FINANCIAL COST-BENEFIT ANALYSIS OF MAIZE STORAGE TECHNIQUES: A CASE STUDY OF NJORO SUB-COUNTY

By

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DECLARATION

This project is my original work and has not been presented in this or any other university for the award of a degree. All information from other sources is acknowledged appropriately.

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RECOMMENDATION

This work has been submitted with my approval as the University supervisor.

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ACRONYMS AND ABBREVIATIONS

BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CBK	Central Bank of Kenya
GDP	Gross Domestic Product
FAO	Food and Agriculture Organization
FAOSTAT	FAO Statistics
FGD	Focus Group Discussion
KNBS	Kenya National Bureau of Statistics
NCPB	National Cereals and Produce Board
NPV	Net Present Value
NRI	Natural Resources Institute
PHL	Post Harvest Losses
PP	Polypropylene
SSA	Sub-Saharan Africa
USD	United States Dollar

ABSTRACT

This study analyzes the cost benefit implication of maize storage techniques used by farmers and traders, and further identifies challenges in the uptake of new and improved technology and innovations. Using a case study area in Njoro sub-County from Kenya, we identified and evaluated the economic feasibility of the various technologies that farmers and traders used to store their maize against being attacked by insects and rodents. Analysis showed that most feasible storage innovation amongst farmers was the metal silo with a benefit-cost ratio (BCR) and net present value (NPV) of 4.4 and Kshs.44 respectively. Furthermore, amongst traders storage of threshed maize in a hired premise was identified as the most feasible storage option with BCR of 1.3 and NPV of Kshs.2443. These findings have implications on maize storage technologies, and they indicate that policies which enhance appropriate on-farm storage structures and effective storage techniques along the maize value chain should be adopted.

Key words: storage techniques, cost–benefit analysis, maize, Kenya, Njoro

CHAPTER ONE

1.0 Introduction

Kenya's productive sectors predominantly the agricultural economy contributes about 26% of the overall GDP and almost 75% of the total labor force (Kang'ethe, 2011). Maize is a major staple crop in the country and most households rely on maize mainly as a source of food. However, maize has other consumption needs such as animal feed and as an industrial crop in maize milling. Hence, production of maize in Kenya has significant direct and indirect linkages with other sectors in the economy for example, manufacturing, transport and employment. The average production of maize in the country is estimated at 3 Million tonnes per annum. Both large scale and small scale farmers engage in production of the crop and the land area under cultivation accounts for about 56% of the total cultivated land which is approximately 1.6 million hectares (Republic of Kenya, 2012).

The term 'postharvest loss' (PHL) as defined by (Tefera, 2012) refers to measurable quantitative and inherent purchase and consumption characteristics loss along the postharvest chain. Along this system are interconnected activities from the time of crop harvest, crop processing, marketing, storage, to the consumption whereby the consumer decides to consume or discard the food. The value chain describes the interrelationship between various actors and activities in transforming a commodity from the production to consumption stages (Bair, 2009). Efficient value chain development facilitates smallholder farmers explore market opportunities, (Tobin, Glenna, & Devaux, 2016). Along the maize value chain, the product is likely to be subjected to postharvest losses (PHLs). Post harvest deterioration in maize reduces and often times limits marketing and consumption of the output due to loss in food value, grain quality and quantity

(Grolleaud, 2002). The infestation by pests and insect damage during storage are considered among the major causes of postharvest losses in maize. The risk of losses during postharvest activities often times determines the storage behaviour by both farmers and traders.

Both producers and consumers suffer maize storage losses and one of the main reasons for the increasingly level of losses is damage by insects and pests due to lack of modern storage facilities. As a result of damaged grain from insect attack and pests, the return from sales is usually low since the sales are at discounted prices which are usually lower than the expected output prices (Kadjo, 2013).

