ANALYSIS OF WILLINGNESS TO PAY FOR COMMUNITY BASED POTATO COLD STORAGE FACILITIES: A CASE OF SMALL SCALE PRODUCERS IN NAKURU COUNTY

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EGERTON UNIVERSITY

MAY, 2016

DECLARATION AND APPROVAL

DECLARATION

This thesis is my original work and it has not been presented in any university for the award of a Degree or a Diploma.

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APPROVAL

This thesis has been prepared under our supervision and submitted to the Graduate school for examination with our approval as university supervisors.

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DEDICATION

This work is dedicated to my parents Simon and Anna Mbugua for their love, support and encouragement. They have been my main source of inspiration through their hard work, determination, discipline, patience and who taught me the great value of hard work and always encouraged me to dream big and work towards turning my dream into reality.

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ABSTRACT

Potatoes are crops that although perishable can be stored easily with minimum loss of quality and quantity. Potato storage in Kenya is not common with the few farmers that practice it doing it traditionally and are therefore exposed to risks and consequently losses. Studies have indicated that the storage of potatoes is a means of protecting farmers from seasonality in supply and price fluctuations constraints. Studies in Tunisia, India, and USA have shown the benefits of potato storage but little has been documented on the willingness of farmers in Kenya to use or pay for specialised potato storage facilities. This study looked into the willingness of farmers to pay for the services offered at these centres as well as elicited the amount they would be willing to pay for the storage. The study used cross sectional data that was collected using predesigned interview schedules. A sample of 207 farmers was used in the study and it was obtained using the multi-stage sampling. The data was analysed and summarised using Excel, Stata and SPSS. Potato farmers in the county were characterised using descriptive analysis. The amount of money the farmers were willing to pay as storage cost was elicited using the Double Bounded Dichotomous Choice Model with the underlying distribution being a probit model. The empirical results indicated that age, education level, role of agriculture to the household, farm size and distance from the main road, access to market information and access to agricultural extension were significant factors at 0.05 confidence level. All of these factors had a positive influence on willingness to pay except age which had a negative influence. The results of the study also indicated that the amount farmers were willing to pay is higher than what the actual fee is. This therefore indicates that the Community based storage facilities are viable investments and can be used in achieving the vision 2030 which aims at increasing income from farming through innovative, commercially oriented and modern agriculture. The study recommends that a pilot cold storage facility be set up to so as to make the farmers fully understand the potential and benefits of potato cold storage technology. There is need for more consultation on the most optimum cost of storage facilities so as to influence the farmers in the region to use warehouse storage facilities.

TABLE OF CONTENT

DECLARATION AND APPROVAL ..... **ii**
COPYRIGHT ..... **iii**
DEDICATION ..... **iv**
ACKNOWLEDGEMENT ..... **v**
ABSTRACT ..... **vi**
LIST OF TABLES ..... **ix**
LIST OF FIGURES ..... **x**
LIST OF ACRONYMS AND ABBREVIATIONS ..... **xi**
CHAPTER ONE **1**
INTRODUCTION **1**
1.1 Background of the Study ---------- 1
1.2 Statement of the Problem ---------- 5
1.3 Objectives of the Study ---------- 5
1.3.1. General Objective ---------- 5
1.3.2. Specific Objective ---------- 5
1.4 Research Questions ---------- 5
1.5 Justification of the Study ---------- 6
1.6 Scope and Limitation of the Study ---------- 7
1.7 Definition of Terms ---------- 7
CHAPTER TWO **9**
LITERATURE REVIEW **9**
2.1 Potato Trends ---------- 9
2.2 Potato Production in Kenya ---------- 9
2.3 Potato Post Harvest Practices ---------- 10
2.4 Potato Storage ---------- 11
2.5 The Potential of Organised Storage Facilities ---------- 13
2.6 Risk ---------- 15
2.7 Willingness to Pay ---------- 16
2.8 Theoretical Framework ---------- 17
2.9 Conceptual Framework ---------- 19
CHAPTER THREE **20**

METHODOLOGY **20**
3.1 Study Area ----- 20
3.2 Sampling Procedure and Sample Size ----- 21
3.3 Methods of Data Collection ----- 22
3.4 Data Processing and Analysis ----- 22
3.4.1 Empirical Model ----- 22
CHAPTER FOUR **28**
RESULTS AND DISCUSSION **28**
4.1 Socio-economic Characteristics of the Smallholder Farmers ----- 28
4.1.1 Age ----- 28
4.1.2 Gender ----- 28
4.1.3 Highest Level of Education ----- 30
4.1.4 Land Ownership ----- 31
4.1.5 Planting and Marketing Decisions ----- 32
4.1.6 Access to Agricultural Extension ----- 33
4.1.6 Storage Practices in Nakuru County ----- 34
4.1.6.1 Knowledge on Ware Potato Storage ----- 34
4.1.6.2 Potato Storage Practices ----- 34
4.2 Factors Influencing the Willingness to Use Storage Facilities ----- 35
4.3 Average Fee That Farmers Are Willing To Pay for Storage Facility Services ----- 38
CHAPTER FIVE **39**
CONCLUSIONS AND RECOMMENDATIONS **39**
5.1 Conclusions ----- 39
5.2 Recommendations ----- 39
5.2.1 Policy Recommendations ----- 39
5.2.2 Recommendations for Further Research ----- 40
REFERENCES **41**
APPENDIX I **46**
Appendix 1: Research Survey Questionnaire ----- 46

LIST OF TABLES

Table 1: Description and measurement of variables to be used in the model..... 27
Table 2: Farm Size Descriptive Statistics..... 31
Table 3: Farm Size Distribution..... 31
Table 4: Farm Size vs. Role of Agriculture and Land Tenure on Potato Production..... 32
Table 5: Farmers Knowledge on Potato Storability and Methods of Storage..... 34
Table 6: Farmers Response to First Bid Offered..... 35
Table 7: Frequency of Farmers Responses to Various Bid Amounts..... 35
Table 8: DBDC Model Results for WTP..... 36
Table 9: Mean Value, Farmers are Willing to Pay..... 38

LIST OF FIGURES

Figure 1: Potato Production Trends 9
Figure 2: UK Storage Losses for the Record Variety 12
Figure 3: Conceptual framework 19
Figure 4: Farmers Age Distribution 28
Figure 5: Farmers Gender 29
Figure 6: Role of Agriculture to Farmers 29
Figure 7: Role of Agriculture in Relation to Farmers Gender 30
Figure 8: Farmers Level of Education 30
Figure 9: Role of Agriculture vs. Form of Land Ownership 32
Figure 10: Planting/ Marketing Decision Maker 33
Figure 11: Access to Extension Services and Market Information 33
Figure 12: Reasons/ Use of Stored Tubers 34

LIST OF ACRONYMS AND ABBREVIATIONS

ADC	Agricultural Development Corporation
cdf	Cumulative distribution function
CFC	Common Fund for Commodities
CIP	International Potato Centre
DBDC	Double Bounded Dichotomous Choice
FAO	Food and Agriculture Organisation of the United Nations
FAOSTAT	Food and Agriculture Organisation of the United Nations Statistics
GoK	Government of Kenya
HH	Household
Km	Kilometre
KES	Kenya Shillings
mm	Millimetres
MoA	Ministry of Agriculture
NPCK	National Potato Council of Kenya
PSDA	Promotion of Private Sector Development in Agriculture Programme
SHoMaP	Smallholder Horticulture Marketing Programme
Sq	Square
SSA	Sub-Saharan Africa
SPSS	Statistical Package for Social Sciences
USA	United States of America
WTP	Willingness To Pay

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Potatoes are the world's leading non grain staple food, and it ranks third among the most important food crops in terms of human consumption in the world after rice and wheat with more than a billion people consuming it worldwide (CIP, 2010). In the year 2010, worldwide potato production ranked fourth with an estimated 324,271,626 tonnes (FAOSTAT, 2012).

Over the years, there has been an increase in potato production area; this increase has been greater than all other food crops in developing countries (CIP, 2010). This might have been attributed to the fact that: a hectare of potato can yield up to four times the food quantities of cereal crops, are up to seven times more efficient in using water in their growth than cereals, and; they mature within 3 to 4 months, which is less than the number of months most cereals take (CIP, 2010). Developing countries are ideal for potatoes production as they are characterised by low land availability and abundant labour supply (FAO, 2006). In the year 2007 Kenya was ranked 8th in Africa in terms of potato production with an estimated area of 120,000 hectares of land covered with potatoes and 800,000 tonnes produced from this area at an average yield of 6.7 tonnes per hectare with the neighbouring country Uganda following closely as the ninth (FAO, 2008).

In Kenya, potatoes are the second most important food crop after maize (MoA, 2012). Potatoes are used as cash crops as well as a food crops (GoK, 2009). Potato production in Kenya is mainly done in the highland areas and most of the producers depend on rain fed agriculture (Gildemacher *et al.*, 2009). In the highlands, potatoes are considered a much more constant source of income compared to maize because they mature in 3 to 4 months while maize can take up to 10 months due to the climatic conditions. Therefore, potatoes production is an important source of income for farmers in potato growing regions.

According to Muthoni and Nyamongo (2009), main potato growing areas include parts of Molo, Meru, Kirinyaga, Embu, Laikipia, Nyandarua and Muranga counties, production in these regions is done twice a year during the two rainy seasons. This leads to excess supply after the rainy seasons and low during off seasons, which in turn lead to prices rising after the end of harvest, and later falling when the next harvest begins there is therefore a supply trend

that depends on the season (Walingo *et al.*, 2003). During months of glut supply, prices fall drastically and as a result, farmers' income is greatly reduced and may sometimes lead to losses. Most of the Potatoes produced in Kenya are consumed locally (FAO, 2008).

Potatoes unlike cereals are not exposed to border parity price volatility and other international market influences. This may be attributed to the fact that only a very small portion of the potatoes produced are traded internationally and hence their prices are determined by local demand and supply conditions, these makes it an ideal crop for food security in developing countries (FAO and CFC, 2010). An increase in potato production has the potential to reduce dependency on cereal foods, which will in turn reduce exposures to price volatility as well as reduce dependency on importation of cereal food commodities by developing countries (FAO and CFC, 2010). Therefore, ways of ensuring food security need to be sought and utilised. As in 2011, Neves identified investment funds operating in futures markets and other agribusiness markets as well as the increased use of food crops in the production of bio fuels as some of the reasons for the increased food prices and the expected further increase.

Although perishable, potatoes can be stored easily thus making them readily available to consumers by ensuring a regular supply all year round (Fuglie, 1999). Depending on the method of storage adopted, potatoes can be stored for 2 to 9 months (Lerner and Dana, 2000). In Kenya, potato storage is not common as most of the produce is sold at harvest (Kaguongo *et al.*, 2008). Farmers sell 80% of their produce at harvest while the rest is stored and used as seed in the next planting season (Gildemacher *et al*., 2009). Lack of proper potato storage facilities in Kenya has been attributed to be a major problem and an influencing factor to other constraints. Farmers in Meru, Laikipia and Nyandarua Sub-Counties are aware of the importance of potato storage and are already storing potatoes Walingo *et al*. (2003), they were in fact willing to improve storage if there was a guaranteed market for the stored potatoes, at the same time very few farmers in Nakuru practise potato storage as most of the production is done on hired land.

There are different ways of storing potatoes and the choice of structure and design to be adopted ought to depend on the quantity of potatoes to be stored, length of storage period, characteristics of varieties to be stored, the climatic conditions during the storage period and the use of the potatoes after storage (Booth and Shaw, 1981). Traditional methods of storing potatoes include leaving in the field by delaying harvest, clamping and covering with hay or soil. Potatoes stored using traditional methods cannot be store for long periods, this is due to

the fact that potatoes are living organisms and consequently respire. To be able to store potatoes for longer periods of time, longer than 1 month, stores specifically made for potato storage must be used. These stores must be able maintain tubers at a desired temperature, maintain a high relative humidity to promote wound healing at harvest and to prevent tuber shrinkage, provide oxygen for respiration and remove carbon dioxide and other harmful gasses as well deal with adverse storage conditions (Small and Pahl, 2003). Ventilation within the structures can be done using the refrigeration system or the ambient air system (Pringle *et al*., 2009). Cold storage facilities are helpful in that they prevent the decay of perishable products therefore increasing availability during off-seasons, these aids in preventing farmers from selling their produce at throw away prices and preventing shortages (Eltawil *et al*., 2006).

There are community based storage facilities under construction in the Mt Elgon region (Kasina and Nderitu, 2010). In Meru and Nyandarua counties there are four farmer groups that are willing to engage in setting up collection centres that have storage facilities so as to gain the benefits linked to them (Giencke, 2011). These groups have drawn up proposals or are in the process of writing them with an aim to get funds for the construction from Smallholder Horticulture Marketing Programme, (SHoMaP). The construction of these collection centres has been estimated to cost approximately KES 25 million. The collection centres will be a way for these groups to market their produce collectively as well as increase their bargaining power. SHoMaP is working with Promotion of Private Sector Development in Agriculture Programme (PSDA), with an effort to gain ideas from farmers as well as make them understand the concept of potato collection centres and potato storage.

The lack of storage facilities often lead to increased impact of other constraints farmers are exposed to. An example of these constraints is poor roads which lead to increased transportation costs as well as probability of post-harvest losses, in some areas the roads are not passable and this often leads to loss of the entire harvest. When harvesting takes place during drier months traders collect the produce straight from the farms, but if the converse occurs farmers have to hire carts or tractors at their cost to transport the produce to the nearest market centre (Diop, 1998).

The potato marketing chain has been characterised as being ineffective and affected by problems of marketing and production (GoK, 2009). There is therefore need for innovations aimed at improvement in the chain. Most potato farmers sell their produce on farm to traders

and brokers, prices obtained are most of the time non-negotiable this is due to the high sellers to buyers' ratio (Muthoni and Nyamongo, 2009). Farmers lack sufficient market information which often leads to uneven bargain power thus leading to exploitation by traders who in some instances set the prices rather than allow the demand and supply forces to play their role (Walingo *et al*., 2003). In 2005, the government of Kenya developed laws with the objectives of stream lining the chain and ensuring that farmers profit from potato production after identifying the ineffectiveness of the potato marketing chain (Kasina and Nderitu, 2010). However, these laws are not being adhered to and the lack of storage facilities was mentioned as one of the reasons why.

