage of cowpeas, Purdue researchers observed that farmers were increasingly using the bags to store other crops. Since the technology's initial testing, the intended use of the bags has been for pulses and grain storage, and in that role the bags have multiple benefits. Foremost among them is their ability to prevent insect damage to the stored crops. When properly sealed, the PICS bag inhibits respiration, leading to the desiccation of insect pests (causing their death) and prevention of mold. Work by ACDI/VOCA, among others, has shown that the bags also inhibit the spread of the aflatoxin-producing fungus, which is a serious health risk in all regions of Kenya and is particularly prevalent in smallholder maize. Hermetic grain storage is highly applicable to household storage and makes the use of insecticides in stored grain redundant (USAID, 2016).

PICS bags (and other hermetic bag solutions) are easily used by farmers with very basic training. The grain needs to be dried to a maximum moisture content of 13.5 percent, which is normally done in the sun. According a USAID (2016) report on scaling the use of hermetic technology (PICS bags), in order to get to this level of accuracy, moisture meters are necessary and the government is currently distributing them. Itinerant grain-drying machines are also being developed – notably by Sophie Walker. The farmer then places the grain in the bag and squeezes out as much air as possible.

To seal the bag, the farmer ties each of the two interior bags in turn, finishing with the outer layer. The dryness level is extremely important; if the grain is too damp it will rot and/or germinate. Because PICS bags are a post-harvest storage technology, they require little or no change in farmers' cultivation practices. Instead of bagging up their grain in hessian or similar bags, farmers use the triple layered plastic solution. According to USAID (2016), moisture control is very important, and farmers need to recognize that they will not get the intended results if they do not adhere to the drying protocol. This was less important when they used non-hermetic containers, as further drying could take place after bagging, which is not the case with PICS bags.

However, the freedom from having to use chemical pesticides on the grain more than offsets the changes in behaviour that PICS bags require, including meticulously expelling the air and tying each layer separately to ensure the bag is fully sealed. The same USAID (2016) report further says that pesticides, when used, need to be re-applied within two months, which necessitates the emptying and re-bagging of the crop. The only major change in farmers' storage practices is that grain stored in PICS bags needs to be stored separately from anything that could attract rodents which could chew through the bag. However, none of the end users interviewed indicated that this was a problem (most stored their grain inside the family dwelling).

Prior to the arrival of PICS bags in Kenya, grain was stored in polypropylene or burlap bags. Storage periods varied: up to 10 months in areas of a single, annual harvest, and for 3 months in those areas with 2 growing seasons though with generally lower yields) (USAID, 2016).

However, this system of storage is highly inefficient. According to the World Bank, 45 percent of all PHLs in Kenya in 2009 were due to poor storage, and the rest depended on spillage and weather conditions.

In 2013, PfI, a USAID/BFS project, assisted the Purdue University team in introducing PICS bags to Kenya. This decision was based on reports of high levels of PHLs in the white maize crop. These losses can amount to as much as 50 percent in areas affected by the LGB, known locally as "Osama" because of its potentially destructive effects and the difficulty in eliminating it. Further extensive damage can be caused by the lGB, maize weevils, and bruchids in pulse crops (USAID, 2016).

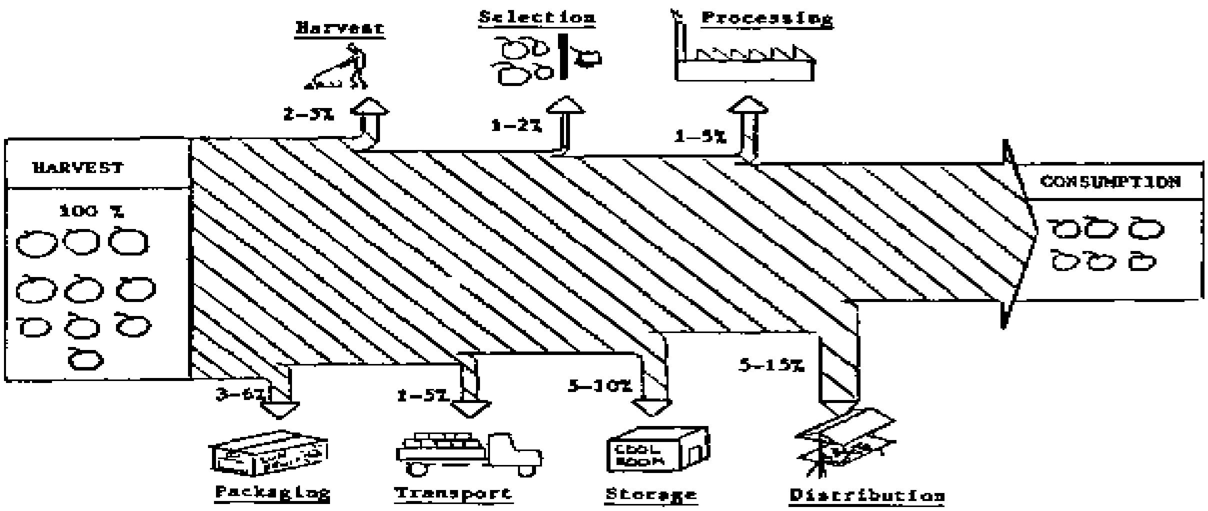
The same USAID report says further that smallholders (on land of less than 2.5Ha or 6 acres) typically attempt to produce a minimum of 6 bags of 90 or 100 kilograms each (equal to a family's consumption over a year) Since many plots are much smaller than 2.5Ha (the average smallholder plot in Kenya is 0.86Ha and not all the land is available for maize - it is used for accommodation, livestock, or other crops - even growing enough for six or eight bags can present a challenge. Farmers reported that they plant up to 30 percent more maize than they theoretically need to compensate for the expected post-harvest losses. This results in the planting of more land under maize than would otherwise be the case, limiting the amount of a small farmer's land available to grow high-value cash crops.

The Purdue Improved Crop Storage (PICS) bag is a triple layer closed bag that allows farmers to store their grain without the use of insecticides (Dieudonné Baributsa, 2015)**.** This bag uses two liners of high-density polyethylene (HDPE) and an outer layer composed of woven polypropylene. Together, they create low-oxygen environments that reduce insect development

(Murdock, 2012). The sealed plastic bags cut off the oxygen supply to create airtight conditions, thereby eliminating insect damage in storage of dry grain Murdock and Baoua (2014). PICS bags were constructed from available local materials to maintain the nutritional quality of the stored grains The PICS bag technologies cost effect, (Dieudonné Baributsa, 2015), and has been tested on cowpeas. He further notes that the efficacy of PICS bags to reduce pest damage in other crops like maize, sorghum, wheat, rice, peanut, common bean, hibiscus seed, mung bean, pigeon pea and bambara groundnut further needs testing. The PICS project disseminates bags through local distributors, agro-dealers, farmers, cell phone vendors, and entrepreneurs (Hays, *et. al*., 2014).

Whereas in East and Southern Africa, farmers use cow dung ash in small bags, wood cribs, pits, iron drums enclosed with mud, and metal bins for storing the grains (Abass, 2014), PICS bags are envisage to provide alternative approach to storage. Additionally, PICS bag has proven to be an effective alternative to chemical pesticides for stored grain. As much as 98% of all insect pests can be eliminated within just 1 month of storage, reducing damage and weight loss caused by feeding (Baoua, 2012).

Figure 1: The Post-Harvest Loss Process



Source: Grolleaud, (2002).

It is important to note that as the understanding of the subject of food security has evolved over time, so has its definition by different authors below. The definition and concepts of food security have undergone substantial evolution. For example, the definition derived from the World Bank conference of 1974 paid attention on food supply and focused mainly on food availability and stable food prices.

Time over, however, the definition has shifted to include multidimensional concepts such as food accessibility, food utilization and food stability; as well as bringing on board the importance of households and individuals in food security concerns. Writers like Sen in the early 80s have been dominating in this debate, bringing in the issue of entitlement.

The debate resulted in the shift of focus from the global and national concerns to include individual and households. In 1983, FAO modified the definition of food security to: "Ensuring that all people at all times have both physical and economic access to the basic food they need".

In this definition, two important concepts can be derived: first, the concept of sustainable food production and second, sustainable livelihood enabling people to access food at all times. Maxwell presents these distinctive variables clearly in his 1988 definition of food security: "A country and people are food secure when their food system operates efficiently in such a way as to remove the fear that there will not be enough to eat" (Paciello, 2015). It can therefore be deduced that the understanding of food security and its definition has evolved a lot since the 1974 World Food Conference in Rome.

Farmers Discontinued Usage of Chemicals in Grain Preservation during Storage

Murdock (2015) notes that while hermetically sealed storage bags may be new to Kenya, storage bags *per se* are not; farmers have been using burlap or polypropylene bags to store their harvests for generations. So, the initial effort undertaken by Purdue's PICS team and Partnering for Innovation, and then by USAID-KAVES, Bell Industries, and a number of non-governmental partners, was to educate the potential market about the differences and benefits of PICS bags compared with traditional practices. The next challenge was to produce a sufficient number of units to satisfy the resulting demand.

The effectiveness of existing practices in curbing insect infestations was perceived as inadequate by the farmers interviewed. Farmers were already aware of the impact on their livelihoods and food security of post-harvest insect infestations. They were doing their best to counteract such losses by using chemical pesticides with their traditional bagging practices (Murdock 2015). However, according to interviewees and local officials, the effectiveness of the chemicals was between 80 and 90 percent, and this was only for the first month.

The effectiveness of the pesticides declined sharply thereafter, and farmers had to empty the bags and re-treat the grain with pesticides every two or three months before re-bagging. Farmers interviewed reported that they found the explanation of the use of the PICS bags easy to understand. Faced with high costs of chemicals for treating grain in non-hermetic conditions, and believing that the chemicals are harming their children's health, farmers are easily persuaded to adopt the new technology (Williams, 2014).