The ultimate goal of any economic agent is to maximize on profit, however these storage losses usually reduce on profit earnings for producers whereas consumers become food insecure. Eventually low incomes limit on credit access and finances available to enhance effective storage practices. The incentive to store grain is to ensure food availability for consumption especially during the lean season. Another reason is that stored grain evens out unexpected price fluctuations in the market. Stored grain also provides for seed needed for planting in the next season (Proctor, 1994).

At the commercial level of storage (for example cooperatives and millers); grain is held for limited periods to satisfy urban consumer needs and also used as a reserve for the government to supply to hunger stricken families during drought. On the contrary, at trader level grain storage is for very limited period enough to only gain immediate meaningful profit (Hall, 1980).

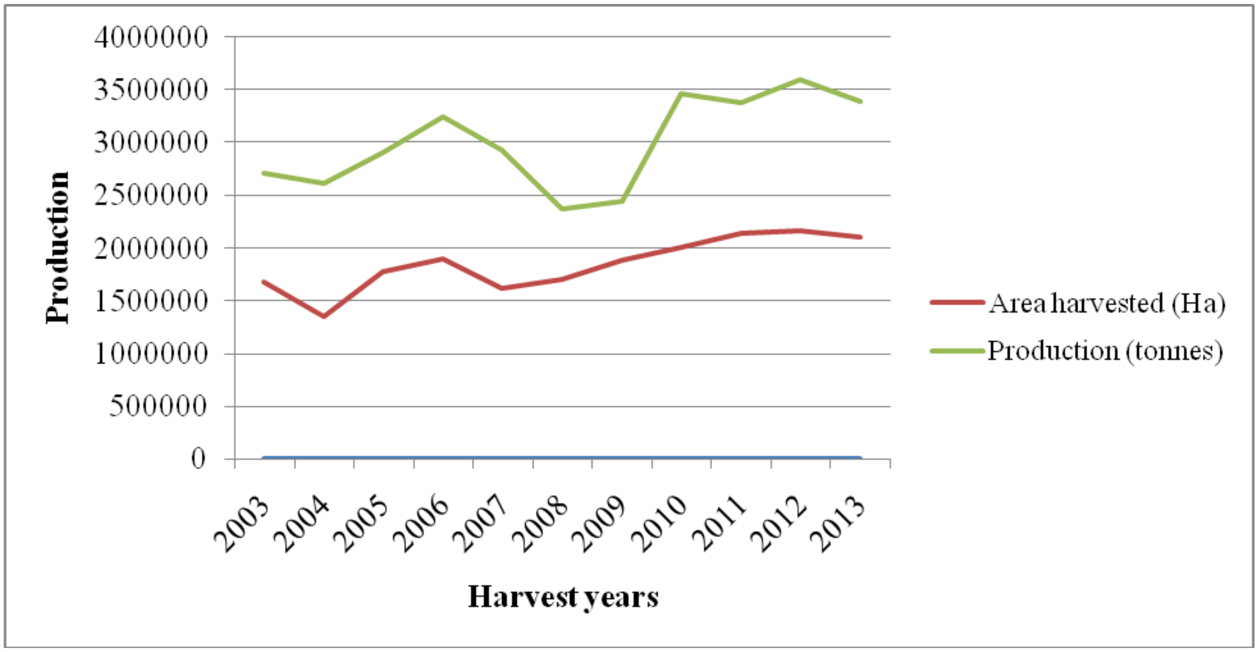
1.1 Background

Agriculture is the main sector of Kenya's economy, directly contributing 24% of the GDP annually valued at KSH 342 billion and another 27% indirectly of GDP. The sector accounts for 65% of the country's total exports and supports 18% of formal employment and more than 60% of informal employment in the country as stipulated in (Government of Kenya, 2007).Therefore, the sector is not only the driver of Kenya's economy, but it is also the means of livelihood for the majority of the Kenyan people. Staple foods are important sources of both food security and income generation for the majority of households in developing countries, including Kenya.