Farmers are also not able to obtain credit due to lack of collateral and incomes that are not constant. The lack of sufficient income has often lead to farmers selling immature tubers due to urgent cash needs which leads to poor quality tubers reaching the market which in turn fetch low prices. Insufficient income leads to poor crop husbandry and input use which lowers the quality and quantity of produce (Kabira, 2002). Most potato farmers in Kenya do not add any value to their produce and therefore have remained uncompetitive. It has been estimated that potatoes are worth less than half at farm gate compared to at consumption level (GoK, 2009).

Proper storage and collection centres have been identified as innovative tools that have the potential to improve farmers' income by protecting them from selling their produce at throw away prices before they decay (Eltawil *et al*., 2006). The introduction of proper storage facilities would help smooth out supply of potatoes to the market and in turn reduce or eliminate peaks during months of bumper harvests and depths during months of low supply and help reduce overall price oscillations (Fuglie, 1999). According to (Booth and Shaw, 1981) unwavering supply and prices lead to increased overall potato consumption. Increased consumption leads to increased potato demand. Collection centres would in addition be a source of information for farmers, and farmers would be able to market their produce through the centres there by increasing their bargaining power. Value addition can be done in these collection centres thereby integrating farmers vertically, increasing their income, and bargaining power. Food security and a steady source of income for potato farmers will eventually be achieved by reducing overdependence on maize, which is subject to international market influences, and its price is very volatile. The government of Kenya acknowledges the potential potatoes have as far as creating employment, income generation

and attaining the Millennium Development Goal No.1 of reducing extreme poverty and hunger by more than half by the year 2015 (MoA, 2009).

1.2 Statement of the Problem

Potatoes although semi-perishable can be stored for periods of between 3 weeks to 9 months depending on the store type, potato variety as well as the pre and on storage conditions. The current system of production which relies on rain fed agriculture leads to a seasonality in supply due to the bi-annual rainy seasons. Potato storage in Kenya is only practiced by few farmers with most of them selling their produce immediately after harvest. The few farmers that store potatoes in Kenya store very small quantities mainly for home consumption and the storage methods adopted are traditional or in multi-use stores. Therefore, there has been continuous low income for farmers as they sell their produce during months of glut. This kind of storage which lacks favourable conditions to ensure significant loss reduction means that the storage period is very short and with a high probability of losses. The current storage of potatoes is not sufficient to ensure a regular supply to the market and thus cyclical seasonality in the market supply. Storage of potatoes is not only important to ensuring food security but also securing the income of farmers in Kenya. Cold storage facilities are able to minimise losses in quality and quantity of potatoes for a longer period of time. Potatoes need to be stored after harvest in appropriate conditions where storage losses are significantly reduced. This study sought to address this question by assessing the willingness of potato farmers to use and pay for storage services in Community Based Cold Storage Facilities.

1.3 Objectives of the Study

1.3.1. General Objective

The study's general objective was to study potato storage among farmers in Nakuru County and their willingness to use and pay for the warehouse storage facilities and in so doing give an insight into the economic viability of these facilities.

1.3.2. Specific Objective

i. To determine the characteristics of potatoes farmers in the targeted regions.
ii. To determine factors influencing willingness of farmers in the region to use and pay for warehouse storage services.
iii. To determine the fee that farmers would be willing to pay for the storage services

1.4 Research Questions

i. What are the characteristics of potato farmers in Nakuru County?
ii. What are the factors that influence the willingness to use as well as to pay for warehouse storage services in Nakuru County?
iii. What is the fee that farmers would be willing to pay for the storage services?

1.5 Justification of the Study

Potato farming is an important source of income for farmers in Molo and Kuresoi Sub-Counties. Potatoes have the potential to provide food security for Kenya, create employment and earn income (MoA, 2009). Potatoes can cushion consumers from the high cereals prices which are susceptible to international markets movements, speculation activities and are subject to the import duties imposed on them (FAO and CFC, 2010). There are a number of opportunities such as the increased demand for ware potatoes, seed potatoes, processed potatoes and industrial goods that use potatoes as their raw materials, this has been brought about by the emerging trading blocs but have however not been taken advantage of (GoK, 2009).

The lack of storage has been identified as a major constraint for potato producers in Kenya (Muthoni and Nyamongo, 2009). Kasina and Nderitu (2010) identified the lack of storage as one of the causes of inefficiency within the potato marketing chain plus the lack of implementation and enforcement of the set of laws established in 2005 and the additional ones of 2008 laid down to stream line it.

Seasonality of the potato supply in Kenya results in price oscillations. The use of collection centres are a way of increasing farmers bargaining power ensuring a higher and constant source of income, provide farmers with information and input supplies as well as integrate them both vertically and horizontally. Increased incomes lead to a constant potato tuber supply and almost certainly an increase in yields.

The study aimed to collect information that will help decision makers to understand the characteristics of farmers they should target for storage of potato tubers. It will also give an insight if the production of potatoes in Kenya is ready to go to the next level of incorporating technology with an aim of increasing farmers' income. The study targeted to generate imperative information that will expound the willingness of farmers to store potatoes. Information generated by the study will guide policy making process in line with the

achievement of vision 2030, which seeks to increase income from agriculture through innovation, commercial orientation and modern agricultural production.

1.6 Scope and Limitation of the Study

The study covered Nakuru County in Rift Valley Province and focused on potato farmers within Molo and Kuresoi Sub-Counties. The study targeted farmers who had grown potatoes as a source of income and practiced potato production for at least 1 year before the study. Molo and Kuresoi Sub-Counties were considered because they are the highest potato producing Sub-Counties within Nakuru County. Owing to the limited time and financial resources, only a fraction of potato farmers within this region will act as a representative of all the potato producing farmers in the county. The study sought to achieve the following objectives: determine the characteristics of potatoes farmers who used cold storage and those that did not; determine factors influencing willingness of farmers in the region to use and pay for warehouse storage services and lastly; determine the fee that farmers would be willing to pay for the storage services.

1.7 Definition of Terms

Community based potato storage facilities: Are premises where potatoes are collected to be marketed immediately in the same form or after value addition or stored in cold rooms and sold later when prices go up. The aim of using the facilities is to take advantage of the seasonal price changes and increase overall farmers' income from potatoes.

Potatoes: potatoes are tuberous plants that belong to the Solanaceae family. Potatoes refer to both the plants as well as the edible tubers. Potatoes are usually white fleshed and very starch with skin that can be either whitish or pinkish.

Tubers: Are the edible part of the potato plant. Their shapes are round or oval and are commonly red or white in colour. They are usually underground during the growth period. They have depressions which are called the eyes and which if exposed to favourable conditions can sprout into new shoots.

Opportunity cost: Profit that potato farmers opt to go without by choosing to sell their produce at a specific time. This includes selling immediately after harvest rather than storing,

then selling later or opting to store then sell them later instead of selling immediately after harvest.

Potato farmers: Potato farmers are people engaging in the production of potatoes. They must have produced potatoes as a cash crop before the study.

Post-harvest activities: Are all activities that are carried out on the potatoes after they have been harvested. They include sorting, grading, storing, packaging and selling.

Price movements: These are the potato price changes over different seasons in the production areas over a period of one year.

Potato prices: The potato prices will be on farm or farm gate potato prices, which are prices the farmers' obtain for the potatoes from traders and brokers who are buying the tubers with the aim of selling them in other markets not local markets.

Risk: Are all unfavourable events that are likely to occur and whose impacts will expose potato farmers to significant loss of utility, wealth or income.

Ware potatoes: Are potatoes that are for consumption purposes. They are generally larger in size as compared to seed potato.

CHAPTER TWO
LITERATURE REVIEW

2.1 Potato Trends

Potatoes are the world's leading non grain staple food. It is the worlds' third most important food crops in terms of human consumption after rice and wheat with more than a billion people consuming it worldwide (CIP, 2010). In the year 2010 worldwide potato production was estimated to be 324,271,626 tonnes and it ranked fourth (FAOSTAT, 2012). More than half of the worlds potato production now comes from developing countries (Lutaladio *et al*., 2009). Worldwide there has been an increase in both potato production and consumption this may be attributed to the fact that the demand for industrially processed potato based products has been on the rise (InfoResources, 2008). This shows that potatoes are becoming more and more an important food and cash crop.

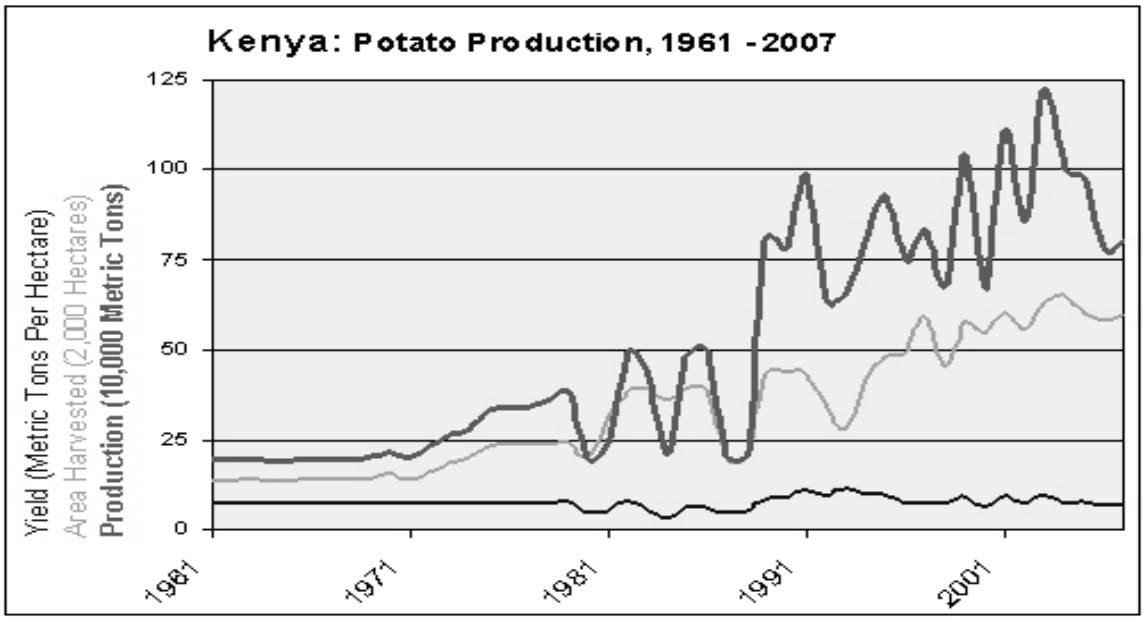

Figure 1: Potato Production Trends
Source: International Potato Centre, (2008)

2.2 Potato Production in Kenya

In their study on the policy implementation effects on potatoes value chains, Kasina and Nderitu (2010), identified potatoes as being an important food and cash crop in Kenya. Potatoes have also been identified as being the second most important crop in both consumption and production in Kenya (MoA, 2009). Potato production is mainly done on the

highlands because of the advantages it has over maize (Muthoni and Nyamongo, 2009). The Ministry of Agriculture (2009) identified the major potato growing areas in Kenya to be mainly found in Rift valley, Central and Eastern provinces. It was further noted that potato production has also extended to Western provinces (Mt Elgon region) as well as the Coast Province (Taita). The major potato growing areas were stated to include parts of Laikipia, areas on the slopes of Mt. Kenya such as Meru, Embu, and Kirinyaga, parts of the Aberdare ranges that include parts of Nyeri, Muranga, Kiambu and Nyandarua Sub-Counties. They are also grown in Mau-narok and Molo, which are areas on the highlands of Mau Escarpment as well as Tinderet, Nandi Escarpment and Cherang'ani hills (MoA, 2009). Potato producers in Kenya depend on rain fed agriculture and only a few regions for example Meru central practise potato irrigation (Muthoni and Nyamongo, 2009), the major potato production areas experience two main rainy seasons thus potatoes are mostly grown twice in a year and therefore the seasonal supply to the market.

Kenya was ranked eighth in Africa in terms of potato production in the year 2008 with: 120,000 ha under potatoes; an estimated harvest of 800,000 tonnes and; an average yield of 6.7 tonnes per hectare (FAO, 2008). Muthoni and Nyamongo (2009) identified the average yield range to be between 5 and 10 tonnes per hectare, which is very low compared to a potential of 40 tonnes per hectare. Gildemacher *et al*. (2009) noted that there has been an increase in the demand, supply and production area of potatoes in Kenya. The authors however noted that the increase in supply might not be attributed to an increase in yields rather to the increase in production area; the production area has been increasing steadily at an annual rate of 4.3%. It was further noted than an improvement in production alone will not result in a remarkable increase in profitability of potato production. According to the authors potato farmers' most important concern and influencing factor in their decision making was marketing. Therefore, technological innovation in combination with marketing intervention would increase the chance of success of interventions in the smallholder potato system in Kenya (Gildemacher *et al*., 2009).

2.3 Potato Post Harvest Practices

In a study done by (Gildemacher *et al*., 2009), in Kenya, Uganda and Ethiopia revealed that farmers in Kenya generally sell up to 80% of the quantity of potato produced while the remaining 20% is set aside for use as seed during the next planting season and for home consumption. Kaguongo *et al*. (2008) mentioned that most potatoes farmers in Kenya sell

their produce on farm to traders and brokers and since farmers depend on rain fed agriculture they all tend to harvest at the same time therefore potato prices during harvesting time tend to be low due to the high supply. The authors further noted that, both farmers and potato traders do not store potatoes which lead to large differences between potato farm gate prices and market prices with this differences being as high as 70%.