In addition, the technology is promoted by public or NGO extension workers and non-governmental contacts with whom farmers are already familiar and with whom they have already established relationships of trust. The disastrous impact of severe insect infestation in recent memory has also played a role in farmers' seeking effective methods of control (Shilpa, et al 2017)

Shilpa (2017) goes on to say that initial demonstrations by USAID-KAVES, CSOs, and NGOs, as well as the supplier, Bell Industries, had an immediate effect. Whereas Bell had supplied a mere 3,105 units in 2013, almost all of which went to promoters, the following year 88 percent of over 66,000 units went to the commercial sector, and by 2015 almost all the production as sold through the commercial distribution network as reported. At the beginning of 2016, demand had risen so sharply that Bell was unable to keep up with it, and the network of suppliers was reporting empty shelves throughout the country.

In countries like Kenya, Farmers at every level in Kenya's staple sectors experience postharvest losses. In fact, it is not uncommon for a farmer to lose one-third of her maize as a result of poor storage and pest infestation. To address postharvest loss in Kenya, in 2013 Feed the Future Partnering for Innovation, a USAID program that develops public private partnerships to commercialize agricultural technologies for smallholder farmers, funded Purdue University to commercialize its Purdue Improved Crop Storage bag (PICS), a triple-layer, hermetic grain storage bag. PICS bags sell individually for about $2.50 USD and are adjustable, holding up to 90 kilograms of grain. Households as well as small aggregators can now use them over multiple seasons

The PICS Bags project in Uganda trains farmers in the use of triple layer crop storage sacks and finds local agribusiness dealers to supply them to the farmers. Purdue University partnered with NCBA CLUSA to pilot the introduction of PICS bags in the Kiryandongo, Apac, and Dokolo districts in February 2014 to March 2015. During the pilot project, farmers were taken through a series of awareness sessions and educational demos to create awareness about the bags and how to use them effectively. In the awareness sessions, volunteer farmers were selected from farmer groups at the village level to store crop grain of their choice in PICS bags for a period of at least 4 months after which the bags were opened during Open Bag Ceremonies (OBCs) for the farming community to witness the performance of the grain's quality after being stored in PICS bags versus traditional bags

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter explains the approaches and methods to be employed to obtain data on the research problem. It comprises of the research design, the area of study, the study population, the sampling approach (sample procedure, sample size, and sampling techniques), data collection methods and instruments, quality control methods (validity and reliability checks) and data management and processing, data analysis. It also indicates ethical considerations and highlights the problems anticipated during the study.

3.1 Research Design

According to Yin (2009) research design is a “blueprint” for conducting research, dealing with at least four problems: what questions to study, what answers are relevant, what data to collect and how to analyse the results. It is much more than a work plan. The main purpose of the research design is to help avoid the situation in which the evidence does not address the initial research questions. It is the conceptual structure within which research is conducted. It constitutes the blueprint for collection, measurement and analysis of data. The study focused on evaluating the relationship between usage of PICS bag technology and reduction of post-harvest losses in maize in Dokolo District. The approach helped to broaden data collected from respondents and this led to generation of more data on the problem.

Quantitative research employs numerical indicators to estimate 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 Yin (2009). Qualitative approaches on the other hand are based on 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, 2008). The quantitative method was administered by the use of questionnaire while the qualitative methods used key informant interviews and document reviews.

3.2 Area of Study

The area of the study was Dokolo District whose coordinates of the district are 01 55N, 33 10E. Dokolo District was established by the Ugandan parliament in 2005. It became operational on 1 July 2006. Before that, Dokolo was a county in Lira District. It is part of the larger Lango sub-region. The district is a predominantly rural district. Dokolo District is bordered by Lira District to the northwest, Alebtong District to the northeast, Kaberamaido District to the east and south, Amolatar District to the southwest, and Apac District to the west. The coordinates of the district are 01 55N, 33 10E. The population of Dokolo district is estimated to be around 197,400 UBOS (2017). Of the 1352 Km^2, 77.8 Km^2 is open water, protected forests 46.1Km^2 and 516.02 Km^2 is under cultivation. The district is characterized by Tropical climate with two seasons; dry and wet seasons. There is also a bimodal rainfall pattern with one peak during April-May and the other in September-October. The hottest months of the year are December, January and February. The whole district is dominated by tropical savannah woodlands consisting of shrubs and dominated mainly by Combretum, Albezia and Accacia. The researcher choses Dokolo District because it's one of the maize growing areas in Uganda. The study respondents comprise of small holder/individual/commercial maize farmers and warehouse/maize store owners managers in Dokolo District. The study will basically look at the relationship between the use of PICS bag technology and post-harvest loss management on maize production in Dokolo District LG.

3.3 Study Population

The study population included small holder/individual/commercial maize farmers and warehouse/maize store owners/managers selected from Dokolo District villages. The assumption is that they must have the relevant information in relation to the study variables.

3.4 Sampling Procedures

The researcher conducted the study on a sample of **198** respondents. The subsistence/commercial maize famers were systematically randomly selected from the villages. The farmers are those that have been active for the past 5 years growing maize. Warehouse/maize store staff will be selected purposively.

3.4.1 Sample Size

The sample is a collection of some (subset) elements of a population (Amin 2005). The study used a sample size of 198 respondents from a study population of 384 as estimated basing on Krejie and Morgan table (1970) as adapted by Sekaran (2003) for decision on sample size selection

Calculating the Sample Size

$$N = (Z\text{-}Score)^{2} \times SD \times 1\text{-}SD / E^{2}$$

Where; N = TOTAL POPULATION; SD = STANDARD DEVIATION; E = CONFIDENT INTERVAL (CI)

Where our SD is 50%, confident interval (CI) is 95%, Z-Score is 1.96.

$$SD = \mathbf{50/100} = 0.5$$

$$\mathbf{E} = 95\% = 100\% - 955 = 5\%: 5 / 100 = \mathbf{0.05}$$

$$\mathbf{N} = (Z\text{-}Score)^2 \times SD \times 1\text{-}SD / E^2$$

$$\mathbf{N} = (1.96)^2 \text{ x } 0.5 \text{ x } 1 - 0.5 / (0.05)^2$$

$$N = 3.8416 \times 0.5 \times 0.5 / 0.0025$$

$$\mathbf{N} = 3.8416 \text{ x } 0.5 \text{ x } 200$$

$$\mathbf{N} = 3.8416 \text{ x } 100$$

$$\mathbf{N} = 384.19$$

Population sample size is 384.19

The number of PICS Bags is unknown in Dokolo District and due to the time scope and resources available the sample size is still very high so the research decided to cut it down in order to finish up with the research.

$$\boldsymbol{TS = (n \times N) / (n + N - 1)}$$

Where; TS = TOTAL SAMPLE; N = SAMPLE SIZE OF THE POPULATION STUDY; n = POPULATION OF THE SAMPLE

The research used 384 sample size as the TS, N and n

$$\boldsymbol{TS = (n \times N) / (n + N - 1)}$$

$$\mathbf{TS} = (384 \text{ x } 384) / (384 + 384 - 1)$$

$$\mathbf{TS} = 147456 / 384 + 383$$

$$\mathbf{TS} = 147456 / 746$$

$$\mathbf{TS} = 197.66$$

$$\mathbf{TS} = 198$$

Hence the study considered a sample size of 198 respondents

Table 1*: Showing Population, Sample Size and Sampling Techniques*

Category of Respondents	Population (N)	Sample Size (S)	Sampling Procedures
Small holder farmers	200	103	Purposive Sampling
Individuals	100	52	Purposive Sampling
Subsistence/commercial Maize farmers	46	24	Simple Random sampling
Warehouses / Maize stores staff	38	19	Purposive Sampling
TOTAL	**384**	**198**	

Source: Krejcie and Morgan (1970)

3.4.2 Sampling Techniques

Bhattacherjee (2012) defines a sampling procedure as a way of obtaining a sample from a given population. The researcher uses appropriate and relevant sampling techniques for the study i.e. purposive sampling technique and simple random sampling are to be used to select samples and obtain information from each category of respondents as indicated in the table 1 above. In this study purposive sampling technique was applied selecting subjects that are considered to be relevant for the study.

However, judgment of the researcher is more important than obtaining a probability. Purposive sampling is the deliberate choice, it is a non-random technique and its results are usually expected to be more accurate than those achieved with the alternative form of sampling. Therefore, in this study, warehouse/maize store staff category of respondents were purposively selected to include those that are easy to acquire information from and save time. Also, simple random sampling technique is to be used by choosing an element at random from the elements and selecting the k^{th} consecutive element.

3. 5 Data collection sources

3.5.1 Primary data:

Primary data collected using first approach (Kumar, 2011). The researcher used primary data collection methods by obtaining information for the directly from the respondents. The primary data was collected from questionnaires and interview guides

3.5.2 Secondary data:

Sometimes the information required is already available in other sources such as journals, previous reports, censuses and you extract that information for the specific purpose of your study. This type of data which already exists but you extract for the purpose of your study is called secondary data (Kumar, 2011). 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. Document reviews assisted 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, 2011).

3.6 Data Collection Methods

The data collection methods that were used during this study include; questionnaires, key informants interview guide and document review.

3.6.1 Questionnaire Survey

A questionnaire survey is a research method that was used for collecting information from respondents using standardized questionnaires (Mugenda & Mugenda, 1999). This method involved collecting information from a selected sample in a systematic way Amin (2005) recommends using questionnaire survey to obtain a high level of general capability in representing a large population. Due to the usual huge number of people who answers survey, the data being gathered possess a better understanding of what is being studied. The high representativeness brought about by the questionnaire survey method also makes it easier to find statistically significant results than other data gathering methods (Sekaran, 2003).

3.6.2 Face to face Oral interviews

Face-to-face interview is a data collection method where the interviewer directly communicates with the respondent in accordance with the prepared questionnaire. In this study, the probing interviewing tactic was used extensively to obtain a deeper explanation of the issue at hand from the respondents as recommended by DiCicco-Bloom & Crabtree (2006). The respondents often need stimuli to expand and clarify their own answers or ideas to bring broader understanding in the findings of this study. In addition to interview guides, oral interviews were used to solicit for responses and these will be conducted by the researcher. These provided confidence and protection to the respondents and thus open up for more information.

3.6.3 Document review checklist

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 (PICS bag technology usage) and the dependent variable (post-harvest loss reduction in maize) were also reviewed.