Production level of maize in the country has not sufficiently matched the consumption trends despite the crop being an important staple for most households. Farmers in Kenya face several production challenges. For example, lack of adequate quality inputs (seeds, fertilizer), diseases (for example leathal necrosis), lack of access to market information and poor infrastructure. Another current challenge of maize production in Kenya is civil unrest. After the post-election violence, production of maize declined and consequently the price of maize meal rose steadily.

Civil crises after 2007 election negatively impacted on maize yield because there was destruction of 0.3 million tonnes of maize and a 20% reduction in the total area under maize cultivation during the long rains in 2008 (Zorya, 2009). That was followed by dry spells, which affected the next two harvests that were anticipated to address food crisis. According to official estimates, the total production reduced by 19% in 2008 and the condition persisted until 2010 when normal levels were recovered.

Figure 1: A Comparative Analysis of Trends in Kenya Maize Production (tonnes) and Area Harvested from 2003-2013.



Source: FAOSTAT

Maize is a regionally important crop grown for both home consumption and to a greater extent especially in large scale production zones for cash income. While expanding the industrial use of the crop either in cooking oil production or manufacture of animal feeds most large scale producers sell a greater proportion estimated at about 70% of their output based on the annual crop performance and commercial demand. In the case of small and medium scale producers, they have a higher tendency of selling their grain remaining to as low as 1% of their total output. The unsold output is mainly for home consumption, animal feed and use for planting seed.

According to (Mrema & Rolle, 2002), the level of resources used and the efficiency of production are contingent upon use of appropriate technologies, infrastructure, marketing, and transportation. In sub-Saharan Africa, insect pests which attack maize result to major constraint in terms of food availability and consequently income earnings (Abebe et al., 2009). In addition damaged grain is sold at discounted prices, thus fetching low market value as most consumers prefer good quality grain for consumption and or as seed. In Africa, farmers lack suitable storage structures and innovations to store their grains. As a result, most farmers sell most of their produce immediately after harvest and hardly remain with grain to sustain even their consumption need (Kimenju et al., 2009).

While dealing with storage losses, farmers face problems such as credit inaccessibility, limited market information and lack of modern storage innovations. To evaluate the benefit of post-harvest interventions at the farm level, there is need to understand the linkages between farmers and marketing systems. Sometimes farmers may want to sell the produce later when prices are higher but feel constrained by, among other things poor drying, cost of storage facilities, crop damage by pests and the need for immediate cash either to pay school fees and other necessities such as cooking oil, kerosene e.t.c. In addition, many farmers avoid insect and rodents losses by selling few months after harvest. Therefore, they are unable to benefit from future potential profits. Low profitability of agricultural production imply low investment to other activities relating to agriculture such as modern storage technologies (Kadjo, Ricker-Gilbert, Alexander, & Tahirou, 2013).

According to a value chain analysis report by (Kirimi et al., 2011), maize in Kenya is mainly produced by small-scale farmers who account for about 70% of total output. A majority of the smallholder farmers, especially those at the lower end of the scale (0-5 acres), produce mainly for home consumption, but sell varying proportions for cash each year. It is important to understand the maize value chain to identify and address production and postharvest challenges for any given crop. The main actors along the maize value channel include (i) farmers (large, medium and small); (ii) input suppliers (iii) brokers (local and regional); (iv) traders (wholesalers and retailers) (v) commercial and government reserves (for example, NCPB); (v) transport agents; (vi) processors (small, medium and industrial millers); (vii) consumers who mill their grain at the posho mill or source for maize meal from retailers; and (viii) animal feed manufacturing outlets.

A situation analysis report by (Kang'ethe, 2011) prepared for FAO, reported that in Kenya, domestic production from small and large-scale farmers forms the major domestic supply on a normal year. About, 50-70% of the maize produced is marketed either to millers, large traders, small assemblers, the National Cereals and Produce Board or to neighbouring households.