Sorting and grading is done on farm with the traders dictating the size of potatoes to be packaged the remaining tubers are used as seed during the next planting season or for home consumption or as livestock feeds. The produce is not weighed but packed in bags which are supplied by the traders. The size and design of a bag depend on the market the traders supply. Farm gate prices are also affected by factors such as the distance of the farm from main road, road conditions at time of harvest as well as the skin colour of the potatoes. Potato post-harvest practices in Kenya are not developed and farmers do not have a voice as soon as they harvest the tubers.

2.4 Potato Storage

Potatoes are perishable but can be stored for periods between 1 and 9 months. The fact that potatoes are perishable makes their storage a risky business (Fuglie, 1999). The quality of potatoes cannot increase during storage, however; their storability as well as storage losses depends on the potato variety, pre-storage conditions including agronomic activities during growth and harvesting, storage conditions and the length of storage period (Booth and Shaw, 1981). Losses which are mainly decrease in weight or reduced quality can be categorised as being pathological, physiological or physical (Walingo *et al*., 2003). Physical losses are brought about by mechanical damage which occurs from pre-harvest all through the storage handling period, physiological losses are as a result of respiration, sprouting or loss of water through evaporation or exposure to extreme conditions such as temperatures and humidity, pathological losses are brought about by micro-organisms attack and are predisposed by both the physical and physiological losses (Booth and Shaw, 1981). Storage losses cannot be avoided absolutely but can be significantly reduced (Guenthner, 1995). Shrinkage which result in weight loss is brought about by the respiration of potatoes which brings about loses in water weight; shrinkage is also as a result of rot and other deterioration. For well-managed US storages the first month shrink is about 2-3%. After that the shrink is about 0.5% per month, then goes back up to 2% later in the season. Losses in weight as a result of water weight loss may not be a big concern to farmers in Kenya in that potatoes are sold on a

volume basis rather than a weight basis. However loss of quality should be a concern as it translates into reduced selling prices for the potatoes.

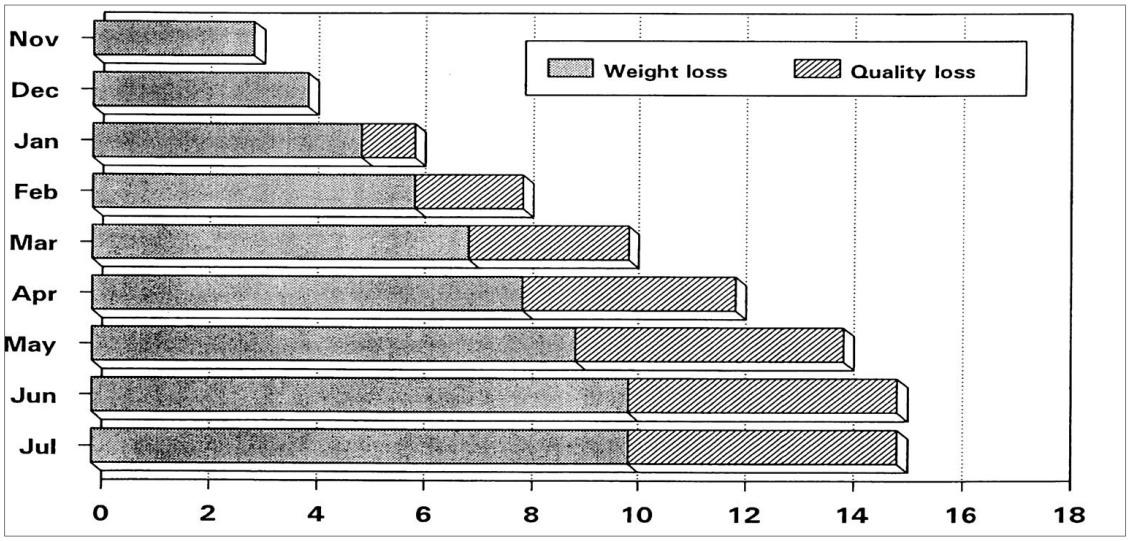

Figure 2: UK Storage Losses for the Record Variety
Source: Guenthner (1995)

Figure 2 shows potato storage losses for Record variety in a well-managed cold storage facility in the UK over the months. At least 15% of the potatoes are lost through weight loss and quality loss if the potatoes are stored for an entire season which is 9 months with quality losses starting after the second month and increasing thereafter (Guenthner, 1995).

Method of storage depends on the use of the stored tubers for example if the stored tubers will be used as seed, for consumption or as raw materials in potato processing industries (Eltawil *et al*., 2006). Potato storage in Kenya is not common; however, there are many opportunities that can be taken advantage of by storing tubers for example the exportation of frozen chips. Low potato storage practices have been attributed to farmers' lack of knowledge of the benefits of storing potatoes, urgent cash needs and damaged tubers (GoK, 2009). In a study by Walingo *et al*. (2003), it was revealed that Kenyan potato farmers use multi-purpose stores for storing potatoes, which greatly increase chance of losses due to the lack of favourable conditions. Chimalwar and Subrata (2007) identified traditional methods of potato storage to include the use of pits, heaps, baskets, rooms or left in the ground without harvesting. The authors mentioned that, tubers stored traditionally can last for a maximum of 2 months. Potatoes can also be stored in cold stores that are either electric or solar run for up to 8 months, solar operated potatoes cold stores are economical and greatly reduce storage costs (Bhatt, 2011). Farmers can lease out storage space or sell their produce to other actors

in the supply chain who may store the tubers. The storage of potatoes has been a success story in some countries, for example India, USA, Tunisia, Vietnam, South Africa and Great Britain. In Great Britain, 3.5 to 4 million tonnes of potatoes are stored annually in cold stores (Potato Council, 2011), these potatoes can be stored for several months, and these stores can be designed to function on refrigeration or ambient air cooling. The potato cold storage facility that is currently functional in Kenya is in Molo, run by ADC, and is used for seed storage and has a capacity of 2,250 tonnes (MoA, 2009). Little has been documented on the benefits, costs, willingness and risks of storing potatoes collectively in cold rooms in Kenya.

2.5 The Potential of Organised Storage Facilities

Proper potato storage facilities are essential in ensuring that there is a smooth flow of potatoes to the market without fluctuations in supply (Booth & Shaw, 1981), smooth supply reduces fluctuation of potato prices which in turn increase overall potato demand and ensure regular consumption patterns. In Eltawil *et al*. (2006) study on potato storage technology and storage design, it was found that Indians have not been able to develop regular potato consumption practices because of the irregularity in supply this because supply falls sharply a few months after harvest and the prices shoot up the rest of the year. In a study by Muthoni and Nyamongo (2009), the lack of on farm storage facilities was cited as a major constraint that often leads to farmers selling their produce straight from the field assuming that cash needs was not the main problem. Therefore, the presence of proper storage facilities reduces farmers' exploitation by traders in terms of prices, and improves farmers bargaining power and would lead to an increased consumption, as consumers would be able to develop regular consumption patterns.

Kirumba *el al*. (2004) characterised the potato value chain as being fragmented, having low levels of cooperation and integration, involving high transaction costs, mistrust, price inefficiencies and quality losses. Gildemacher *et al*. (2009) noted that the marketing system was far from perfect and the lack of proper storage was a major constraint, this is conflicting with the fact that Kenya compared to Ethiopia and Uganda, had a better developed marketing system that allowed farmers to sell their produce directly from the field, hence a lack of potato storage facilities. It was also noted that retailers and processors in Kenya suffer irregularity in both supply and potato quality, this is because of the lack of grading and packaging benchmarks in addition to the lack of proper storage.

Kasina and Nderitu (2010) mentioned the lack of ware potato storage facilities as one of the causes of the lack of implementation and enforcement of the 2005 laws and Legal notice No.113 of 2008. The authors further identified the economic impacts of the non-implementation of these laws in addition to farmer exploitation to include loss of money as a result of lack of transparency; KES 1.04 billion goes to brokers while KES 490.6 million is lost due to corruption at road blocks and an additional loss of council revenue of KES 300.7 million. Therefore, the introduction of storage facilities would be a step to the implementation of the laws set by the government to protect farmers as well as reduce income losses.

Mhlanga (2010) in the study on private sector agribusiness investment in SSA, mentioned the lack of proper storage facilities as an example of poor infrastructural development in rural areas that often raised small-scale farmers costs of starting and running agribusinesses.

In the cereals sector, there has been the introduction of Warehouse Receipt System. Coulter (2009) identified the WRS is an innovation package designed to increase efficiency in agricultural trade as well as modernise agricultural marketing systems. In the WRS, receipts are presented by warehouse operators to depositors, this receipts indicate the quantity and quality of produce supplied, the name of supplier as well as where the products were supplied, warehouse operators are also liable for any losses while goods are still in their custody, the receipts are transferable, depositors can be farmers, traders, processors or banks. The author in addition noted that the WRS forms a basis of other innovations such as grading, contracting and exchange trading, WRS would also help farmers store food and avoid instances where they sell all their produce only to buy them back when there are shortages for example during drought. Onumah (2010) mentioned increased accessibility to more profitable markets, reduced post-harvest losses, improved marketability of produce, increased income and improved implementation of standards and policies as some of the benefits linked to the WRS. Coulter (2009) noted that Kenya has great potential in the use of the WRS, due to the large urban population, a significant commercial farming sector and the presence of an active farmer' associations. The author further mentioned Lesiolo Grain Traders Limited of Nakuru and Grain Bulk Handlers of Mombasa as examples of companies that are already providing storage services to the public. The author however noted that the proper running of the whole WRS was greatly dragged back by politically driven government interventions in the maize market.

The Brookside Dairy Limited has set up milk collection and cooling plants in major milk producing regions in Kenya (Brookside Dairy, 2009). Some of these centres are co-owned or run together with farmers in the region, an example being Olenguruone Collection centre in Kuresoi Sub-County. Farmers supply milk to the collection centres which is assessed for quality, cooled and transported to the main processing unit in Ruiru. The setting up of this collection centres near dairy farmers has enabled them have an assured market for their produce irrespective of the season, assess credit, save on transport costs, reduce losses and wastages as well easy access to dairy feeds.

Therefore, proper storage facilities would: aid in reducing farmers exposure to price risks; ensure that only good quality tubers reach the market; lead to increased profits for farmers, as well as; reduce post-harvest losses (which may be brought about by inaccessible roads, lack of market due to oversupply and would also ensure that yields do not fall due to the lack of good quality seed as farmers would be able to store seed).

2.6 Risk

Hardaker *et al*. (2004) identified financial, production, price, personal and institutional risks as risks that farmers are commonly exposed to. The authors further noted that farmers, commercial firms selling to or buying from farmers, policy makers and planners ought to concern themselves with risk in agriculture. Mhlanga (2010) reccomended that new forms of risk mitigation strategies ought to be sought due to the very high levels of risks linked to production in agriculture.

The constraints that potato farmers are exposed to are sources of risks that affect their production and consequently their income. Muthoni and Nyamongo (2009) identified some of these constraints to include: Seasonal productivity, Low soil fertility, Poor marketing channels, lack of seed, pests and diseases and, high production costs. From a number of studies done, potato farmers in Kenya are faced with all the above mentioned types of risks.

2.6.1 Risks Associated with Storage

Fuglie (1999) acknowledged that the storage of potato is a risky business as potatoes are perishable and the storage conditions as well as the quantity stored affect the profitability of storage. In a situation where storage facilities are available, a potato farmer is faced with a dilemma: to harvest the crop and sell the harvest at the current market price or store the

harvest with the intention of selling at a later date and at the same time incurs storage costs and losses. The option of storing the produce carries with it price uncertainty due to the lack of certainty on the future market supply conditions which will affect the price of the tubers. According to Barnard and Nix (1973) uncertainty of the future complicates decision making due to the lack of perfect knowledge of the planning data which fluctuates irregularly over time. The quality of potatoes during the storage period cannot increase and there are losses associated with potato storage which cannot be completely eliminated but can be reduced. Therefore, the storage of potatoes carries two types of risk: price risk and production risk. Production risk is as a result of uncertainty of the result of the stored potatoes; these may be brought about by the harvest handling methods, climatic conditions, pests and diseases or any other unpredictable sources. Price risk on the other hand may be as a result of prices not being as they had been anticipated. This comes about when after storage prices are lower than the pre storage prices or are not high enough to cover the storage costs and losses.

Lack of proper management of storage facilities will often lead to great losses both in quantity and quality terms (Fuglie, 1999). Booth and Shaw (1981) identified detailed information on quantity produced, production patterns, demand quantity, demand patterns; marketing systems adopted as well as price movements over time as important concerns of interest when determining storage patterns to employ. The authors in addition, revealed that the stability and predictability of these patterns as factors influencing the measurement of risks that farmers using the facility are exposed to. It is therefore important to account for risk in the storage of potatoes bearing in mind that stability and predictability cannot be obtained perfectly.

2.7 Willingness to Pay

Consumer willingness to pay for a product or service is a good measure of its demand and is dependent on its features as well as the socio-economic characteristics of the buyer/ user. Consumers are assumed to maximize their utility subject to budget constraints and will, therefore, choose the option that gives them the highest utility (Kimenju and De Groote, 2008). In a study on the Economic viability of energy crops in the EU, Soldatos *et al*. (2010) mentioned the viability of a crop to be achieved when farmers are willing to participate in its production. Different people have different WTP for a particular good, and it is the distribution of this WTP among the target population that offers insight into market information of that particular product or service (Kimenju and De Groote, 2008). Therefore

not only does the willingness to pay measure demand but also gives an insight into economic viability of a product or service.

The economic value of non-marketed goods can be estimated by use of either the stated preference technique or the revealed preference technique. The current transactions associated with a public commodity are used in the estimation of its value under the revealed preference technique; approaches under the revealed preference technique include the Hedonic pricing and travel cost methods (Jubin and Aruna, 2010). In travel cost method, the cost of enjoying the environmental amenity is used as a proxy to value it. In hedonic pricing, researchers associate the price of a marketed commodity to its characteristics or the service it provides. The third and the most widely used technique is the Contingent Valuation (CV) method which has become an ideal tool for estimating a hypothetical demand curve of non-marketed good by attempting to generate points of the Total Value Curve by deducing stakeholders WTP for a hypothetical commodity (Prasenjit and Sarmila, 2009) . In this method people are asked to directly report their WTP or WTA by creating a hypothetical market place in which no actual transactions are made (FAO, 2000)

There are four major elicitation methods in CVM surveys, namely Open ended format, Bidding game, Payment cards and Dichotomous or Discrete choice (Gebremariam and Edriss, 2012).