3.6.4 Observations

Observation is a systematic data collection approach (Robert Wood Johnson, 2008). (Curtis Newbold: 2018). Observations helped the researcher better to determine what people did with the PICS Bags. The focus was on the use of bags and maize production

3.6.5 Focus group discussion

A focus group discussion involves gathering people from similar backgrounds or experiences together to discuss a specific topic of interest. (Dr Sushil Baral 2016). The purpose of the focus group was to collect information about people's opinions, beliefs, attitudes, perceptions about PICS Bags (Annette Gerritsen, 2011)

3.7 Data Collection Instruments

Data collection instruments are tools that in execution of research data collection (Bhattacherjee, 2012).

3.7.1 Questionnaires

The questionnaires were used to collect quantitative data directly from warehouse/maize stores staff. A questionnaire was used to facilitate the quantitative data collection. 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. 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 (Bhattacherjee, 2012).

Questionnaires comprising both open and closed end questions were used for data collection. Therefore, the researcher prepared a questionnaire to collect information about the dimensions of - post-harvest loss trends and post-harvest reduction in maize production.

3.7.2 Face to face Oral interviews

Key interview guides are qualitative (Kumar, 2011). They helped the researcher to obtain more information from the respondents as the researcher was able to make interactions with the respondents by asking questions. These guides had a list of questions that were asked in relation to the themes of study specifically the independent variable (PICS bag technology usage) and the dependent variable (post-harvest loss reduction in maize production). During this time the researcher used interview guides to interact with the busy farmers to enable the researcher collect information related to the study objectives. This tool further helped the respondents who did not have time to write and read and also help the researcher to make observations as she was taking notes in her notebook.

3.7.3 Document review checklist

A document review checklist was used for carrying out the document review. This is an instrument which contains a list of all documents reviewed that were relevant to the phenomena under study.

3.7.4 Observations

Observations checklist was helped the researcher to determine how people interact about the PICS Bags and their behavior in the different environments.

3.7.5 Focus group discussion

The research gathered different maize farmers in the region and discussed with them about PICS Bags and maize production in their district. This helped the research to collect qualitative data consisting of a structured discussion and obtained in-depth information about PICS Bags.

3.8 Quality Control Methods

Here the tests of validity and reliability quality for empirical social research offered by Yin (2009) and confirmed by Kumar (2011) shall be used. Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. The validity and Reliability of instruments also refers to the quality that a procedure or instruments (tool) of a research is accurate, correct, true, and meaningful and right (Ishengoma 2011).

3.8.1 Validity

According to Bhattacherjee (2012), validity, often called construct validity, refers to the extent to which a measure adequately represents the underlying construct that it is supposed to measure. Validity relates to the ability to produce results that are in agreement with the conceptual values i.e. to measure what is expected to be measured and that the data collected reflects the true opinion of the respondents, which is determined by research instruments (Kumar, 2011). It offers triangulation, using several methods, as a means to ensure construct validity of results obtained from research. Here, results from one method e.g. a qualitative one, can be used to inform another method e.g. a quantitative one, and vice versa. As Amin states, any bias inbuilt in a particular data source, investigator or method would be defused when used in combination with another data source, investigator or method. The researcher requested two supervisors to score the content with the questionnaire and the average percentage of the score was used to determine the Content Validity Index (CVI); in cases where the average percentage found to be above 70%, the content and was considered valid.

Table 2: Validity findings

	Relevant items	Not relevant items	Total
Rater 1	28	2	30
Rater 2	29	1	30
Total	57	3	60

$$CVI = \frac{\text{Relevant Items X 100}}{\text{Total Number of Items}}$$

$$= \frac{57 \text{ X } 100}{60}$$

$$= 95$$

The content validity index (CVI) computed above was above 70% the instruments were considered valid

3.8.2 Reliability

Reliability refers to the assessment of accuracy of the closeness amongst indicators to which a research instrument is dependable and trustworthy such that another investigator using the same tool would come up with the same results (Kumar, 2011). This is such that errors and biases are eliminated and this study shall achieve it using Cronbach's Alpha coefficient to ensure accuracy, completeness and consistent measurement across time and across the various items in the instruments (Kumar, 2011). Cronbach's Alpha value also assisted in establishing the extent of relationship between the various items in the questionnaire and also checked for the internal consistency of our scale in order to recognize problem items in the scale and to calculate overall index of the repeatability preset in the scale.

The questionnaire was pre-tested in one cohort in order to calculate this value. The pre-test cohort did not use again in the major study. This test, together with the CVI enabled the researcher to check and improve the items in the questionnaire. The different items were then refined with some being added and possibly others which are found not to be necessary removed. The research used the opportunity of the test to train some research assistants who assisted in the main study.

3.9 Data Management and Processing

Data from the field was sorted, coded and organized in tables to reveal the percentage scores of the different study attributes. The researcher applied editing of the data to be collected to ensure accuracy and completeness and coding whereby code the pre-coded question so that all answers obtained from different respondents are classified into meaningful categories. Further the researcher applied frequency tabulation which involved placing the number of responses falling into a particular category and recording to them by using tallies so as to come up with a statistical table. This was an easy way of organizing raw data for easy interpretation. Qualitative data was enhanced by conducting interviews with some key informants such as subsistence commercial maize farmers and warehouse/maize store staff. The researcher was able to understand the participant's experience and perspective in relation to their storage of maize after harvest and storage before sale in Dokolo District. The researcher is to be in position to identify the pattern of themes for example finding common statements or ideas that appears repeatedly and to code the data. Qualitative data was presented highlighting the key aspects that are to be pointed out by the respondents from the field to draw conclusions from the study.

3.10 Data Analysis

The researcher evaluated the worth of the data using both the quantitative and qualitative methods in the data analysis.. Data collected from the questionnaires was coded, entered, edited for consistency and evaluation and analysis was made to determine the adequacy of the information and the credibility, usefulness and consistency. The data collected was later analyzed using Statistical Package for the Social Sciences (SPSS) computer program. Quantitative data was presented in form of descriptive statistics using mean and standard deviations for each of the variables used in the study. Data from questionnaires was presented in form of tables and charts to give meaningful interpretation of the study.

In qualitative analysis, content analysis was used to edit data from interviews and focus group discussion and reorganize it into shorter meaningful sentences. These were then presented to supplement the quantitative data in order to have a clear interpretation of the results.

3.11 Ethical Considerations

The researcher and research assistants took into consideration a number of ethical issues. Confidentiality of respondents was kept since they were not be required to reveal their names nor their contacts on the questionnaires. Identification numbers were used instead of names to avoid information given being traced to a respondent.

Organizational identity and other critical information were also kept strictly confidential and all data gathered was used only for the purpose of this study and nothing else.

The research procedures were explained to all the respondents before they take part in the research and their informed consent obtained.

All the sources of literature were acknowledged throughout the whole study through proper citations and referencing.

Personal bias was avoided during the entire study i.e. during data analysis and reporting.

3.12 Limitations of the Study

During the field study, the researcher faced some difficulties such as being limited by the reluctance of some respondents to complete the questionnaires promptly. In this case the researcher ensured patience and direct involvement in completion

The researcher experienced a problem of limited finances with respect to this study. Costs regarding this limitation included transport, printing and photocopying of relevant materials. However, the researcher had to request for grants or source some money from relatives, friends and used it sparingly so as to overcome the cost constraint.

Another challenge was the busy schedule of the respondents. This made it difficult to get them to respond in a timely manner. In this case, there call for persistence in making appointments provided great help

The researcher also faced a time constraint in data collection, analyzing of data and in final presentation of the report. However, the researcher overcame this problem by ensuring that the time element is put into consideration and that all appointments agreed upon with respondents are fully met

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter comprises of a presentation of results and their interpretation. The presentation in this chapter shows the results as tested according to the objectives of the study. The chapter begins with the demographic characteristics of the respondents such as gender, head of family, land owned, decision makers and family type which were all presented using cross tabulations.

4.1 Response rate

The study administered the following instruments for the collection of the data**.**

Table 3: Showing the Response Rate of the Respondents

Instruments	**Targeted No**	**Actual respondents**	**Percentage (%)**
Questionnaires	174	174	100.0
Interviews & Focus group Discussion	24	20	83.3
Total	198	194	98.0

Source: Primary data

Table 3 demonstrated the distribution of the respondents according to the instruments used by the researcher that, 100.0% of the targeted respondents participated by answering the questionnaires whereas 83.3% participated by giving responses during the interview and Focus group discussion. The outcome from the table shows that the level of participation was absolutely effective as shown by the number of the respondents in relation to the research instrument employed as shown. From the study, 174 questionnaires were filled and 20 responded to interviews and FGDs; which were returned and passed the data response cleanup process for acceptance for data analysis. The overall response rate was 98.0%. According to Amin (2005) a response rate equivalent to 50% is good, however that of 98.0% is excellent.

4.2 House hold characteristics

This section shows the gender, head of family, land owned, decision makers and family type of the respondents.

4.2.1 Gender of respondents

The researcher was in interested in finding out whether the gender of the respondent can influence the use of PICS Bags in the district

Table 4: Gender of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	58	33.3	33.3	33.3
	Female	116	66.7	66.7	100.0
	Total	174	100.0	100.0	

Source: primary data (2018)

The finding in the table 4 above showed that 33.3% of the respondents where male and 66.7% were female. This implies that the female where more responsive compared to their male counterpart. Therefore the respondents were enough for the research to assess the contribution of PICS Bags in the district in monitoring postharvest loses and trends in maize production. This was found relevant because respondents of different genders could be having varying views and knowledge on the contribution of Purdue improved Crop Storage bag technology to monitoring post-harvest loss trends and post-harvest reduction in maize production. A study by Lusiba, *et. al.,* (2017) revealed that that female farmers were prone to high levels of losses than their male counterparts and that male farmers tended to experience less loss than females. Ansah and Tetteh. (2016) also pointed out that males increased Post Harvest Loss when they were hired as labor by female-headed households; there was more Post Harvest Loss because the labor was accessed late and there was no effective supervision due to cultural restraints.

4.2.2 Family head

The researcher was in interested in finding out whether the head of the family can influence the purchase and use of PICS Bags in the district

Table 5: showing findings on Family head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Husband	138	79.3	79.3	79.3
	Wife	19	10.9	10.9	90.2
	Guardian	16	9.2	9.2	99.4
	Children	1	.6	.6	100.0
	Total	174	100.0	100.0	

Source: primary data (2018)

The finding in the table 5 above showed that 79.3% of the respondents families where headed by husbands compared to the 10.9% wives, 9.2% guardians and 0.6% children. This implies that most of family heads the researcher visited where husbands, so they could affect the contribution of PICS Bags in the district in monitoring postharvest loses and trends in maize production.