1.2 Statement of the Research Problem

Post-harvest losses (PHL), which can and do occur along the food chain, and in our case the maize supply chain, result in higher prices and loss of revenue that in turn reduces real income and eventually disposable income for both producers and consumers. Therefore, it is crucial to note that agricultural production does not end at harvest; rather there is an economic channel linking the different activities from production to consumption stages (Randela, 2003). According to research findings by the World Bank, in association with FAO and NRI, this economic channel was described as a value chain, whereby different activities are carried out, including harvesting, drying, threshing, storage, assembling, transportation and marketing. The key players or actors within the value chain are also actively involved in performing those activities.

Most incidences of food losses can be attributed to ineffective practices especially in crop management during pre-harvest and postharvest processes. The losses affect the market supply through reduction by producers and the consumers' purchasing power by raising consumer prices. While most studies have concentrated on storage practices at the farm level, it would be important to consider technologies that are along the maize value chain. This paper analyzes the storage techniques at producer and trader levels.

1.3 Study Objectives

The objectives of this study were:

1. To map out the maize value chain and identify the storage innovations. In doing so, this study contributes to the empirical literature on commodity value chains and also to economics of grain storage.

2. To determine the cost benefit analysis of the storage innovations previously identified. This is an important issue because for maize storage to be profitable, the practice adopted determines the feasibility for long term use by both farmers and traders.

3. To identify the challenges on the uptake of new and improved storage technology for maize in the area. In order to explain constraints of the adoption of effective technologies which are more effective and efficient to control storage losses.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter consists of a review of empirical literature on maize storage structures; their effectiveness, and attractiveness in investing in new technologies; the extent of postharvest losses in maize and also a review of maize supply chain from production to marketing. It also highlights the conceptual framework and summary of the literature review.

2.2 Theoretical Literature

2.2.1 Cost Benefit Analysis Concept

The modern economic theory is a structured approach based on the principle that economic agents have a common goal of maximizing profit or welfare. The Cost-Benefit analysis is founded on two main principles (i.e. benefit and cost). The benefits are considered as the gains in human well being, whereas, the costs are the losses in utility or human welfare. According to (A. Boardman, Greenberg, Vining, & Weimer, 2001) the Cost-Benefit Analysis involves a complete evaluation of all the gains acquired against the losses incurred and that provides a benchmark for measuring the performance of a project. It requires both valuation and forecasting of all parameters of efficiency using actual prices or shadow prices. The shadow price is the forgone cost to an individual or entire society, whereas the actual price is the prevailing market rate for goods and services. The main contribution of Cost-Benefit analysis is derived from its efficiency in resource allocation against competing needs among economic agents (Hahn & Sunstein, 2002).

Cost-benefit analysis (CBA) is an established economic analytic tool designed for comparing the benefits and costs of a given project or activity. The CBA procedure enumerates, measures, and evaluates net benefits and total costs. The policy makers and or individuals are able to make informed decisions on the basis of options appraisal outcome. Gittinger, 1982a identifies various measures of comparing costs and benefits in the context of agricultural development projects.

The application of the cost theory relates to economic choices that individuals or firms decide upon in any given set of available options. However, if there were no scarcity of economic resources or no alternatives to choose between, then costs and choice would be irrelevant. Full economic evaluation is the comparative analysis of alternative courses of action in terms of both costs (resource use) and consequences according to, (Drummond, 2005).

2.2.2 Discounting

Assessing flows of economic costs and benefits created by investment policies occur at different points in time and cannot be directly compared (Dinwiddy & Teal, 1996). The costs incurred and benefits accrued in any project at different points in time are adjusted by a discount rate factor to be made commensurate for comparison. The discount rate is considered as the prevailing cost of capital in the economy. To appraise the possible consequence of a project in an economy, assessment of future and current outcomes are weighed using the social discount rate according to (Campbell & Brown, 2003). This study used the NPV approach to evaluate the cost-benefit outcome of different storage innovations used by farmers and traders.