2.8 Theoretical Framework

Assuming that ware potatoes collection centres have many benefits linked to them for example an increase in income. Based on the assumption that the farmers' willingness to utilise the collection centres depends on the expected utility from use of these collection centres, therefore farmers will adopt the collection centres if and only if the profits they expect to derive from the collection centres will be high. Utility in this case will be measured in monetary terms (KES).

The expected utility theory states that when decision makers are faced with a risky decision their choice between the set of alternatives will be based on comparison of their expected utility (Davis *et al.*, 1997). Economic agents (potato producers) will decide to use the collection centres and collection centres if and only if the benefits they expect to obtain will be higher than the benefits of selling their produce directly from the farm.

Assuming that U_a and U_b represent a farmers' utility from two alternatives. The choice between the two alternatives indicate the one that yields the greater utility, the observed indicator equals 1 if $U_a > U_b$ and 0 if $U_a \leq U_b$ (2.1)

The linear random utility can then be specified as

$$U_a = \beta_a X_i + \varepsilon_a \text{ and } U_b = \beta_b X_i + \varepsilon_b \quad (2.2)$$

Where U_a is the perceived utility for the use of collection centres and U_b is the utility for the sale of potatoes directly from the field, a and b are the choices for using or not using the collection centres, X_i is the vector of explanatory variables that influence the perceived desirability of each choice, β_a and β_b are utility shifters, while ε_a and ε_b are error terms which are assumed to be independently and identically distributed (iid) (Greene, 2002). If a farmer opts to use the collection centres then the perceived utility from this choice is said to be greater than the utility from the other option of selling directly from the field in this case since we will measure the utility in monetary terms then the use of collection centres will be perceived as one that increases the wealth of the farmers more than selling directly from the field.

If the farmers' choice of using the collection centres is denoted by $Y = 1$ then the associated probability will be as follows:

$$\text{Prob}[Y = 1 \mid X] = \text{Prob}[U_a > U_b]$$

$$= \text{Prob}[\beta_a X_i + \varepsilon_a - \beta_b X_i - \varepsilon_b > 0 \mid X]$$

$$= \text{Prob}[X_i(\beta_a - \beta_b) + \varepsilon_a - \varepsilon_b > 0 \mid X]$$

$$= \text{Prob}[X\beta + \varepsilon > 0 \mid X], \text{ where } \beta = \beta_a - \beta_b \text{ and } \varepsilon = \varepsilon_a - \varepsilon_b \quad (2.3)$$

Basing the argument on the expected utility theory then it is clear that the collection centres will be viable if they will yield a higher utility than the current system of selling potatoes directly from the field. But utility in this case will be in monetary terms as an expression of the increased income.

2.9 Conceptual Framework

The conceptual framework shows the relationship between different variables and how they are interrelated. The willingness to pay is the dependent variable, the institutional and socio-economic are independent variables. The expected utility theory will be applied in the conceptual framework: Assuming that farmers are rational decision makers and when faced with decisions they will often choose the option that increases their overall income. In this particular case, farmers will be willing to use the collection centres if they expect the income after storing their potatoes to be higher than the current income from selling potatoes directly from the fields. Factors affecting the willingness are categorised as Socio-economic and Institutional.

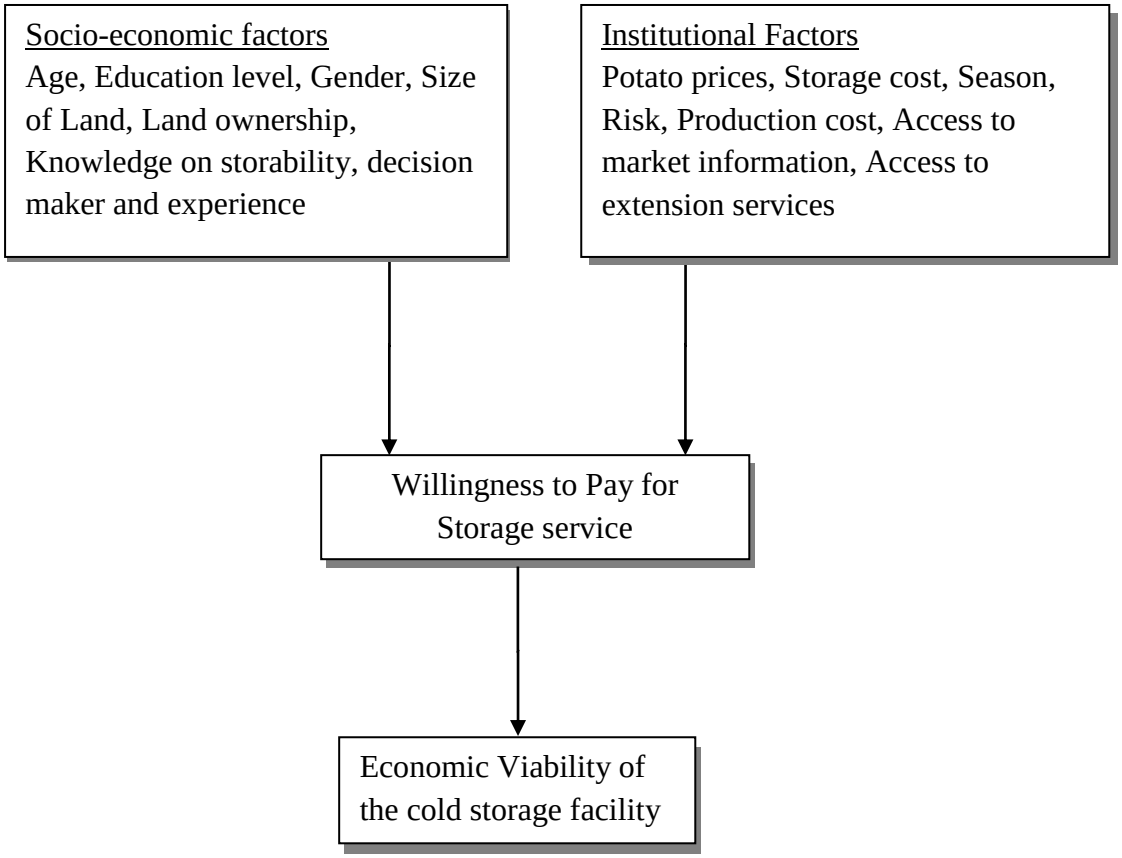

Figure 3: Conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was conducted in Nakuru County. Nakuru County lies within the Great Rift Valley and it borders Baringo and Laikipia to the North, Nyandarua to the East, Kajiado and Kiambu to the south, Narok to the south West and Kericho and Bomet to the West. The County covers an area of 7,495 Sq Km and is located between 35°28´ and 36´E, 0°3´N and 1°10´S(NCAPD, 2005). It lies about 2100 m above sea level. Nakuru County was selected purposively as it is among the highest potato producing counties in Kenya and Rift Valley Province (Ogola *et al*., 2011). Molo and Kuresoi are Nakuru County's Sub-Counties.

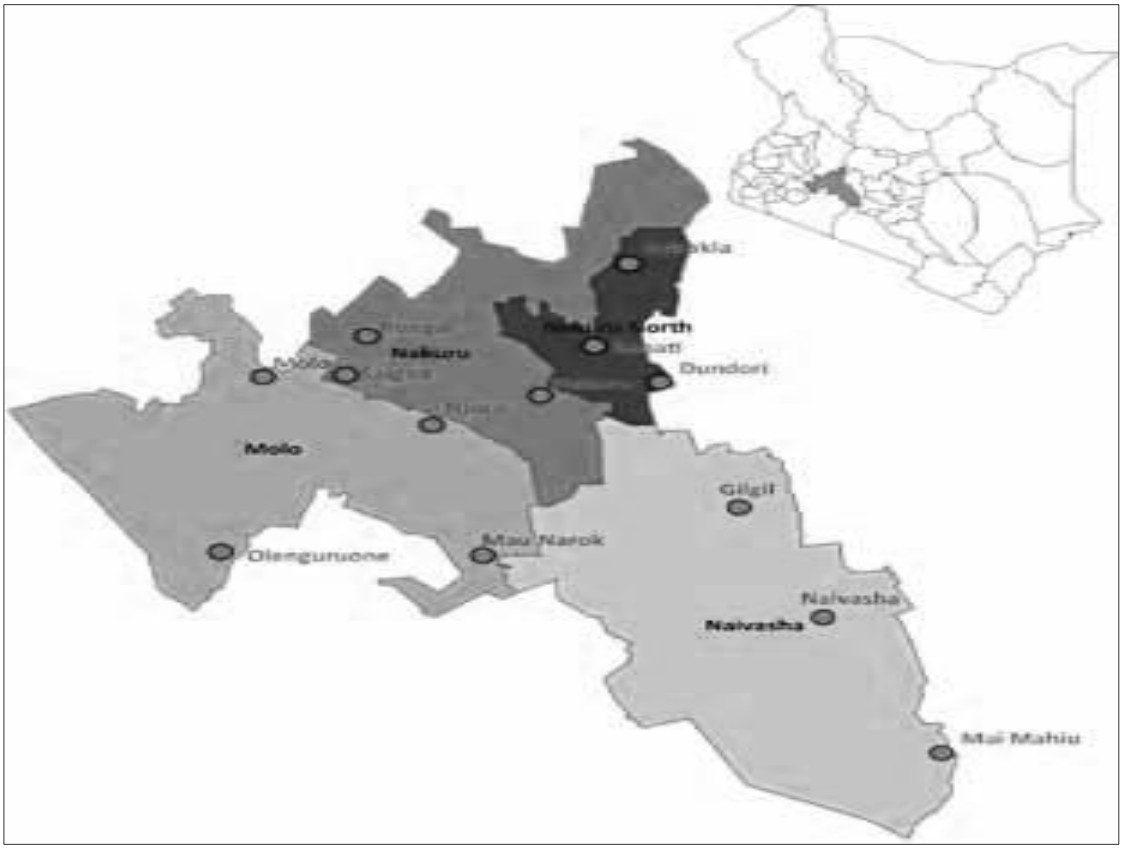

Figure 4: Nakuru County
Source: Kenya Decides (2012)

The Molo Sub-County profile obtained from the Sub-County Agricultural Office (2011) identified that the Sub-County covers a total area of 478.7 Sq Km, with 333 Sq Km being arable land. It lies between 1800 and 2800 metres above sea level. Molo Sub-County receives an average rainfall of 1240mm annually. The average temperature is 18.5^0 C, with highs of up

to 29^0 C in the months of December, January, February and March and lows of 8^0 C between June and July. Molo Sub-County encompasses 4 divisions namely Molo, Turi, Elburgon and Sachangwan, 13 locations and 26 sub-locations. Agriculture is the main economic activity in the region while the major enterprises include potatoes, pyrethrum, wheat, barley, dairy, wool sheep and beans. There are estimated to be 24,756 farm families in the area.

From the Kuresoi Sub-County profile (2012), the Sub-County covers a total area of 1210.8 Sq Km, 35,810 ha of the area is cultivated. Average annual rainfall ranges between 1000mm and 2000mm, long rains are between April and July while Short rains fall between September and December. The Sub-County lies between 2580-2800 metres above sea level with temperatures ranges of 25^0 C- 28^0 C. There are 4 divisions, 22 locations and 52 sub-locations within the Sub-County. There are 42,705 farm families in the Sub-County. Agriculture is the main economic activity in the Sub-County with the main enterprises being wheat, barley and potato production.

3.2 Sampling Procedure and Sample Size

The population of interest are potato farmers in Nakuru County. Multi-stage sampling procedure was employed. Molo and Kuresoi Sub-Counties which are among the potato producing Sub-County within the county were selected purposively. Molo division was selected purposively from Molo Sub-County while Keringet and Kuresoi divisions were also selected purposively from Kuresoi Sub-County for the study. Since production in Kuresoi Sub-County is larger than that in Molo Sub-County 2 divisions were used. Simple random sampling procedure was applied to choose households that were interviewed for the study. To determinate appropriate sample size, a proportionate to size sampling methodology as specified by Kothari (2004) was used as follows:

$$n = \frac{z^2 pq}{e^2} \tag{3.1}$$

where: n = sample size

p = proportion of the population producing potatoes

$q = (1 - p)$

z = the value of the standard variant at a given confidence level and to be worked out from table showing area under Normal Curve

$e =$ the acceptable error (precision)

Using $p = 0.84$, $z = 1.96$, $q = 0.16$ and an acceptable error of 5%.

The sample will be determined as:

$$n = \frac{1.96^{2} 0.84(1 - 0.84)}{0.05^{2}} = 206.5 \quad (3.2)$$

The computed sample size applying the formula above is 207. Respondents from the two Sub-Counties were distributed proportionally to the number of farm families in the region. There were 77 respondents from Molo Sub-County and 130 from Kuresoi Sub-County.

3.3 Methods of Data Collection

Cross sectional data was used in the study. Primary data was obtained from the sampled potato farmers from the two Sub-Counties. The method of data collection employed was interviews with the data collection instrument being semi-structured interview schedules. A team of pre-trained enumerators from the region were used to tackle the problem of language barrier.

3.4 Data Processing and Analysis

After collection, data was entered into a computer using pre-designed CSPro templates and later exported into SPSS where it was cleaned to reduce inconsistencies and increase accuracy. The data analysis was aided by SPSS and STATA softwares. The data was analyzed through both descriptive and inferential statistics. Descriptive statistics included use of measures of relative frequencies, measures of central tendency (means), and measures of variability (standard deviation). Inferential statistics included regression analysis which helped establish the relationship between socio-economic and institutional and willingness to pay for the storage services. The analyzed data was presented using tables, bar charts and pie charts.