4.2.3 Land ownership

The researcher was in interested in finding out whether land owned by an individual will affect him or her on how to use during a given maize season hence influencing the use of PICS Bags in the district

Table 6: Showing Land ownership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Customary land	131	75.3	75.3	75.3
	free hold land	43	24.7	24.7	100.0
	Total	174	100.0	100.0	

Source: primary data (2018)

The finding in the table 6 above showed that 75.3% of the respondents owned customary land compared to the 24.7% that owned free hold land. Customary land is the land communally owned by a particular group of people in a particular area. Its utilization is usually controlled by elders, clan heads or a group in its own well-defined administrative structures while free hold land is a system of owning land in perpetuity and was set up by an agreement between the Kingdoms and the British Government. Grants of land in freehold were made by the Crown and later by the Uganda Land Commission. The grantee of land in freehold was and is entitled to a certificate of title. This highly implies that the land owned by an individual will affect the use of PICS Bags in monitoring postharvest loses and trends in maize production in the district.

4.2.4 Decision making

The researcher was in interested in finding out whether the decision makers of the family will influence the purchase and use of PICS Bags in the district.

Table 7: Decision making

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	husband	139	79.9	79.9	79.9
	wife	11	6.3	6.3	86.2
	guardian	23	13.2	13.2	99.4
	children	1	.6	.6	100.0
	Total	174	100.0	100.0	

Source: primary data (2018)

As seen in the table 7 above the decision makers in most where husbands. This implies that most of family decision makers where husbands, so they could affect the contribution of PICS Bags in the district in monitoring postharvest loses and trends in maize production.

4.2.5 Type of family

The researcher was in interested in finding out whether the type of the family will influence the purchase and use of PICS Bags in the district. As the larger the family the higher the resources needed in the family.

Table 8: Showing the Type of family

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	extended family	95	54.6	54.6	54.6
	nuclear family	44	25.3	25.3	79.9
	single parent family	23	13.2	13.2	93.1
	grandparent family	10	5.7	5.7	98.9
	step family	2	1.1	1.1	100.0
	Total	174	100.0	100.0	

Source: primary data (2018)

The finding in the table 8 above showed families were extended. This implies that the type of family influences the use of PICS Bags in the district in monitoring postharvest loses and trends in maize production. Aidoo, *et. al*. (2014) that the larger the household size, the more the ability to manage postharvest losses effectively compared to smaller sized households the argument is that relatively high amount of family labour are more readily available and are at the disposal of the farmer for harvesting and other processes for speed and efficiency, ceteris paribus and thereby record lower levels of post-harvest loss. Abdul-Fatahi, *et. al*., (2016) also argued that It is unlike the smaller sized households where the scarcity of hands will reduce the speed and efficiency with which post-harvest activities can be carried out, thereby leading to high post-harvest losses. It means then that large family size is negatively correlated to Post Harvest Loss.

4.3 The adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District.

4.3.1 Growing maize

The numbers of respondents who grow maize are showed in this table 9 below as the research's aim was rotating around maize production

Table 9: Showing whether respondents you grow maize

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	135	77.6	77.6	77.6
	no	39	22.4	22.4	100.0
	Total	174	100.0	100.0	

Source: primary data (2018)

Table 9 above shows that 77.6% of the population the researcher approached grew maize hence the aim of the researcher.

4.3.2 Methods used for storage.

The researcher's aim was to find out whether the people of Dokolo district used PICS bags in storing their produce hence cross tabulated those who grow maize and the methods used in storing maize.

Table 10: showing a cross tabulation on the methods used for storage.

			methods used in storing maize				Total
			pics bags	grannies	grass baskets	clay pots	
Do you grow maize	Yes	Count	130	1	2	2	135
		%	99.2%	100.0%	100.0%	100.0%	99.3%
	No	Count	1	0	0	0	1
		%	0.8%	0.0%	0.0%	0.0%	0.7%
Total		Count	131	1	2	2	136
		%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

Basing on table 10 above shows that the respondents use PICS Bags in storing there maize over 130 respondents out of the 174 respondents approached by the research used the bags. This implies that the people of Dokolo district adopted the pics bags technology in the reduction of post-harvest losses in maize production. However other respondents used grannies, grass baskets and clay pots. Nzioki and Kandiwa (2015), noted that farmers widely store their grains inside the house and in their bedrooms (though the women would rather not store in their bedrooms because they believe that the practice of dusting the maize with super - actellic is hazardous to their health); storing inside the house is done as a result of theft which is a major threat to farmers and as a liquid savings mechanism.

4.3.3 Which grain they stored in PICS Bags

Since the researcher's aim was on relationship between PICS Bags and maize what farmers used the PICS Bags for was important.

Table 11: showing which grain they stored in PICS Bags

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	maize only	92	52.9	70.2	70.2
	maize and legumes	34	19.5	26.0	96.2
	legumes only	5	2.9	3.8	100.0
	Total	131	75.3	100.0	
Missing	System	43	24.7		
Total		174	100.0		

Source: primary data (2018)

Table 11 above shows that the respondents used the PICS Bags in storing in maize at 70.2% and basing on our above table 10 that gives us a 99.2% respondents who have PICS Bags hence the use of the PICS Bags technology in monitoring the reduction of post-harvest losses in Dokolo district.

4.3.4 PICS bags owned by a farmer

The researcher wanted to know how many bags each respondent owned in order to determine the adoption rate of the bags cross tabulating those who grew maize and the bags they owned.

Table 12: PICS bags owned by a farmer

			pics bags owned				Total
			2 – 5	6 - 10	11 - 15	others	
do you grow maize	yes	Count	58	41	26	5	130
		%	98.3%	100.0%	100.0%	100.0%	99.2%
	no	Count	1	0	0	0	1
		%	1.7%	0.0%	0.0%	0.0%	0.8%
Total		Count	59	41	26	5	131
		%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

Basing on table 12 above, it clearly indicates that most of the respondents that owned PICS Bag Fall under the range of 2-5 bags at almost 98.3%. As per the researchers observations at least every respondent approached had two PICS Bags this implies the adoption rate technology of the reduction of post-harvest losses. It is important to note that PICS bag storage is sustainable, cost effective, user-friendly and environmentally benign and its use has resulted in up to a 98% reduction in storage losses, maintained seed viability and quality for long storage times (Villers, *et. al.*, 2008).

4.3.5 Frequency of PICS Bags usage.

Are the farmers who have the PICS Bags using them or just keeping them for just hence the researcher wanted to know if the bags as it was meant to be used. The researcher analyzed those who grow maize with the frequency the farmers used PICS Bags.

Table 13: showing the Frequency of PICS Bags usage

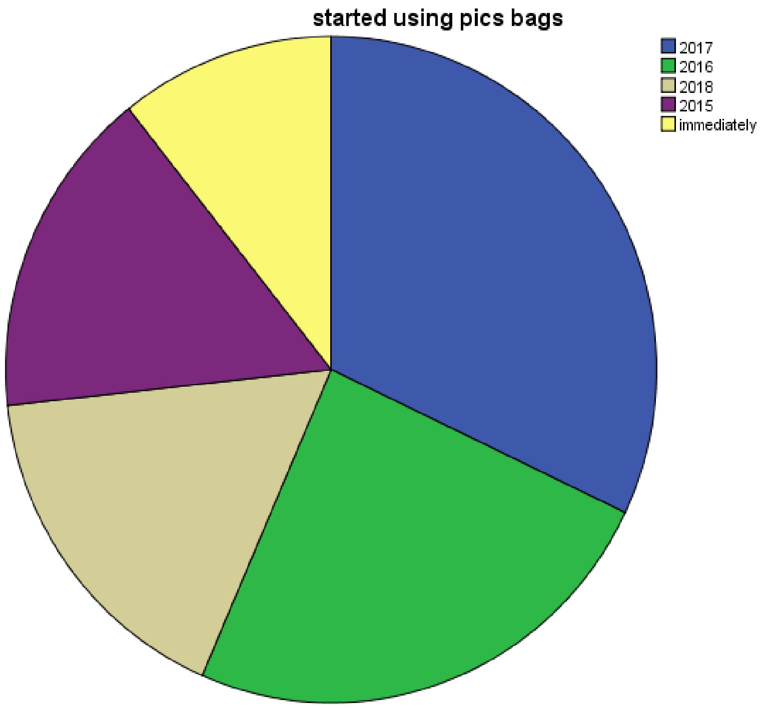
			frequency of pics bags use			Total
			every season	once every season	twice in every season	
do you grow maize	yes	Count	126	3	1	130
		%	99.2%	100.0%	100.0%	99.2%
	no	Count	1	0	0	1
		%	0.8%	0.0%	0.0%	0.8%
Total		Count	127	3	1	131
		%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

Table 13, clearly indicates the positive impact on monitoring post-harvest losses as the almost all respondents that use the PICS bags used the bags almost every season.

4.3.6 Starting to use PICS Bags

Since the introduction of PICS Bags in Uganda 1n 2014, the researcher wanted to find the rate at which the bags have been adopted since then to current date



Source: primary data (2018)

Figure 2: showing when the respondent started to use PICS Bags

Basing on the figure 2 above, it clearly indicates the year in which the respondents adopted the PICS Bags. As the years go by there's a change in adoption of PICS Bags compared to when the Bags were first introduced in 2014 as most of the respondents were reluctant about the PICS Bags that is 2018:16.0%, 2017:32.1%, 2016:24.4%, 20.15: 16.0%, immediately: 10.7% as per May 2018. This shows that the Bags are brought every year and there's a slight increment in the number of bags percentage owned by the respondents every year however it shoots higher in 2017 at 32.1% hence adoption rate technology of the reduction of post-harvest losses.