3.4.1 Empirical Model

To achieve objective one, descriptive statistics was used. This entails cluster analysis to characterise the potato farmers in the Sub-County. Means, medians and frequencies were

used to summarise socio-economic characteristics such as age, level of education and marital status.

The second and third objectives, which were to determine the factors influencing farmers' willingness to use as well and their willingness to pay for the storage services and ascertain the amount they are willing to pay as storage fee the double bounded dichotomous choice models was used. The logit and probit models could be used interchangeably, as noted by (Gujarati, 2004), the two have no convincing advantage over each other. The logit assumes all factors to be independent and identically distributed thus unobserved factors are uncorrelated and have the same variance for all alternatives (Train, 2002), with the underlying distribution being logistic while the probit conversely takes into account correlations but is based on the assumption that unobserved factors are normally distributed. According to Kimenju and De Groote (2008) in their study on the WTP for genetically modified foods noted that the logistic distribution has a cdf of closed-form which is an advantage in that the proportion of the population whose WTP lies below a certain value can be represented by it. The probit model was chosen over logit the model due to its ease of use.

A pilot survey of 20 random sample households in the study area was carried out so as to design bid amounts for the final survey and test the questionnaire. The determination of the bid amounts followed the one used by Boyle *et al*. (1988) where farmers were presented with open ended questions on amount they would be willing to pay.

In the final survey farmers were then asked a series of questions regarding the amount they were willing to pay as storage fees for a 110 Kg bag of potatoes for a period of one month. Farmers were represented with two bids. The initial bid amounts were 30, 40, 50, 60, 70, 80, 90 or 100 and these bid amounts were presented to the farmers randomly. The second bid presented depended on the response to the first bid. If the response to the first bid is "yes" a higher bid which was double the initial bid amount was presented. If the answer to the first bid had been 'no' then a lower bid of half the initial bid was presented. If however, the farmers response to both the initial and second bid is "no" they were asked the maximum amount they are willing to pay as the fee.

According to Kimenju and De Groote (2008), the WTP of a group of consumers for a particular product at a bid b can be assumed to have a certain probability distribution function which is a function of price, where a higher price has a lower probability of being accepted.

The double-bounded model is an efficient measure of willingness to pay as it assumes that there exists a single function behind the two responses to the first and initial bid amounts (Lopez-Feldman, 2012)

Assuming that the WTP can be modelled as the linear function below,

$$WTP_i(z_i, u_i) = z_i'\beta + u_i \text{ and } u_i \sim (0, \sigma^2)$$

where z_i is a vector of explanatory variables,

β is a vector of parameters and

u_i is an error term

Let's call the first and the second bid amounts b^1 and b^2 respectively

From the series of questions farmers are asked there are four possible responses,

1. A "yes" followed by a "yes" which implies $b^2 > b^1$ then $b^2 \leq WTP < \infty$
2. A "yes" followed by a "no" which implies that $b^2 > b^1$ then $b^1 \leq WTP < b^2$
3. A "no" followed by a "yes" which implies $b^2 < b^1$ then $b^2 \leq WTP < b^1$
4. A "no" and "no response" which implies $b^2 < b^1$ then $0 < WTP < b^2$

If y_i^1 and y_i^2 are the variables representing the dichotomous response and assuming $WTP_i(z_i, u_i) = z_i'\beta + u_i$ and $u_i \sim (0, \sigma^2)$ then their respective probabilities can be represented as

1. $y_i^1 = 1$ and $y_i^2 = 1$

$$\Pr(y, y) = \Pr(WTP > b^1, WTP \geq b^2)$$

$$= \Pr(z_i'\beta + u_i > b^1, z_i'\beta + u_i \geq b^2)$$

Applying Bayes rule that states $\Pr(A, B) = \Pr(A \mid B) * \Pr(B)$ then

$$\Pr(y, y) = \Pr(z_i'\beta + u_i > b^1 \mid z_i'\beta + u_i \geq b^2) * \Pr(z_i'\beta + u_i \geq b^2)$$

Since $b^2 > b^1$ then $\Pr(z_i'\beta + u_i > b^1 \mid z_i'\beta + u_i \geq b^2) = 1$ this implies that

$$\Pr(y, y) = \Pr(z_i'\beta + u_i \geq b^2)$$

$$\Pr(y, y) = \Pr(u_i \geq b^2 - z_i'\beta)$$

$$= 1 - \Phi\left(\frac{b^2 - z_i'\beta}{\sigma}\right)$$

$$\Pr(y, y) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right)$$

2. $y_i^1 = 1$ and $y_i^2 = 0$

$$\Pr(y, n) = \Pr(b^1 \leq WTP < b^2)$$

$$= \Pr(b^1 \leq z_i'\beta + u_i < b^2)$$

$$= \Pr\left(\frac{b^1 - z_i'\beta}{\sigma} \leq \frac{u_i}{\sigma} < \frac{b^2 - z_i'\beta}{\sigma}\right) \text{ since } \Pr(a \leq X < b) = F(b) - F(a)$$

$$= \Phi\left(\frac{b^2 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{b^1 - z_i'\beta}{\sigma}\right)$$

$$\Pr(y, n) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right)$$

3. $y_i^1 = 0$ and $y_i^2 = 1$

$$\Pr(n, y) = \Pr(b^2 \leq WTP < b^1)$$

$$= \Pr(b^2 \leq z_i'\beta + u_i < b^1)$$

$$= \Pr\left(\frac{b^2 - z_i'\beta}{\sigma} \leq \frac{u_i}{\sigma} < \frac{b^1 - z_i'\beta}{\sigma}\right)$$

$$= \Phi\left(\frac{b^1 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{b^2 - z_i'\beta}{\sigma}\right)$$

$$\Pr(n, y) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^1}{\sigma}\right)$$

4. $y_i^1 = 0$ and $y_i^2 = 0$

$$\Pr(n, n) = \Pr(WTP < b^1, WTP < b^2)$$

$$= \Pr(z_i'\beta + u_i < b^1, z_i'\beta + u_i < b^2)$$

$$= \Pr(z_i'\beta + u_i < b^2)$$

$$= \Phi\left(\frac{b^2 - z_i'\beta}{\sigma}\right)$$

$$\Pr(n, n) = 1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right)$$

The log-likelihood function for a sample of N farmers after combining the probabilities of the four responses as shown above is denoted as:

$$= \sum_{i=1}^{N}\left[d_i^{yy} \ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right)\right) + d_i^{yn} \ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right)\right)\right.$$

$$\left. + d_i^{ny} \ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^1}{\sigma}\right)\right) + d_i^{nn} \ln\left(1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{b^2}{\sigma}\right)\right)\right]$$

where, d_i^{yy} , d_i^{yn} , d_i^{ny} and d_i^{nn} are arbitrary values that take value 1 if that particular outcome occurs and 0 otherwise. Parameter estimates can then be obtained by maximizing the likelihood function, the WTP formula is $\tilde{z}'\hat{\beta}$ (Lopez-Feldman, 2012).

Table 1: Description and measurement of variables to be used in the model

Variable	Description	Unit of measurement	Expected sign
Dependent variable			
	Willingness to pay	0= Not willing 1= Willing	
Independent variables			
age	Age	Years	±
edc_HHhead	Highest level of education	0=Never went to school 1=Primary 2=Secondary 3=Tertiary	±
gender_HH	Gender HH	0= Female, 1= Male	±
hh_role_agri	Role of agriculture in the HH	0= No, 1= Yes	±
mstatus	Marital status	1= Single 2= Married Monogamously 3= Polygamous 4= Divorced or Separated 5= Widowed	±
tot_land	Total land owned	Acres	±
own_land	Own land used in potato production	0= No 1= Yes	±
dec_mrkt	Who makes marketing decisions	0= Wife 1= Husband 2= Both	
agract	Role of agriculture in HH	1= Principal 2= Secondary	+
dst	Distance of farm from nearest road	Km	+
otheract	Involved in other economic activity	0= No 1= Yes	±
exp_losses	Have ever experienced after harvest losses	0= No 1= Yes	±
mrkt_info	Have access to market information	0= No 1= Yes	+
extn	Have access to agric extension services	0= No 1= Yes	+

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the Smallholder Farmers

4.1.1 Age

The mean age of farmers as per the study was 37.7, with majority, 32.3% being in the 20-29 age brackets. 30.3% between 30 and 39, 17.4% between 40 and 49, 10.0% between 50 and 59. Figure 4 shows the distribution of farmers in various age brackets.

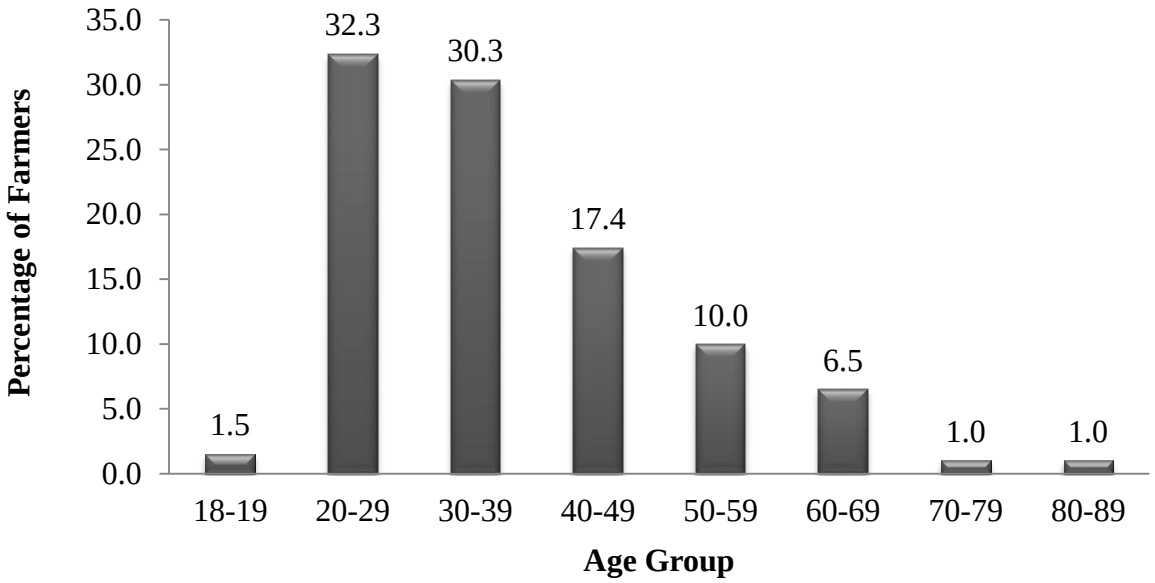

Figure 5: Farmers Age Distribution

4.1.2 Gender

The study revealed that there was a larger proportion of male to female potato farmers in the region. The results in Figure 5 show that 69.2% of the farmers were male with 30.8% being female. According to a study by Kasina and Nderitu (2010) potatoes are both cash and food crops in Kenya. Therefore the results of the study are in agreement to (Doss, 1999) that there exists a link between gender and type of crops produced. The author linked female farmers to production of crops for home consumption and male farmers with cash crops production. This is justified by the fact that women are responsible for feeding the family and hence tend to grow subsistence crops in small scale, whereas men are responsible for providing cash in the households and therefore grow cash crops.

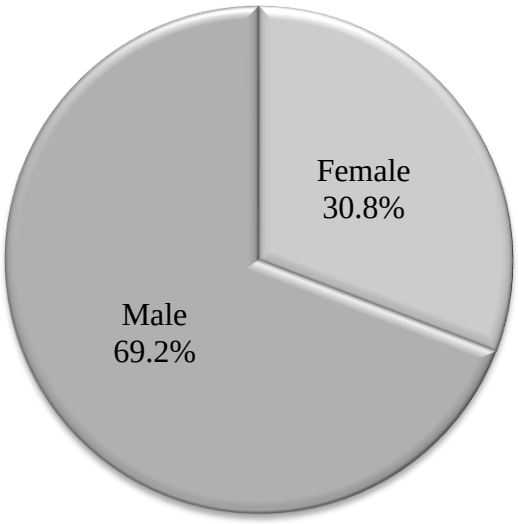

Figure 6: Farmers Gender

The study further revealed that out of the interviewed farmers 75.1% mentioned agriculture as a principal economic activity with 24.9% recognising it as a secondary activity (Figure 6).

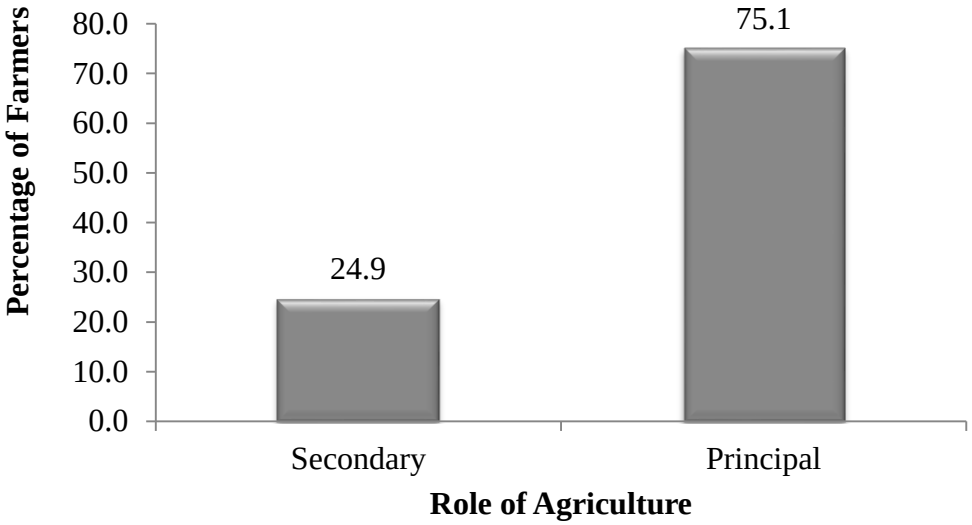

Figure 7: Role of Agriculture to Farmers

Out of the farmers who practise agriculture as a primary activity 69.2% were male and 30.8% female. A higher percentage, 81.3% of interviewed male farmers mentioned agriculture as the main economic activity compared to 61.3% of the interviewed female farmers. The Role of agriculture in relation to the gender of the farmers is summarised in Figure 7.

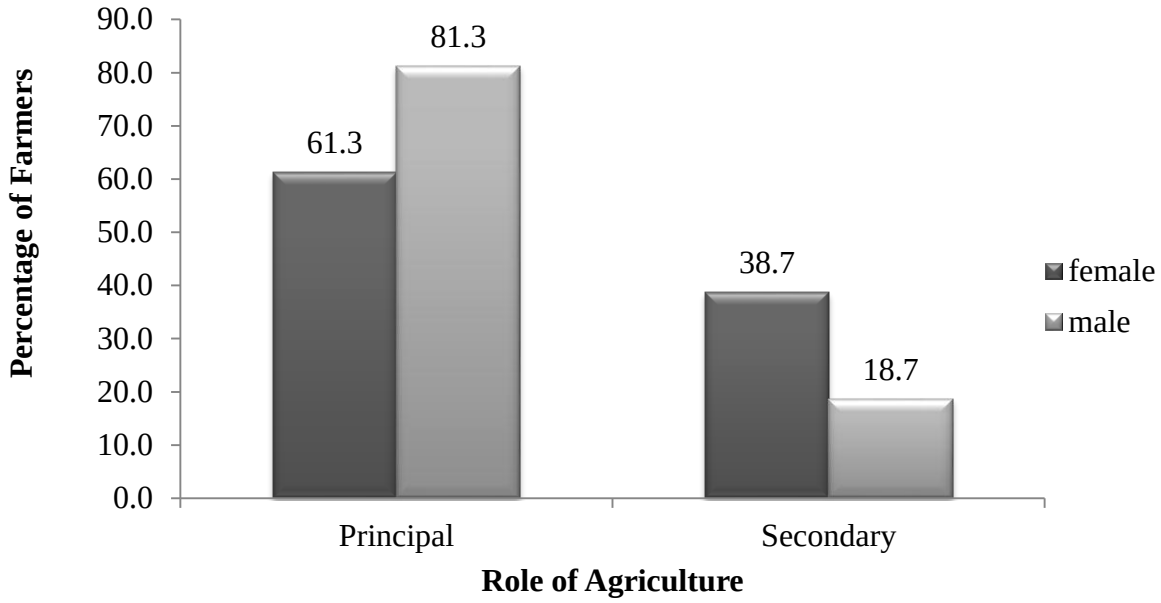

Figure 8: Role of Agriculture in Relation to Farmers Gender

4.1.3 Highest Level of Education

The results of the study indicated a very low percentage, 3.1% of farmers that have never gone to school. 46.4%, 35.1%, 3.1% and 12.4% have completed primary, secondary, tertiary college and tertiary university education levels respectively as shown in Figure 8. Therefore most of the potato farmers in the region are literate. The graph below shows a summary of the distribution.

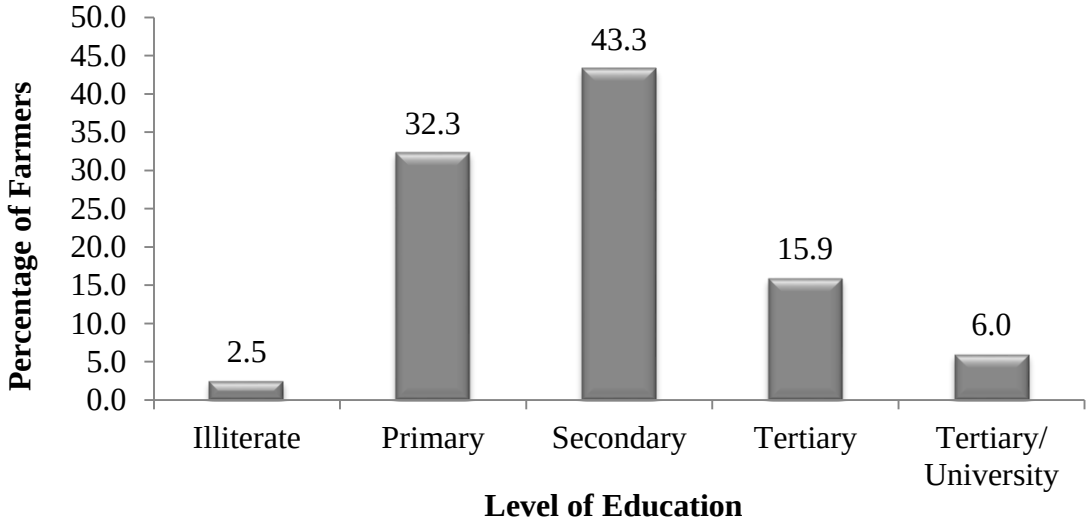

Figure 9: Farmers Level of Education

4.1.4 Land Ownership

All of the interviewed farmers owned land. The average land size is 8.5 acres. The land owned ranged between 0.4 and 100 acres with a standard deviation of 16.25 (Table 2).

Table 2: Farm Size Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Dev	Variance
Farm Size	201	0.4	100	8.529104	16.24931	264.040

Land size versus number of farmers is summarised in the Table 3. The largest percentage own less than 2.5 acres of land followed by between 2.6 to 5.0 acres. The size of Land owned is an important aspect especially in determining the activities to be undertaken on the land and what portion out of the entire to allocate to each activity.

Table 3: Farm Size Distribution

Farm Sizes	Frequency	Percent
<2.5	77	38.3
2.6 - 5.0	54	26.9
5.1 - 10.0	38	18.9
10.1 - 12.5	6	3.0
12.6 - 15.0	9	4.5
>15.0	17	8.5
Total	201	100.0

From the study 80.8% of the potato farmers owned the land they used for potato production, 19.2% did not own the land while 8.2% of the farmers who owned the land for potato production also used leased land. Figure 9**,** summarises land owners ship against the kind of agriculture practised. Under all the tenure systems in consideration majority of the farmers practised agriculture as a primary activity. The highest percentage of farmers who mentioned agriculture as a principal activity owned land with lowest percentage of farmers practising agriculture as a secondary activity practicing it on both their owned or leased land. This implies that a majority of the farmers in the study area own land on individual basis. Table 4, summarises the farm sizes against land ownership and forms of land tenure.

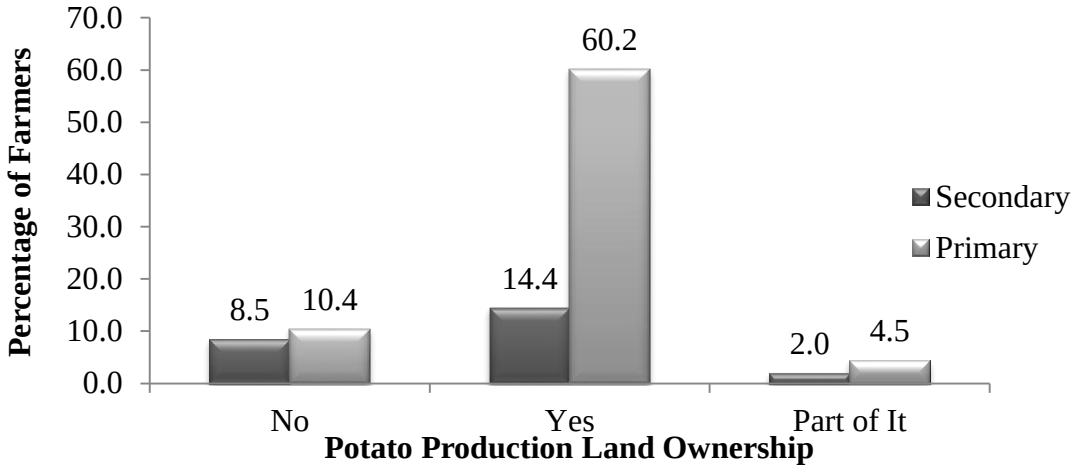

Figure 10: Role of Agriculture vs. Form of Land Ownership

Table 4: Farm Size vs. Role of Agriculture and Land Tenure on Potato Production

Farm Size	**Secondary**				**Primary**				**Grand**
	0	**1**	**2**	**Total**	**0**	**1**	**2**	**Total**	**Total**
<2.5	5.5%	4.5%	1.0%	10.9%	7.0%	18.9%	1.5%	27.4%	38.3%
2.6 - 5.0	1.5%	3.0%	0.0%	4.5%	2.0%	18.9%	1.5%	22.4%	26.9%
5.1 - 10.0	0.0%	2.5%	0.0%	2.5%	0.5%	15.4%	0.5%	16.4%	18.9%
10.1 - 12.5	0.0%	0.5%	1.0%	1.5%	0.0%	1.0%	0.5%	1.5%	3.0%
12.6 - 15.0	0.0%	1.0%	0.0%	1.0%	0.0%	3.0%	0.5%	3.5%	4.5%
>15.0	1.5%	3.0%	0.0%	4.5%	1.0%	3.0%	0.0%	4.0%	8.5%
Total	**8.46**	**14.43**	**1.99**	**24.88**	**10.45**	**60.20**	**4.48**	**75.12**	**100%**

0= Leased land, 1= Own land and 2= Both own and leased land

4.1.5 Planting and Marketing Decisions

The results of the study indicate that the person responsible for the planting decisions is the same one who makes the marketing decisions. In 5% of the households women are the decision makers, in 31% of the interviewed household the men (husbands) are the decision maker and in 64% of all the households both the wives and husband are involved in the production and marketing decisions. All the households where women are decision makers are headed by women. Women who are household heads are either divorced or widowed.

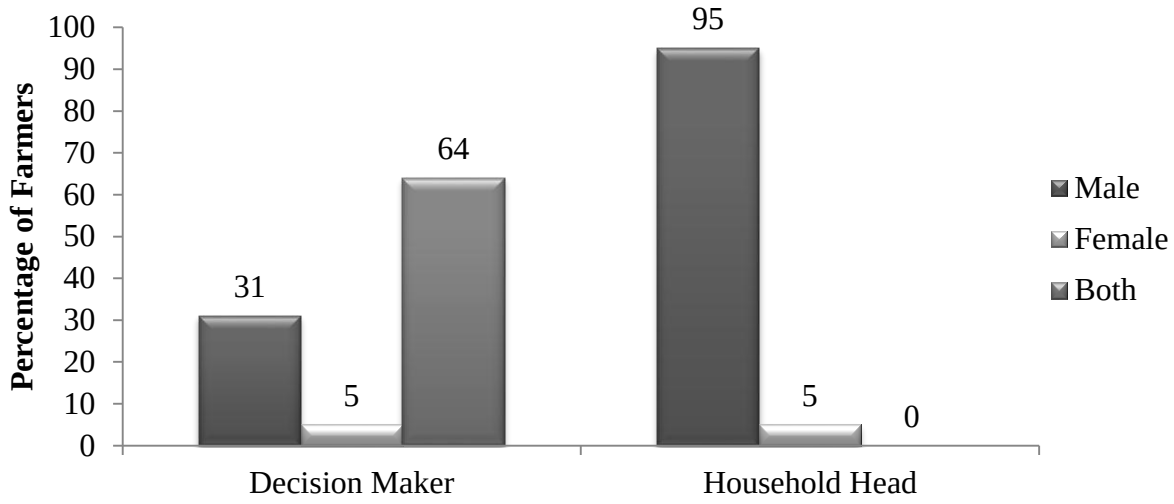

Figure 11: Planting/ Marketing Decision Maker

4.1.6 Access to Agricultural Extension

Access to extension services is important to farmers as it is a way of acquiring information. According to Akudugu *et al*. (2012) extension is a means of providing relevant information to farmers thereby promoting technology adoption through the reduction of subjectivity in decision making. Figure 11, summarises access to extension services and market information to potato farmers in Nakuru County. In Nakuru County only 32.3 percent of farmers have access to extension services. A higher percentage, 41.3 of farmers had access to market information. From the study a lower percentage of farmers have access to extension services or market information.

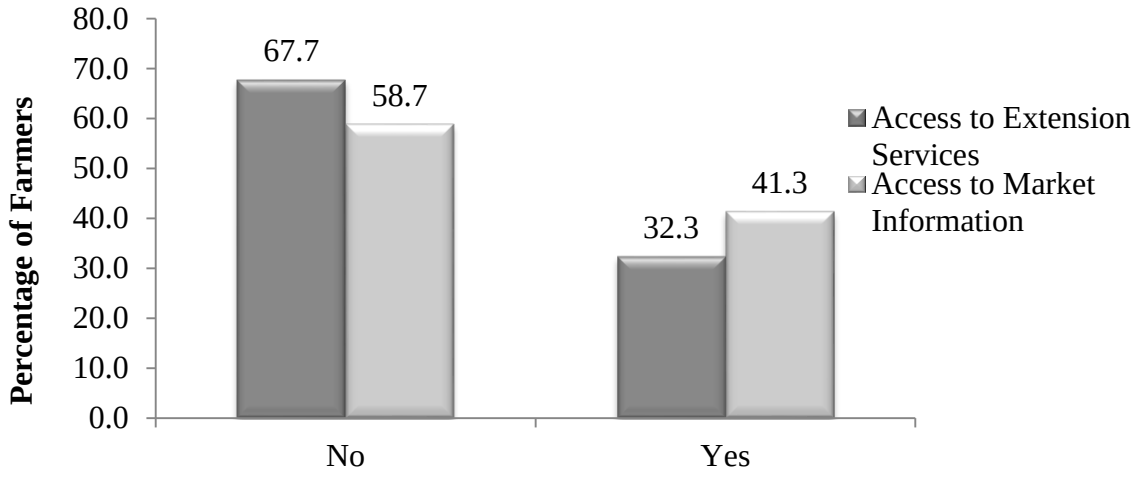

Figure 12: Access to Extension Services and Market Information

4.1.6 Storage Practices in Nakuru County

4.1.6.1 Knowledge on Ware Potato Storage

The study revealed that out of the interviewed farmers 36.3% did not have prior knowledge on the storability of ware potatoes while 63.7% had knowledge on the same. Among the farmers that stated they knew ware potatoes were storable 9.4% did not know methods that can be used to store the ware potatoes while 90.6% did have knowledge on the same Table 5

Table 5: Farmers Knowledge on Potato Storability and Methods of Storage

Storability	Yes	63.7%	Storage Methods	Yes	90.6%
				No	9.4%
	No	36.3%	Storage Methods	Yes	0.0%
				No	0.0%

4.1.6.2 Potato Storage Practices

Farmers were then asked on their potato storage practices; the use of potato was not specified. Therefore, the potatoes could either be seed or ware potato. Out of the interviewed farmers 25.3% did not store any potatoes while 74.7% stored. Some of the reasons cited for the storage of potatoes were for seed, home consumption, both seed and home consumption as well as for price speculation purposes. Figure 12 summarises the percentage of farmers who stored potatoes against the various reasons cited.