4.3.7 Factors that limit the usage of PICS Bags

The researcher cross tabulated the factors that limited the farmers from using PICS Bags from the time they started using the bags hence knowing why farmers fail to adopt the PICS Bags technology. The researcher cross tabulated factors that limited the usage of PICS Bags and when the farmers started using PICS Bags

Table 14 showing cross tabulated factors that limited the usage of PICS Bags and when the farmers started using PICS Bags

		started using pics bags					Total
		immediately	2015	2016	2017	2018	
lack of awareness	Count	6	7	6	7	9	35
	%	42.9%	33.3%	18.8%	16.7%	40.9%	26.7%
too expensive	Count	6	6	12	16	8	48
	%	42.9%	28.6%	37.5%	38.1%	36.4%	36.6%
usability of the pics bags	Count	2	5	8	8	0	23
	%	14.3%	23.8%	25.0%	19.0%	0.0%	17.6%
accessibility of the pics bags	Count	0	3	4	8	5	20
	%	0.0%	14.3%	12.5%	19.0%	22.7%	15.3%
availability of the pics bags	Count	0	0	2	3	0	5
	%	0.0%	0.0%	6.3%	7.1%	0.0%	3.8%
	Count	14	21	32	42	22	131
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

Basing on the table 14, each year there's a reason why PICS Bags are not used. Bags are too expensive as complained by the respondents at a 36.6% compared to the other reasons that is lack of awareness at 26.7%, usability of the PICS bags at 17.6%, accessibility of the PICS bags at 15.3% and availability of the PICS Bags lowest at 3.8%. This implies that the PICS Bags are available in the district but the prices are high at a range of UGSHS5000 – UGSHS6000. However at the time the PICS Bags were introduced and those who started using them immediately rotate under two reason lack of awareness and too expensive both at a 42.9% however this goes on changes as the years go on.

4.3.8 Source of material

The researcher wanted to know where the farmers got the PICS Bags from hence tabulating the source of material with the factors that limited the usage of PICS Bags.

Table 15: showing the cross tabulation of the source of material with the factors that limited the usage of PICS Bags.

		factors that limit usage of pics bags				
		lack of awareness	too expensive	usability of the pics bags	accessibility of the pics bags	availability of the pics bags
		Count	Count	Count	Count	Count
source of material	brought from the market	27	38	18	9	4
	received from NCBA CLUSA	2	2	2	2	0
	borrowed from a friend	6	8	3	9	1
	home made	0	0	0	0	0
	world food programme	0	0	0	0	0
	others	0	0	0	0	0

Source: primary data (2018)

Basing on table 15 above in correspondence with table 8.6, it Cleary indicates that the bags are expensive at 36.6% since they are brought from the Market compared to other factors that limit the usage of PICS Bags and were they got the Bags from.

4.4 The extent to which maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District.

4.4.1 Maize affected by pests

The researcher if the farmers that stored the maize with PICS bags was affected by pests this was cross tabulated with the causes of why their maize was affected.

Table 16: Cross tabulated with the causes of why their maize was affected.

			causes		Total
			bags were not tighten well	others	
maize affected by pests	yes	Count	37	0	37
		%	100.0%	0.0%	27.8%
	no	Count	0	96	96
		%	0.0%	100.0%	72.2%
Total		Count	37	96	133
		%	100.0%	100.0%	100.0%

Source: primary data (2018)

Basing on table 16, it shows respondents who used PICS Bags in storing their maize. Out of the 135 of 174 respondents who used PICS Bags technology only 27.8% out of the total respondent population's maize was affected by maize due not tighten their bags well. A PICS Bag is a three layer bag where each layer should be well tightened in order not to allow in air and keep the maize safe away from weevils. This implies PICS Bags technology to monitor post-harvest loss and trends reduction in maize production.

4.4.2 Approximate percentage of maize grain unaffected by weevils

The researcher wanted to find out the maize unaffected with weevils at the end of the storage period hence cross tabulating the approximate percentage of the grain unaffected with weevils at the end of season with the methods used in storing maize

Table 17: Cross tabulation of the approximate percentage of the grain unaffected with weevils at the end of season and the methods used in storing maize

			methods used in storing maize				Total
			pics bags	grannies	grass baskets	clay pots	
approximate % of the grain unaffected by weevils	approximately 10 - 40%	Count	1	0	1	0	2
		%	0.8%	0.0%	50.0%	0.0%	1.5%
	Approximately 41 – 70%	Count	1	0	0	1	2
		%	0.8%	0.0%	0.0%	50.0%	1.5%
	Approximately 71 – 100%	Count	129	1	1	1	132
		%	98.5%	100.0%	50.0%	50.0%	97.1%
Total		Count	Count	1	2	2	136
		%	%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

Basing on table 17 above it crosses over the approximate percentage of maize grain unaffected with weevils at the end of the storage period and the method one uses for storing in maize. As per the statistics above it showed that those who used PICS Bags in storing their maize, it was unaffected by weevils at 98.5% compared to the other respondents who don't use PICS Bags.

4.4.3 Maize grain already affected and the results

The researcher cross tabulated the results of the farmers who stored there already affected maize grain in PICS Bags with the results of the outcome after the storage period.

Table 18: Showing the cross tabulated of the farmers who stored there already affected maize grain in PICS Bags with the results of the outcome after the storage period.

		stored maize in PICS bags affected by pests	Total
		yes	
the pests in maize stored died	Count	94	94
	%	97.9%	97.9%
maize was all the same	Count	2	2
	%	2.1%	2.1%
Total	Count	96	96
	%	100.0%	100.0%

Source: primary data (2018)

As seen from Table 18 it shows results of those who stored their already affected maize by pests and what happened to those pests. As per the table it clearly indicates that irrespective of maize being affected by pests when stored in the PICS Bags and used us directly all the pest will die hence PICS Bags technology contribution in monitoring post-harvest lose and trends reduction in maize production. This is implies that the weevils eventually die after a long period because weevils consume the small amount of oxygen available and emit carbon dioxide (CO2). In just a few hours a low oxygen and enriched carbon dioxide (CO2) environment is created which stops the bruchids from causing the damage as noted by Murdock *et. al.,* (2003)

Table 19: Cause of post-harvest loses

Since the researcher's aim was to find the extent at which maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District. This helped in finding the root cause of maize losses.

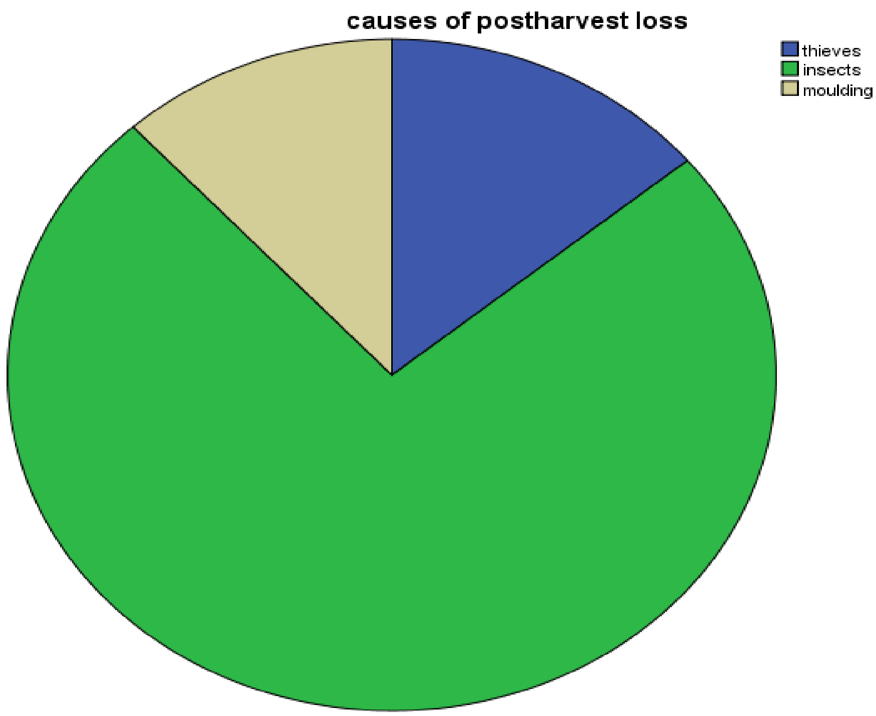
Table 20 Shows the Cause of post-harvest loses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	thieves	19	10.9	14.0	14.0
	insects	101	58.0	74.3	88.2
	Molding	16	9.2	11.8	100.0
	Total	136	78.2	100.0	
Missing	System	38	21.8		
Total		174	100.0		

Source: primary data (2018)

Basing on table 20 above clearly indicates the causes of postharvest loses in maize production. Insects are at the highest percentage of 58.0% while some stock was stolen by thieves at 10.9% hence need of using PICS Bags in maize storage in order to the damages caused by insects. In line with the study findings, Folayan (2013) documented that postharvest loses can be categorized into three: Physical factor which includes temperature and moisture content, of the stored grains, biological factors includes insects and mites, birds, rodents and other wildlife, micro-organism(fungi, mould and bacteria), engineering and mechanical factors include types and efficiency of harvesting tools, equipment and machines; primary processing equipment and machines; drying and storage structures; type and efficiency of non-farm transport, farming system and storage and marketing system etc.

As it's shown in the figure 3 below, insects take the bigger part of destroying stored maize.



Source: primary data (2018)

Figure 3*: Causes of postharvest loses*

4.4.4 Quantitative and qualitative loss of maize

Basing on table and the figure 3 above, Table 21 below shows the qualitative and quantitative post-harvest loss of maize as per the reason given above.

Insects being the highest cause of affected stored maize at 58.0% the qualitative and quantitative lose fall under 82.8% ranging between 10% - 29% maize loss which implies that farmer's loss their stored maize at a higher rate

Table 21: Quantitative and qualitative loss of maize

		qualitative and quantitative postharvest loss of maize				Total
		30% -49%	10% - 29%	5% - 9%	1% - 4%	
Thieves	Count	1	1	4	13	19
	%	2.0%	1.7%	30.8%	92.9%	14.0%
Insects	Count	47	48	6	0	101
	%	92.2%	82.8%	46.2%	0.0%	74.3%
moldings	Count	3	9	3	1	16
	%	5.9%	15.5%	23.1%	7.1%	11.8%
Total	Count	51	58	13	14	136
	%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

4.5 comparison post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it

4.5.1 Farmers understanding on both the PICS Bags and Ordinary Bags

Table 22: showing Farmers understanding on both the PICS Bags

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	pest controller bags	104	59.8	59.8	59.8
	miracle bags	70	40.2.	40.2.	100.0
Total		174	100.0	100.0	

Source: primary data (2018)

In order to compare post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it. The researcher aimed at finding out farmers understanding on both bags. It was revealed that PICS Bags were being understood as pest controller bags at a percentage of 59.8% and as miracle bags 40.2.