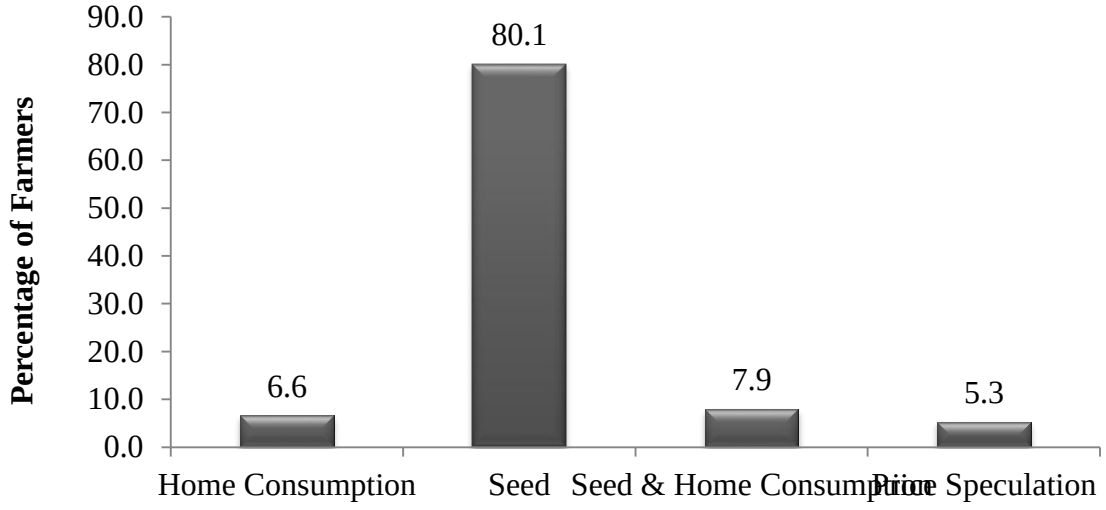

Figure 13: Reasons/ Use of Stored Tubers

4.2 Factors Influencing the Willingness to Use Storage Facilities

The second and third objectives which were to determine factors influencing willingness to pay and the determination of the amount farmers were willing to pay were obtained by using the double bounded dichotomous choice model under the assumption of normality.

The Determining of the initial bid amounts followed the method proposed by Boyle *et al*.(1988) where an initial survey of open ended Willingness to Pay amounts was carried out and from it the initial bids used in the study determined. The initial bids were 30, 40, 50, 60, 70, 80, 90 and 100. The second bid amount was determined using the method used by Tilahun *et al*., (2013) of doubling or halving of the initial bid if the response to the initial bid was yes/ no respectively. Table 6 summarises the responses of the first bid; approximately 63% of the interviewed farmers answered Yes to the first bid offered to them.

Table 6: Farmers Response to First Bid Offered

Response 1	Frequency	Percent	Cumulative
No	75	37.31	37.31
Yes	126	62.69	100.0
Total	201	100.00	

The response to the all the amounts offered in the initial bid were distributed as summarised in Table 7. Total number of farmers offered each of the initial bid amounts was almost equal.

Table 7: Frequency of Farmers Responses to Various Bid Amounts

Response 1	30	40	50	60	70	80	90	100	Total
No	3.85	8.00	16.00	32.00	48.00	52.00	60.00	80.00	37.31
Yes	96.15	92.00	84.00	68.00	52.00	48.00	40.00	20.00	62.69
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

From Table 7 the number of farmers who said Yes to the first bid decreased as the Bid amount went up which is expected according to the law of demand, where the demand decreases as the price of a good/ service goes up.

The factors that affect the willingness to pay for the storage facility services were grouped into two categories; socio-economic and institutional. Under the socio-economic the variables used in the DBDC model include age, gender, education level, marketing decision maker and farm size. Institutional factors include access to market information and agricultural extension services.

Table 8 shows the variables used in the Double Bounded Dichotomous Choice Model and the results. Out of the variables age, education level, role of agriculture to the household, farm size and distance from the main road, access to market information and access to agricultural extension were the determining factors of farmer's willingness to pay for storage facilities as they were statistically significant at 5% confidence level except age which was significant at 10%.

Table 8: DBDC Model Results for WTP

Variables	Coefficient	Std. Err	z	P>|z|	[95% Conf. Interval]	
AGE	-0.8443	0.4648	-1.82	0.069**	-1.7553	0.0667
EDUCATION	13.5789	6.6330	2.05	0.041*	0.5785	26.5792
AGRIC ROLE	36.2984	13.5948	2.67	0.008*	9.6532	62.9437
GENDER	-3.8561	18.9467	-0.20	0.839	-40.9910	33.2787
MARITAL STATUS	6.8619	10.1423	0.68	0.499	-13.0166	26.7403
FARM SIZE	1.0050	0.4474	2.25	0.025*	0.1280	1.8820
OWN_LND_GROW	-10.2038	13.0562	-0.78	0.434	-35.7936	15.3859
MARKETING_DEC	-5.3971	9.9052	-0.54	0.586	-24.8110	14.0167
DIST_MAIN_RD	7.6812	3.4900	2.20	0.028*	0.8408	14.5215
STORE_POT	-20.1386	14.7773	-1.36	0.173	-49.1015	8.8244
AFTR_HRVST_LOSS	-4.8490	14.8434	-0.33	0.744	-33.9416	24.2436
HH_SIZE	0.8535	2.8465	0.30	0.764	-4.7256	6.4326
MRKT_INFO	30.6076	12.7730	2.40	0.017*	5.5730	55.6422
AGRIC_EXTN	29.5240	13.2871	2.22	0.026*	3.4817	55.5663
Constant	34.5520	38.1780	0.91	0.365	-40.2755	109.3794

* denotes significant at 0.05 significance level, ** denotes significant at 0.1 significance level

Age is considered an important factor of adoption; however, it can have a positive, negative or no influence on adoption (Akudugu *et al*., 2012). Age had a negative influence on the willingness to pay for storage facilities and was significant at a 10 percent significance level. This implies that the older the farmer the lower their willingness to pay for storage facilities. This is in agreement with the finding of Ulimwengu and Sanyal (2011) that younger farmers are more likely to pay for agricultural technology due to their longer planning horizon even though older farmers have more experience and would know the usefulness of incorporating technology in farming.

Education had a positive effect on WTP for storage facilities and a significance value of 0.041, it is therefore conclusive to state that the higher the level of education the more the willingness of farmers to pay for the potato storage facilities. This is in agreement with the finding of D'Souza *et al*. (1993), they stated that the more educated the farmer the higher their likelihood to adopt sustainable Agricultural practices. This could be because educated farmers have knowledge on the advantage of incorporating technology in agriculture as a way of ensuring sustainability. According to Ulimwengu and Sanyal (2011) educated farmers have the increased ability of obtain, process and use information and hence a higher likelihood of accepting new technology.

The size of land owned by the farmers had a positive sign and significance value of 0.025 implying that there was enough evidence that it affects the willingness to pay positively. These results are in agreement with those of (Akudugu *et al*., 2012). In their study on factors that influence the adoption of modern production technologies, they indicated that the size of land had positive influence on adoption. However, they noted that the size of land could have positive, negative or no influence on adoption, as size of land could be affected by other factors thus speed of adoption varies with the kind of technology under consideration or underlying factors that influence the size of land.

In the Nakuru county case the positive influence may be attributed to the higher likelihood of farmers with larger sizes of land to grow more potatoes, which translates into excess produce which can be stored or the higher the likelihood to be involved in other economic activities and lesser reliance on potato production.

The distance from the main road was the other significant variable which had a significance value of 0.028. The distance of the farm from the main road had a positive influence on

willingness to pay. This implies that the further the farm from the road the higher the likelihood of willing to pay for storage facilities. This is as expected as the farmers who live far from the road are the ones who face the most marketing problems. Farmers mentioned that during the rainy period they have to incur additional cost for transporting the ware potatoes using tractors from the farms to the main road and sometimes end up losing the whole harvest if transport cannot be obtained.

The role of agriculture to the household was significant at a 5 percent significance level and had a positive influence on willingness to pay for the storage services. Farmers who consider agriculture their primary economic activity were more willing to pay than those for whom agriculture is a secondary economic activity. This could be because they view storing as a way of cushioning them from potato marketing risks as well as increasing their income.

The institutional factors; access to market information and access to agricultural extension services were both significant at 95% confidence level and had positive impact on the willingness to pay for the storage services. This implies that farmers who had access to extension services provided by the government or NGOs were more likely to be willing to pay for storage services.

4.3 Average Fee That Farmers Are Willing To Pay for Storage Facility Services

To estimate the mean amount that farmers in Nakuru County are willing to pay as the fee for the storage facility services the doubleb command was used but this time excluding all the control variables. From the study, the farmers are willing to pay KES 83.76 as the monthly fee for the storage per 100kgs bag Table 9. The relationship is significant as shown by P=0.000<0.05. This value is higher than what the National Potato council of Kenya had estimated would be the average cost. Therefore the cost could be a determinant to farmers' willingness to use the warehouse storage facilities.

Table 9: Mean Value, Farmers are Willing to Pay

		Coefficient	Std. Err	z	P>|z|
Beta	_cons	83.7596	5.9615	14.0500	0.000
Sig	_cons	76.7438	6.5121	11.7800	0.000

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the findings of this study, a higher percentage, 63 percent of farmers were willing to pay for storage facility services as compared to 37 percent who were not willing to pay the first bid amount presented to them. The average amount that farmers in the County were willing to pay as the storage fee for a 100kg bag of potato was higher than the KES 75 that had been proposed by the National Potato Council of Kenya. This implies that farmers were indeed willing to pay for the storage services. It was concluded that community based potato cold storage facilities were thus viable in the study area. It was concluded that the farmers in the study area have little access to agricultural extension and market information and majorly depend on trader to inform them on current buying and selling price for products thus the great need of a marketing and information centre.

From the study, the Socio-economic and institutional factors influencing willingness to pay in Nakuru County, seven factors; age, education level, role of agriculture to the household, farm size and distance from the main road, access to market information and access to agricultural extension were significant at 0.05 confidence level, with one factor (age) being significant at 0.1 confidence level. Out of these factors, only age had a negative influence on willingness to pay.

5.2 Recommendations

5.2.1 Policy Recommendations

From the results of the study, farmers are clearly willing to pay for storage of their potatoes. Farmer's willingness to pay for these services is driven by different needs such as to mitigate potato production and marketing risks, increase their income or add value to their produce. To fully understand the potential of potato cold storage technology there is need to do it practically. This is because the costs as calculated may change or losses maybe more than anticipated or experienced in other countries due to factors such as the variety of potatoes stored or climatic conditions.

A pilot cold storage facility should be set up to understand the implications of storing potatoes. This study also mainly focused on socioeconomic and institutional factors that

affect farmer's willingness to use storage facilities. The study results show that there was variable between the cost the farmers are willing to pay and the cost that the National Potato council of Kenya had estimated would be the average cost. Hence there is need for more consultation on the most optimum cost of storage facilities so as to influence the farmers in the region to use warehouse storage facilities.

5.2.2 Recommendations for Further Research

This study concentrated on socio-economic and institutional factors influencing willingness of farmers to use and pay for warehouse storage services. There is need for further research on the influence of other factors and their influence on potato storability. The study also focused on the farmers only, it is important to look into the willingness of consumers to consume stored potatoes. Moreover, since this study was a case study of Nakuru region, the researcher recommends that a further study be conducted in other areas of the country for comparison of results.

REFERENCES

Akudugu, M. A., Guo, E., and Dadzie, S. K. (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions? *Journal of Biology, Agriculture and Healthcare, II,* 1-13.

Barnard, C. S., and Nix, J. S. (1973). *Farm Planning and Control.* Cambridge: Cambridge University Press.

Bhatt, N. M. (2011). *Solar Thermal Market in India*. A paper presented at AMA during Seminar on 'Trends in Renewable Energy Technologies' organized by GTU.

Booth, R. H., and Shaw, R. L. (1981). *Principles of potato storage.* Lima: International Potato Centre, CIP.

Boyle, K. J., Welsh, M. P., and Bishop, R. C. (1988). *Validation of empirical measures of welfare change: comment.* Retrieved November 2012, from Munich Personal RePEc Archive: http://mpra.ub.uni-muenchen.de/31237/1/MPRA_paper_31237.pdf

Brookside Dairy. (2009). *Cooling Facilities*. Retrieved March 8, 2011, from Brookside Dairy: http://www.brookside.co.ke

Chimalwar, P., and Subrata, S. (2007). *Post harvest profile of potato.* Nagpur: Department of Agriculture and Co-operation, Directorate of Marketing and Inspection.