Table 23: showing understanding on Ordinary Bags

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	maize destroy bags	88	51	51	51
	disaster bags	86	49	49	100.0
Total		174	100.0	100.0	

Source: primary data (2018)

it was also indicated that the ordinary bags are being referred to as maize destroy at 51% and as disaster bags at 49% this clearly indicates the way to go is by using a PICS Bags in storing your maize basing on the statistics above hence PICS Bags technology reduction of post-harvest lose and trends in maize production.

4.5.2 Quantity reduction

Results in table 24 below shows quantity reduction in the maize grain stored in PICS Bags. However the table shows that with all that use PICS bags as per the researcher's respondents there's no such thing like quantity reduction in PICS Bags. This implies PICS Bags contribution in monitoring post-harvest lose and trends in maize production.

Table 24: showing Quantity reduction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	134	77.0	100.0	100.0
Missing	System	40	23.0		
Total		174	100.0		

Source: primary data (2018)

However Table 25 below shows that there's a quantity reduction of maize stored in ordinary bags at 96.5% at a range of 10% - 29% which means that of the maize stored farmers lose 30% of their maize quantity as it's all lost to insects. This was cross tabulated with farmers who said there was a quantity reduction if their maize and the range at which the maize was lost. Hence implies that individuals should shift from using Ordinary bags to PICS Bags.

Table 25: Cross tabulation of with farmers who said there was a quantity reduction if their maize and the range at which the maize was lost

			if yes				Total
			30% - 49%	10% - 29%	5% - 9%	1% - 4%	
quantity reduction ordinary bags	Yes	Count	29	82	18	2	131
		%	100.0%	96.5%	100.0%	100.0%	97.8%
	No	Count	0	3	0	0	3
		%	0.0%	3.5%	0.0%	0.0%	2.2%
Total		Count	29	85	18	2	134
		%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: primary data (2018)

4.5.3 Percentage of maize grain lost.

Despite the researcher knowing quantity reduction in the maize stored in both bags he went on to find out the percentage of grain lost after storage however farmers who used PICS Bags basing on the table 24 where farmers said no to quantity reduction in their maize after storage same here they had no comment while farmers who used Ordinary Bags where misery. PICS bag technology has the potential to decrease post-harvest losses of maize and other crops caused by weevils, improving food security and income generation opportunities as noted by Nzioki and Kandiwa (2015)

The figure 4 below shows the percentage of maize grain lost when stored in Ordinary bags at 67.8% ranging from 10% - 29%. This implies maize grain is lost when stored in Ordinary bags to Insects hence PICS Bags the way to go.

Source: primary data (2018)

Figure 4: Percentage of maize grain lost.

4.5.4 Special facility to store in bags

Table 26 : cross tabulation of growing maize and having special facility for storing pics bags

			special facility for storing pics bags		Total
			yes	no specify	
do you grow maize	yes	Count	135	0	135
		%	99.3%	0.0%	77.6%
	no	Count	1	38	39
		%	0.7%	100.0%	22.4%
Total		Count	136	38	174
		%	100.0%	100.0%	100.0%

Source: primary data (2018)

The researcher wanted to find out if there was any special facility needed to store in both the PICS Bags and ordinary Bags but to the finding in the tables 26 above and 27 below it showed that 99.3% respondents who owned PICS Bags and ordinary Bags. This implies that irrespective of what bag one use you can't just leave it where you want for example an open place that is not shaded from the rain. In a study by Mulunga and Kandiwa 2015), it was revealed that weevils are the primary cause of post-harvest loss in maize, particularly for hybrid varieties. Maize is commonly stored in outdoor structures called nkhokwe typically controlled by women who manage the food stock.

Table 27: cross tabulation of growing maize and having special facility for storing ordinary bags

			special facility for storing ordinary bags		Total
			yes	no specify	
do you grow maize	yes	Count	135	0	135
		%	99.3%	0.0%	77.6%
	no	Count	1	38	39
		%	0.7%	100.0%	22.4%
Total		Count	136	38	174
		%	100.0%	100.0%	100.0%

Source: primary data (2018)

4.5.5 Methods to keep away pests in the facilities of storage

At the different storages that are owned by both respondents who used PICS Bags and those who used Ordinary bags, the researcher wanted to know if they were any methods to keep away pests from their storage facilities. The findings are as follows

Table 28 cross tabulation of methods used in storing maize and method to keep away pest PICS bags

			method to keep away pests pics bags	Total
			none	
methods used in storing maize	pics bags	Count	130	130
		%	100.0%	100.0%
Total		Count	130	130
		%	100.0%	100.0%

Source: primary data (2018)

As the tables 28 above and table 29 below shows that with those that used PICS Bags needed nothing to do with fumigation as all their produce was safe relation to the FGD's conducted May 2018 that were conducted compared to the Ordinary Bags that needed fumigation at the store would be filled with pests allover consuming the stored maize hence using fumigations at a rate of 76.4%. This implies that PICS bags is the way to go irrespective of them being expensive respondents were ready to purchase them as there was no need to buy more pesticides to chase away pests as per the researcher's Observation may 2018

Table 29 respondents using Ordinary bags as fumigants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	fumigants	133	76.4	100.0	100.0
Missing	System	41	23.6		
Total		174	100.0		

Source: primary data (2018)

4.5.6 Period of maize storage before selling it off

The researcher was interested in the longest period the farmers would store in their maize. The research cross tabulated the period the farmers took to store in their maize and when they started using the pics bags comparing it to the period the farmers store their produce in the ordinary bags.

Table 30: cross tabulation of the period of storage pics bags and when they started using pics bags

		period of storage pics bags			Total
		2 - 3 months	4 - 5 months	above 6 months	
started using pics bags	immediately	0	1	13	14
	2015	0	0	21	21
	2016	0	1	31	32
	2017	1	3	38	42
	2018	0	6	16	22
Total		1	11	119	131

Source: primary data (2018)

It was revealed from the study as seen in table 30 that most respondents stored their maize after 6mmonths. As per the FGD's conducted, even those who had just started using the PICS Bags in 2018 are testimonies of keeping their produce safe from pests for longer time and therefore were able to monitor PICS Bags technology both post-harvest loss and trends in maize production. Hodges and Maritime (2012) argued that the expected sign for the storage duration coefficient is positive as very little loss occurs during the initial periods of storage. This denotes that the longer maize is stored, the better the post-harvest techniques that must be employed to avoid losses, implying that longer storage periods translate to higher postharvest losses.

Table 31: use of Ordinary Bags

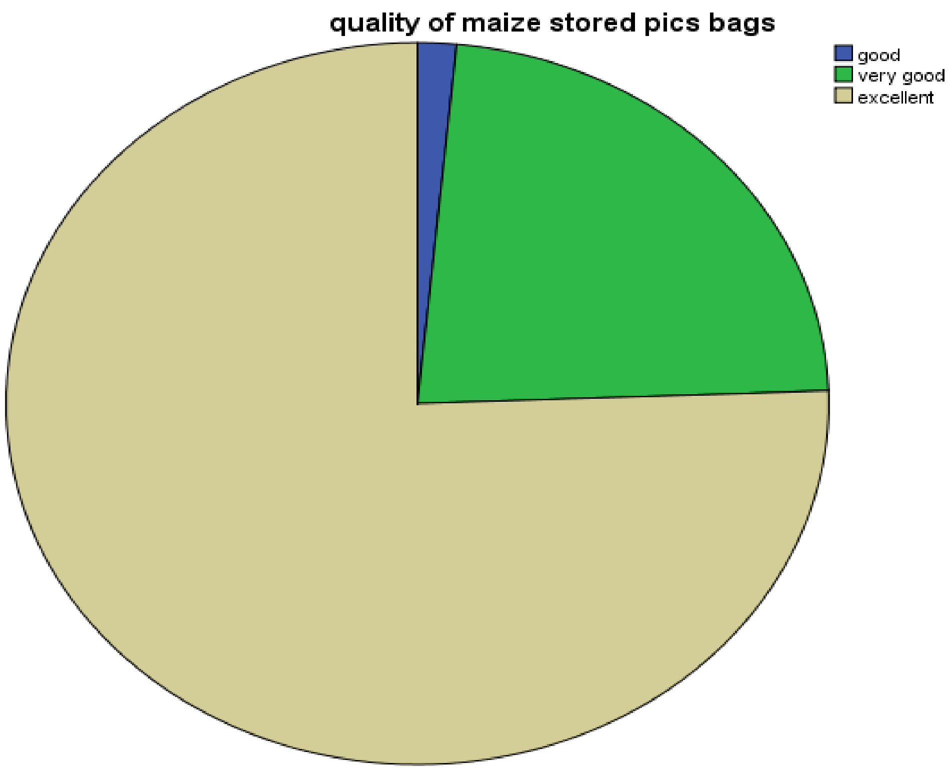
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 - 3 months	110	63.2	80.9	80.9
	4 - 5 months	22	12.6	16.2	97.1
	above 6 months	4	2.3	2.9	100.0
	Total	136	78.2	100.0	
Missing	System	38	21.8		
Total		174	100.0		

Source: primary data (2018)

With the above table 31, it clearly indicated that at 80.9% over used the ordinary bags for a short period of2 – 3 months

4.5.7 Quality of maize after storage:

The researcher was interested in find out the quality of the maize after storage in both PICS Bags and Ordinary bags. This was rated at poor, good, very good and excellent as below. However according to the statistics in the pie charts below, the data was as per the respondent's answers.



Source: primary data (2018)

Figure 5: Quality of maize after storage:

The above figure 5 above shows that farmers who used PICS Bags to store their Maize the quality was excellent compared to the poor quality of the maize when stored in ordinary bags however some produce comes our good. n and women reported how use of PICS bags reduces post-harvest losses thus increasing the amount of food available to farmers. In a study by World

Bank, (2011) Men said that PICS bags saved 20 to 30 percent of the crop from spoiling and therefore being wasted. Both men and women farmers reported that when they used PICS bags their grains kept well and as a result there was more food stored for the household.