CIP. (2008). *The International Year of the Potato*. Retrieved from: http:// www.cip.org/pressroom/facts_figures/ 2008_international_year of the potato. Retrieved January 15, 2012, from International Potato Centre: World Potato Atlas: https://research.cip.cgiar.org/confluence/display/wpa/Home

CIP. (2010). *Facts and figures about potatoes.* Retrieved January 5th, 2012, from International potatao centre: http://www.cipotato.org/potato/facts/

Coulter, J. (2009). *Review of Warehouse Receipt System and Inventory Credit Initiatives in Eastern and Southern Africa.* UNCTAD. United Nations. New York.

D'Souza, G., Cyphers, D., and Phipps, T. (1993). Factors Affecting the Adoption of Sustainable Agricultural Practices. *Agricultural and Resource Economics Review,* 159-165.

Davis, J. B., Hands, W. D., and Mäki, U. (1998). Expected Utility Theory. (J. B. Davis, Hands, D. Wade, and U. Mäki, Eds.) *Handbook of Economic Methodology,* 342-350.

Diop, A. (1998, January). *Storage and Processing of Roots and Tubers in the Tropics.* (D. Calverley, Ed.) Retrieved January 30, 2012, from FAO: http://www.fao.org/DOCREP/X5415E/x5415e04.htm

Doss, C. R. (1999). *Twenty-five years of research on women farmers in Africa: Lessons and implications for agricultural research institutions; with an annotated bibliography.* Mexico: Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT).

Eltawil, M., Samuel, D., and Singhal, O. (2006). Potato Storage Technology and Store Design Aspects. *Agricultural Engineering International: the CIGR Ejournal, 8*, 1-18.

FAO. (2000). *Applications of the contingent valuation method in developing countries.* Retrieved September 2012, from FAO Corporate Document Repository: http://www.fao.org/docrep/003/X8955E/x8955e03.htm

FAO. (2006, November). *Food and agriculture organisation of the united nations; Agriculture and Consumer Protection Department* . Retrieved November 15th, 2011, from FAO: http://www.fao.org/ag/magazine/06//sp1.htm

FAO. (2008). *Potato World Africa*. Retrieved January 25th, 2012, from International Year of the Potato: http://www.potato2008.org/en/world/africa.html

FAO, and CFC. (2010). Technical And Policy Options For Developing Countries. *Strengthening potato value chain in developing countries* (pp. 5-141). Rome: The Food and Agriculture Organization of the United Nations and the Common Fund for Commodities.

FAOSTAT. (2012, January 12th). *FAOSTAT*. Retrieved January 12th, 2012, from FAO: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor

Food Security in Kenya. (2010). *Central Province Food Security Profile*. Retrieved February 25, 2012, from Food Security in Kenya: http://www.kenyafoodsecurity.org

Fuglie, K. O. (1999, December 7th). Economics of Potato Storage: Case Studies. New Delhi, India.

Gebremariam, G. G., and Edriss, A. K. (2012). Evaluation of Soil Conservation Practices in Adwa Woreda, Ethiopia: A Contingent Valuation Study. *Journal of Economics and Sustainable Development, III*(13), 97-107.

Giencke, S. (2011). *Mission Report to GIZ PSDA Kenya: Collection Center Management* . GFA Consulting Group.

Gildemacher, P. R., Kaguongo, W., Ortiz, O., Tesfaye, A., Woldegiorgis, G., Wagoire, W., Kakuhenzire, R., Kinyae, P., Nyongesa, M., Struik, P., and Leeuwis, C. (2009). Improving Potato Production in Kenya, Uganda and Ethiopia: A System Diagnosis. *Potato Research, 52* (2), 173-205.

GoK. (2009). *National Potato Task Force Report 2009.* Nairobi: Ministry of Agriculture.

Greene, W. (2002). *Econometric Analysis* (5th ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

Guenthner, J. F. (1995). Economics of Potato Storage. *American Potato Journal, 72*, 493-503.

Gujarati, D. N. (2004). *Basic Econometrics* (4th ed.). Mc-Graw Hill. New York.

Hardaker, J. B., Huirne, R. B., Anderson, J. R., and Lien, G. (2004). *Coping with Risk in Agriculture.* Oxfordshire: CABI.

InfoResources. (2008). Potatoes and Climate Change. *InfoResources Focus, 1*. (B. Stäubli, R. Wenger, and S. Wymann von Dach, Eds.) Bern, Switzerland.

Jubin, A., and Aruna, R. (2010). *Contingent Valuation: A review with Emphasis on Estimation Procedures.* Retrieved 2012, from InterStat: http://interstat.statjournals.net/YEAR/2010/articles/1007004.pdf

Kabira, J. N. (2002). *Linking ware potato growers with processors of French-fries in Nakuru.* Progress Report to FoodNet. KARI-Tigoni (unpublished).

Kaguongo, W., Gildemacher, P., Demo, P., Wagoire, W., Kinyae, P., Andrade, J., Forbes, G., Fuglie, K., and Thiele, J. (2008). Farmer practices and adoption of improved potato varieties in Kenya and Uganda. *Social Sciences Working Paper 2008-5. 85 p.* Lima, Peru: International Potato Centre (CIP).

Kameri-Mbote, P. (2005). *Land Tenure, Land Use and Sustainability in Kenya: Towards Innovative Use of Property Rights in Wildlife Management, IELRC working paper 2005-4.* Geneva: International Environmental Law Research Centre.

Kasina, M., and Nderitu, J. H. (2010). Policy Implementation And Its Economic Impact On Potato Marketing Value Chain In Kenya. *12th Biennial KARI Scientific Conference on Transforming Agriculture for Improved Livelihoods through Agricultural Products Value Chains* (pp. 1198-1205). Nairobi: KARI.

Kimenju, S. C., and De Groote, H. (2008). Consumer Willingness to Pay for Genetically Modified Food in Kenya. *Agricultural Economics*(38), 35-46.

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques.* New Delhi: New AgeInternational (P) Ltd.

Lerner, R. B., and Dana, M. N. (2000). *Vegetables: Potatoes.* Retrieved January 2012, from Purdue University Consumer Horticulture: http://www.hort.purdue.edu/ext/HO-62W.pdf

Lopez-Feldman, A. (2012, September 4). Introduction to Contingent Valuation using Stata. Retrieved 2012, from Munich Personal RePEc Archive: http://mpra.ub.uni-muenchen.de/41018/

Lutaladio, N., Ortiz, O., Haverkort, A., and Caldiz, D. (2009). *Sustainable Potato Production: Guidelines for Developing Countries.* Rome: FAO.

Mhlanga, N. (2010). *Private Sector Agribusiness Investment in Sub-Saharan Africa.* Rome: FAO.

MoA. (2009). Mainstreaming the potato crop from orphan crop status. Nairobi, Kenya.

MoA. (2012). *News.* Retrieved January 15th, 2012, from Ministry of Agriculture: http://www.kilimo.go.ke/kilimo_docs/pdf/TRADITIONAL_HIGH_VALUE_CROPS.pdf

Muthoni, J., and Nyamongo, D. O. (2009). A review of constraints to ware potatoes production in Kenya. *Journal of Horticulture and Forestry, 1*(7), 098-102.

NCAPD. (2005). *Nakuru Sub-County- Sub-County Strategic plan 2005-2010.* National Coordinating Agency for population and Development: Ministry of Planning and National Development. Nairobi.

Neves, M. F. (2011, May). Food Chains and the Reasons Behind Rising Food Prices. *Food Chain, 1*(1), 52-70.

Neves, M. F., Pinto, M. J., Conejero, M. A., and Trombin, V. G. (2011). *Food and Fuel: The Example of Brazil.* Wageningen: Academic Publishers.

Ogola, J. B., Ayieko, M. W., Orawo, A. O., and Kimani, F. W. (2011). Analysis of fertiliser use in potato production in Nakuru Sub-County, Kenya. *African Journal of Agricultural Research, 6*(16), 3672-3677.

Onumah, G. E. (2010). Implementing Warehouse Receipt Systems in Africa: Potential and Challenges. *African Agricultural Markets Program Policy Symposium* (pp. 1-18). Lilongwe: African Agricultural Markets Program, AAMP.

Pearce, D., and Ozdemiroglu, E. (2002). *Economic Valuation with Stated Preference Techniques, Summary Guide.* Department for Transport, Local Government and the Regions.

Potato Council. (2011). *Storage*. Retrieved 2012, from Potato Council: http://www.potato.org.uk/crop-storage

Prasenjit, S., and Sarmila, B. (2009). Estimation of Average Willingness to Pay from Double Bounded Dichotomous Choice Data: Does the "Follow Up" matter? *Indian Econometric Society, 44.* Hyderabad.

Pringle, B., Bishop, C., and Clayton, R. (2009). *Potatoes Postharvest.* Oxfordshire: CABI.

Small, D., and Pahl, K. (2003). Potato Storage Management- Storage Structures and Ventilation. In *Guide to Commercial Potato Production on the Canadian Prairies.* Western Potato Council.

Soldatos, P., Lychnaras, V., Panoutsou, C., and Cosentino, S. L. (2010). Economic Viability of Energy Crops in the EU: Farmer's Point of View. *Biofuels, Bioproducts and Biorefining, 4,* 637-657.

Tilahun, M., Vranken, L., Muys, B., Deckers, J., Gebregziabher, K., Gebrehiwot, K., Bauer, H., and Mathijs, E. (2013). *Ruralhouseholds' Demand For Frankincense Forest Conservation In Tigray, Ethiopia: A Contingent Valuation Analysis.* Retrieved 2013, from Wiley Online Library: http://onlinelibrary.wiley.com/doi/10.1002/ldr.2207/pdf

Train, K. (2002). *Discrete Choice Methods with Simulation.* Cambridge University Press, United Kingdom.

Ulimwengu, J., and Sanyal, P. (2011). *Joint Estimation of Farmers' Stated Willingness to Pay for Agricultural Services.* West and Central Africa: IFPRI.

Walingo, A., Lung'aho, C., and Kinyae, P. (2003). Evaluation of the potential for ware potato storage in Kenya. *African Crop Science Conference Proceedings, 6,* 692-698.

APPENDIX I

Appendix 1: Research Survey Questionnaire

TITLE: AN ANALYSIS OF THE WILLINGNESS OF FARMERS TO PAY FOR WARE POTATO COLD STORAGE FACILITIES

This survey has the objective of analysing farmers willingness to pay for ware potato cold storage facilities in collection Centres. You have been selected randomly for participation in the study. Your voluntary participation is highly appreciated and the information collected will be confidential and will be analysed together similar data collected from other farmers in the region.

SECTION A: **GENERAL INFORMATION**

A01 Household ID _____

A02 Enumerators Name_____ **A03** Date of Interview_____

A04 County _____ A**05** Sub-County _____

A06 Division _____ **A07** Location _____

A08 Sub location _____ **A09** Village _____

SECTION B: **DEMOGRAPHIC CHARACTERISTICS**

RESPONDENTS CHARACTERISTICS

B01 Respondent's name _____

B02 Respondent's gender *0= Female 1= Male* [___]
B03 Respondents age (years) ___

B04 Relation to the household head (tick where appropriate)

1=head 2=spouse 3= sibling 4= Other Relative 5= worker ____

B05 Education of the respondent in year's ___

B06 Role of Agriculture to the respondent ___ 0= *Secondary 1=Principal*

B07 Has been involved in other economic activity ___ 0= *No 1=Yes*

HOUSEHOLD HEAD CHARACTERISTICS

B11 Name of Household head _____

B12 Household head gender *0= Female 1= Male* [___]

B13 Household head age (years) ___

B14 Education of the Household head in year's ___

B15 Role of Agriculture to the Household head ___ 0= *Secondary 1=Principal*

B16 Has Household head been involved in other economic activity ___ 0= *No 1=Yes*

C. HOUSEHOLD MEMBERS

Please provide details of the households members living permanently within the compound

ID No	**Name**	**Gender** *0=Female 1=Male*	**Age (years)**	**Highest level of education:** *0=Never went to school, 1=Primary 2=Secondary 3=Tertiary*	**Relation to head** *1= Single 2=Married Monogamous 3=polygamous 4=Divorced or Separated 5=Widowed*
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					

D. HOUSEHOLD´S POTATO PRODUCTION

D01 What is the total area of land owned by HH? _____(Acres)

D02 Do you own the land you grow potatoes? *0= No 1= Yes* ___

D03 Has person growing potatoes had any formal training in agriculture? *0= No 1= Yes* ___

D04 Who decides how much potato to grow? *0= Wife 1= Husband 2= Both* ____

D05 Who decides how much and when to sell potatoes? *0= Wife 1= Husband 2= Both* ____

D06 How long have you been growing potatoes? (Years) ____

D07 Have you ever experienced after harvest losses? *0= No 1= Yes*

D08 What were the three main reasons for the losses?

D09 What portion of the total harvest did you lose? (fraction of total harvest)

E. HOUSEHOLD´S POTATO STORAGE

E01 Did you know that potatoes can be stored after harvest? *1=Yes, 2=No* [___]

E02 If yes, do you have any knowledge on methods of storing your potatoes?

1=Yes, 2=No [___]

E03 Do you store your potatoes after harvest? *1=Yes, 2=No* [___]

E04 If yes, why do you store potatoes?

E05 How do you store your potatoes?

E06 If collection centres are introduced, are you willing to use them for marketing/ storage of potatoes? *1=Yes, 2=No* [___]

E07 If yes, what portion of your harvest would you be willing to store (fraction of total production) [___]

E08 Potatoes can be stored for periods of between 1-9 months depending on the storage method used. Community based potato storage facilities, are premises where potatoes are collected to be stored in cold rooms and sold later when prices go up or marketed immediately in the same form or after value addition The aim of using the facilities is to take advantage of the seasonal price changes and increase overall farmers' income from potatoes.

Would you be willing to use the collection centres for the storage of ware potatoes if the storage services will be offered at the price of KES 50 *1=Yes, 2=No* [___]

E.09 If yes, are you willing to use the storage facilities if storage services were offered at a price of: Premium amount = KES 100 _____

E10. If No, are you willing to use the storage facilities if storage services were offered at a price of: Discounted amount = KES 25 _____