4.5. 8: Agreeing to the longest period of storage

The researcher was interested in proving to the fact that PICS bags can last for more than 5 (five) years when they are still in good shape. The was rated at strongly disagree, disagree, not sure, agree and strongly agree of which most respondents strongly agreed that PICS bags can last for more than 5 (five) years when they are still in good shape

It was revealed that out of the 136 respondents agreed to the longest time a farmer could use PICS Bags at approximately 64% as shown in figure 6 below, compared to approximately 68% where not sure if the ordinary bags really had the longest time one would use the bags. FDG's conducted most farmers where in disagreement as the bag will get spoilt in less than a month

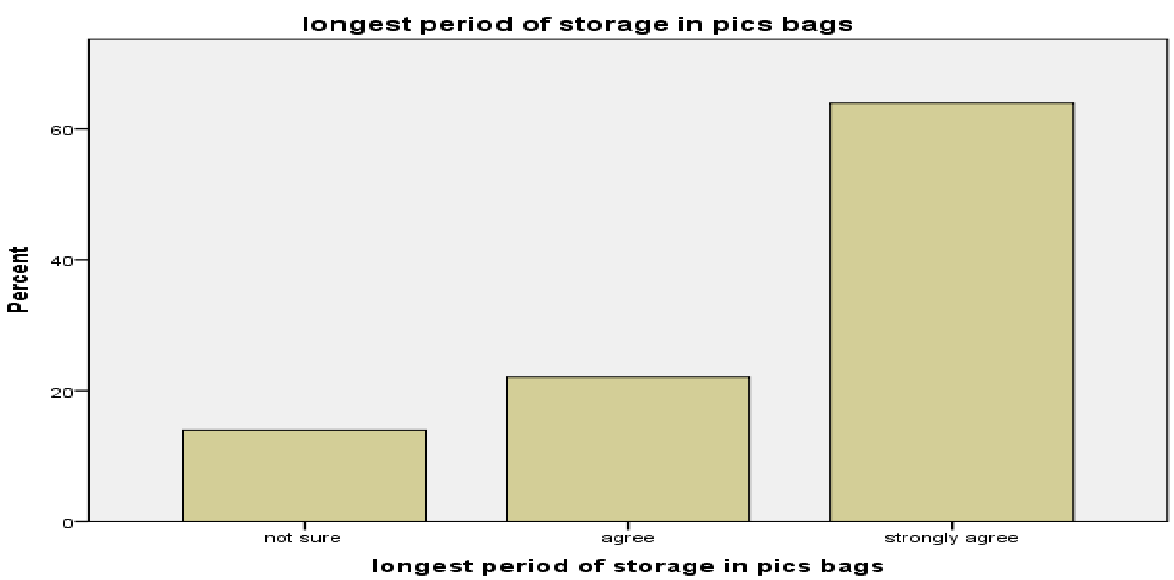


Figure 6: Longest Period of storage in PICS bags

4.6 Correlation analysis

Table 32: Correlation results for Purdue improved crop storage (PICS) and Post-Harvest Loss in Maize production

		Purdue improved crop storage (PICS)	Post-Harvest Loss
Purdue improved crop storage (PICS)	Pearson Correlation	1	-.579**
	Sig. (2-tailed)		.000
	N	174	174
Post-Harvest Loss	Pearson Correlation	-.579**	1
	Sig. (2-tailed)	.000	
	N	174	174

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Primary data (2018)

The researcher sought to establish whether a relationship existed between Purdue improved crop storage (PICS) and Post-Harvest Loss in maize production; this was done with the support of the Pearson Product moment correlation technique. The Pearson correlation (r=.0.579), sig (=.000) N (=174) that a negative relationship exists between Purdue improved crop storage (PICS) and Post-Harvest Loss in maize production. The p- value of .000, that is less than the alpha level of significance of 0.01 which implies that there is a significant correlation

4.7 Regression Analysis

Table 33: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.682[a]	.465	.426	.341

a. Predictors: (Constant), Purdue improved crop storage (PICS)

Source: Primary Data (2018)

The value of R being equal to 0.682 and the coefficient of determination (R squared) is equal to 0.465. The Adjusted R^2 linear value is equal to (0.426). This means that Purdue improved crop storage (PICS) explains 42.6% variation in reduction of Post-Harvest Loss in maize production.

Table 34: **coefficients for the regression equation**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.851	.040	221	21.492	.000
	Purdue improved crop storage (PICS)	.175	.035	.373	5.048	.000

a. Dependent Variable: reduction of Post-Harvest Loss in maize production

Source: Primary Data (2018)

According to the above illustrations, the p values are <0.01 hence there is evidence to accept that the variables Purdue improved crop storage (PICS) contribute to reduction of Post-Harvest Loss in maize production. This is evidenced by the β coefficients as seen in table above. This implies that a unit increases in any of the independent variable other factors constant increases the level of reduction of Post-Harvest Loss in maize production. Taking into consideration the standardized beta coefficient obtained as 0. 373 means that one unit change in Purdue improved crop storage (PICS) technology, results in 0.339 units reduction of Post-Harvest Loss in maize production.

CHAPTER FIVE

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter draws the summary of the findings and conclusions from the study based on the findings presented in data analysis in relation to the study objectives. The chapter also advances the recommendations, as well as identifying the areas for further studies.

5.2 Summary of the findings

5.2.1 The adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District

It was revealed that most respondents (77.6%) in Dokolo district grew maize and used PICS bags in storing their produce so as to reduction of post-harvest losses in maize production. These bags were mainly used to store maize (52.9%) or sometimes legumes (19.5%). The farmers were found to own the bags (98.3%) and mostly used them every season. The PICS Bags were being used in Uganda since 2014. The factors that limited the usage of pics bags included lack of awareness, being too expensive (prices ranging from Ugx 5000 – UGX 6000), usability, accessibility and availability of the PICS bags. The sources of the materials were mainly from the market or borrowing from a friend and others receiving them from NCBA CLUSA. PICS bags have been successfully demonstrated to protect maize against its most common pest, weevils. The success of PICS bags with maize encouraged industrious farmers to store other types of grain, like cowpeas, in PICS bags. This is so because this study has demonstrated that PICS bags protect maize against insect pests during with no loss of quality over 6 months.

5.2.2 The extent to which maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District.

It was revealed that the maize affected by pests (27.8%) was mainly due to the fact that the bags were not tighten well in order not to allow in air and keep the maize safe away from weevils.. Approximately 71 - 100% of the grain stored in the PIC bags was not affected by the weevils at (98.5%)**.** The pests in the affected maize grain in PICS Bags died. PICS bags remained consistent for benchmarks of quality, such as stable moisture content and germination. This was not the case for maize stored in woven bags, especially those infested by the weevil. These results are consistent with the results of other studies focused on PICS bags, which demonstrated better outcomes for grain stored in the triple bags than for grain stored in other way. This implies that PICS bags are an effective method of controlling pests on maize for farmers. Not only is the damage inflicted by weevils severely limited, but other values of grain quality are preserved. The main causes of post-harvest loses included thieves, insects and molding though insets were the most feared factor in destroying stored maize.

5.2.3 Comparison post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it

It was revealed that PICS Bags were being understood as pest controller bags (59.8%) and others as miracle bags (40.2%). It was also revealed that there was no quantity reduction by (82.8%) of the respondents in the maize grain stored in PICS Bags which was not the case for the maize stored in ordinary bags whereby the around 10% - 29% of maize was lost to insects.

Nevertheless, the farmers had a special facility for storing PICS and ordinals bags. Farmers that used PICS Bags needed nothing to do with fumigation as all their produce was safe relation compared to the Ordinary Bags that needed fumigation at the store would be filled with pests allover consuming the stored maize. PICS bags allow farmers to store their grain without the use of insecticides and provides them the flexibility to sell when prices are high, while having chemical-free high quality food for their families throughout the year. Most respondents stored their maize after 6mmonths using the PICS Bags As compared to the ordinary bags for a short period of 2 – 3 months. The quality of the maize after storage in PICS was excellent Bags and Ordinary bags compared to the poor quality of the maize when stored in ordinary bags. PICS bags can last for more than 5 (five) years when they are still in good shape. PICS bags have displayed lower maize storage losses compared to conventional methods of storage bags over a period of time.

5.3 Conclusions

5.3.1 The adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District

There was a good adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District. Farmers in Dokolo district grow maize and used PICS bags in storing their produce so as to reduction of post-harvest losses in maize production every season since 2014. Challenges for the adoption include lack of awareness, being too expensive, usability, accessibility and availability of the PICS bags

5.3.2 The extent to which maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District.

To a large extent, the maize losses been reduced among farmers who use PICS bag technology in maize storage and maize production in Dokolo District. If bags are not tighten well in order not to allow in air and keep the maize safe away from weevils, they can be affected by pests. However, the pests die when they are stored in the PICS Bags.

5.3.3 Comparison post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it

There are fewer post-harvest losses in maize production between farmers who adopted PICS bag technology compared to those who have ignored it. PICS Bags are pest controller bags. Never the less the farmers had a special facility for storing PICS and ordinals bags. Farmers that used PICS Bags needed nothing to do with fumigation as all their produce was safe relation compared to the ordinary Bags that needed fumigation at the store would be filled with pests allover consuming the stored maize.

5.4 Recommendations

The quality of the maize after storage in PICS was excellent and therefore, it is recommended that government should empower households on the adoption of the Purdue Improved Crop Storage (PICS) since they are designed to store crops and reduce post-harvest losses from pests such as bruchids, also known as weevils.

Since some farmers had difficulty accessing PICS bags at points that were far away from the village. Dissemination strategies should consider the different constraints men and women face accessing PICS bag distribution centres to ensure that both men and women can purchase the bags.

More trainings and demonstrations should be given to farmers so that they can gain more complete understanding of how hermetic storage works to control insects and other organisms associated with stored grain.

The challenge of accessibility of PICS was that they were too expensive. It is also recommended that the farmers should join or form association whereby they can be able to purchase the PICS bags as an association and then distribute to the farmers. This will enable get them at subsidized prices and enjoy economies of large scale production

5.5 Areas for further studies

The same study could be conducted a few years from now in order to establish if there are any changes in the contribution of Purdue improved crop storage (PICS) bag technology to monitoring post-harvest loss trends and post-harvest reduction in maize production within this environmental setting.

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Appendix I: Research tools

QUESTIONNAIRE

Dear Sir/Madame,

My name is Busingye Doreen Elizabeth, a second year student of Uganda martyrs University pursuing a Master's Degree in Monitoring and Evaluation. I am carrying out a study in the contribution of Purdure improved crop storage (PICS) bag technology to monitoring post-harvest loss trends and reduction in maize production.

Therefore, I humbly request you to respond to the questions in this questionnaire to enable me get the required information. All the information you provide me will be used only for purposes of this research and therefore considered confidential.

GENERAL INFORMATION

Name: ______________________________________ District: ________________

County: ____________ Sub-county:_____________ Village: ______________

Date: _____/______/_____

Please tick the response most appropriate to you code question (s)

Q1

Gender

☐ Male ☐ Female

Q2

Who is the head of the family?

☐ Husband ☐ Wife ☐ Guardian ☐ Children

Q2

Who owns the land?

☐ Customary Land ☐ Freehold Land ☐ Mailo Land

☐ Leasehold Land ☐ Public Land ☐ Others Specify

Q3

Who Makes decisions in the Home?

☐ Husband ☐ Wife ☐ Guardian ☐ Children

Q4

What Type of Family Do You Live In?

☐ Nuclear Family ☐ Single Parent Family ☐ Extended Family

☐ Childless Family ☐ Step Family ☐ Grandparent Family

Section A

Objective 1

A1

Do you grow maize?

☐ Yes ☐ No

A2

Which of the following methods do you use in storing your maize?

☐ PICS Bags ☐ Grannies ☐ Grass Baskets ☐ Clay Pots

☐ Other (Please Specify)

A3

If you use PICS bags, how many do you have?

☐ 2-5 ☐ 6-10 ☐ 11-15 ☐ Others (Please Specify)

A4

With the bags you have mentioned above, what capacity of bags do you have?

☐ 50kg PICS Bags

☐ 100kg PICS Bags

A5

What quantity of maize do you store in the PICS bags above?

☐ 10-50kgs of maize

☐ 50-100kgs of maize

A6

What is your frequency of use of the PICS bags?

☐ Every Season

☐ Once In Every Season

☐ Twice In Every Season

☐ Others (Please Specify)

A7

Source of material?

☐ Brought from the market

☐ Received from NCBA-CLUSA

☐ Borrowed from a friend

☐ Home Made

☐ World Food Programme

☐ Others (Please Specify)

A8

When did you start using the PICS bags since they were introduced?

☐ Immediately ☐ 2015 ☐ 2016 ☐ 2017 ☐ 2018

A9

Which grain do you use to store in the PICS bags?

☐ Maize Only ☐ Legumes Only ☐ Maize and Legumes

☐ Others (Please Specify) ____

A10

What Factors Limit The Your Use PICS Bags?

☐ Lack of awareness

☐ Too expensive

☐ Usability of the PICS bags

☐ Accessibility of the PICS bags

☐ Availability of the PICS bags

Section B

Objective 2

B1

Which process/stages do you ensure before storage of maize in the PICS bags?

☐ Harvesting

☐ Cleaning

☐ Selecting

☐ Packaging

☐ Storing

☐ Others (Please Specify) ____

B2

Has your maize ever been affected by pests when stored in PICS bags?

Yes ☐ No ☐

B3

What is the approximate percentage of the grain unaffected with weavils at the end of the Storage Period?

☐ Below 10%

☐ Approximately 10-40%

☐ Approximately 41-70%

☐ Approximately 71-100%

B4

What do you think was the cause?

☐ Bags were not tighten well

☐ Only tightened the inner layer of the bags

☐ Bags were too old

☐ Bags were of poor quality

☐ Other (please specify) ____

B5

Have you used PICS bags in storing already affected maize by pests?

Yes: ☐ No: ☐

B6

If yes, what happened to the affected maize that you stored in PICS bags?

☐ The Pests Died

☐ It Was All The Same

☐ Others (Please Specify) ____

B7

What are the causes of post- harvest loss in maize at your storage facility?

☐ Thieves

☐ Insects

☐ Moulding

☐ Environmental Factors

☐ Others (Please Specify) ____

B8

Rate The Qualitative And Quantitative Post-Harvest Loss Of Maize As Per The Above Causes?

☐ Above 50% ☐ 30%-49% ☐ 110%-29% ☐ 5%-9% ☐ L%-4%

Section C

Objective 3

C1

What do you understand

By A PICS Bag?

☐ Miracle Bags

☐ Pest Controller

☐ Others (Please Specify) ____

By Orinary Bags?

☐ Disaster Bags

☐ Maize Destroy

☐ Others (Please Specify) ____

C2

Do you realize a quantity reduction in the maize you stored

In PICS Bags?

Yes: ☐ No: ☐

If Yes, Specify?

____

☐ Above50% ☐ 30%-49% ☐ 0%-29% ☐ %-9% ☐ %-4%

In ordinary bags?

Yes: ☐ No: ☐

If Yes, Specify?

☐ Above 50% ☐ 30%-49% ☐ 10%-29% ☐ 5%-9% ☐ L%-4%

C3

How can you rate the percentage of maize grain lost during maize storage?

PICS Bags

☐ Above 50% ☐ 30%-49% ☐ 10%-29% ☐ 5%-9% ☐ L%-4%

Ordinary Bags

☐ Above 50%: ☐30%-49% ☐0%-29% ☐%-9% ☐%-4%

C4

Do you have a special facility for storing your packaged maize?

PICS Bags

☐ Yes

☐ No (Specify Where You Store) ____________________________

Ordinary Bags

☐ Yes

☐ No (Specify Where You Store) ____

C5

What method do you use to keep away pest from your storage facility?

PICS Bags

☐None

☐ Fumigants

☐ Others (Specify) ____

Ordinary Bags

☐ None

☐ Fumigants

☐ Others (Specify) ____

C6

For what period do you store your maize before selling it off?

PICS Bags

☐ 2-3months

☐ 4-5months

☐ Above 6 Months

Ordinary Bags

☐ 2-3months

☐ 4-5months

☐ Above 6 Months

C7

What is the quality of your maize after storage?

PICS Bags

☐ Poor ☐ Good ☐ Very Good ☐ Excellent

Ordinary Bags

☐ Poor ☐ Good ☐ Very Good ☐ Excellent

C8

Do you agree to the longest period you can use these bags for storage?

PICS Bags

☐ Strongly Disagree

☐ Disagree

☐ Not Sure

☐ Agree

☐ Strongly Agree

Ordinary Bags

☐ Strongly Disagree

☐ Disagree

☐ Not Sure

☐ Agree

☐ Strongly Agree

Interview / Focus Group Discussion Guide

Interview Question Guide On The Contribution Of Purdue Improved Crop Storage (Pics) Bag Technology To Monitoring Post-Harvest Loss Trends And Post-Harvest Reduction In Maize Production.

Objective 1

to establish the adoption rate of the PICS bags technology in the reduction of post-harvest losses in maize production in Dokolo District.

A1

a) Do you grow maize?

b) Do you own PICS bags?

c) How many bags do you have?

d) How many times do you use the PICS bags?

e) Where did you get the PICS bags from?

f) When did you start using the PICS bags?

g) Which grain do you store in the PICS bags?

h) what factors do you think limit the use of the PICS bags?

Objective 2

to establish the extent of maize losses among farmers who use PICS bag technology in maize storage and maize production in Dokolo District.

B1

a) Has your maize ever been affected by pests when stored in PICS bags?

b) What do you think are the reasons why?

c) How do you rate the percentage of grain infected with weevils at the end of the storage season?

d) Have you by any such stored your affected maize by pest stored them in PICS bags? what happened to the maize?

e) What do you think is the cause of post-harvest loss in maize at your storage (s)? rate the quantitative and qualitative maize loss?

Objective 3

to compare post-harvest losses in maize production between farmers in Dokolo District who adopted PICS bag technology and those who have ignored it.

C1

a) What comes to your mind when you hear about PICS and ordinary bags?

b) Do you realize quantity reduction in maize stored in PICS and ordinary bags? rate the quantity reduction?

c) How do you rate the percentage of maize grain lost during maize storage in PICS and ordinary bags?

d) Do have a special facility for storing in your packed maize in PICS and ordinary bags?

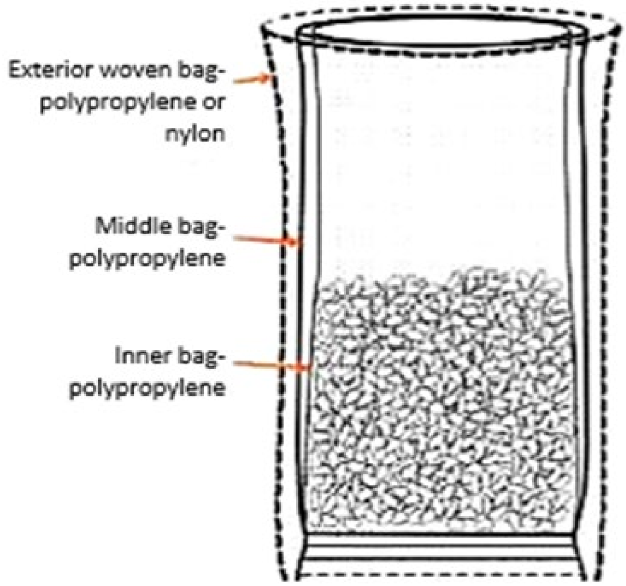
e) Any methods you use to keep pest away from your storage for PICS and ordinary bags?

f) How long do you store your packed maize in PICS and ordinary bags before you selling it off?

g) What is the quality of your maize after storage in PICS and ordinary bags?

h) Do you agree with the longest period of using PICS and ordinary bags for storage?

APPENDIX II: IMAGES OF PURDUE IMPROVED CROP STORAGE (PICS) BAGS



HOW TO TIGHTEN THE BAGS LAYER BY LAYER