2.2.3 Valuation of Economic Costs and Benefits

Assessment of the cost and benefits can be undertaken through financial or economic CBA. A Financial analysis is usually undertaken within the budgetary framework of the person; group or unit directly under consideration, for example, a farm and solely considers financial costs and benefits. A financial analysis differs from an economic analysis in that the former evaluates cost and benefits of a unit, but the latter evaluates an economy's wider costs and benefits. In computing prices, a financial and economic CBA differ in that, while the former uses market prices, the later uses shadow prices according to (Gittinger, 1982).

A financial CBA was used in carrying out the current study from the maize value chain agents' perspective of the costs incurred and benefits obtained during storage of maize. In the current study, the costs evaluated included cost of construction and or hire of the storage facility, the cost of storage bag and the cost of control chemicals used during the period of storage. The benefit was obtained from the revenue proceeds gained from the sale of maize. This study used actual prices as at the time when the survey was conducted.

2.3 Empirical Literature

An empirical study by (Nduku et al., 2013) assessed the feasibility of maize storage structures in Kenya. A financial cost benefit analysis was used to value the feasibility of ten different maize storage structures. The study assessed the cost incurred in maize storage and the benefits accrued by using the metal silo over the traditional methods. The study was appropriate then as it established the worthiness of adopting a new storage technology in relation to the current structures that were being used by farmers. The farmers who used traditional methods incurred more storage losses than those who used the improved storage techniques. The feasibility analysis results showed that the improved granary with wicker wall and the metal silos were more viable with benefit/cost ratio of 2.5 and 3.9 for improved granary with wicker walls and metal silo respectively. The results from the sensitivity analysis also revealed that the largest metal silos would still be viable for maize storage on all the scenarios. This current study further considered maize storage structures employed by maize traders and all the current structures used by farmers in Nakuru area which was not considered in the previous research earlier reviewed.

An economic analysis was conducted by (Kimenju & De Groote, 2010) to determine the attractiveness of investing in new storage technologies. Project benefit was estimated based on the amount of loss the new technology could abate. Quantification of crop loss during storage in a polypropylene bag, super grain bag, and metal silo, was done using the count-and-weigh method on a monthly basis for a period of six months. Storage with metal silo was the most feasible alternative with benefits increasing from USD 8.4 after the month of storage to USD 100 after 12 months of storage. Therefore, if a farmer opted for the metal silo to store one ton for 12 months, the gain would be USD 100, which indicated the loss avoided compared to the control treatment that yielded a loss of 2.82% per month. Measures of project worth i.e. net present value (NPV) and the benefit cost ration (BCR) were used to estimate the expected future net benefits from investing in new technologies. In their analysis, they discounted the incremental benefits and costs over a period of 15 years and with a discount rate of 11%, the incremental net present value (NPV) results from all technologies were found to be positive.

A profitability study by (Adetunji, 2007) examined use of local, semi modern and modern maize storage techniques used by farmers and traders. The study site surveyed was Kwara state in Nigeria. A multi-stage sampling procedure was used to select 188 maize farmers and 182 traders. A well structured questionnaire was administered during data collection. Various analytical techniques such as descriptive, budgetary, partial budget, and marginal analysis were used in analyzing data collected from the study area. From the estimate, the modern storage usage was the most profitable with a gross margin of N 12,435/tonne; followed by semi-modern N 11,135/tonne and local N 8,345/tonne.

A study by (Bett & Nguyo, 2007) was conducted to document types and effectiveness of storage facilities, determine the magnitude of postharvest grain losses due to pest damage and also elucidate types and effects of storage pests and other hazards. The research was conducted in Eastern (Machakos and Mwingi Districts) and Central Kenya (Kirinyaga District). A multistage sampling procedure was used. Data was collected using informal discussions and a semi-structured questionnaire. In Machakos and Mwingi most storage facilities were dilapidated while in Kirinyaga they were almost non-existent with farmers opting to store in the living rooms. From their study storage losses were mainly caused by pests such as the large grain borer and the common weevil, ineffective storage structures and diseases. The estimated proportion of losses was 10-20%, 5-10%, and 5% for storage pests, ineffective storage structure and diseases respectively. The findings seem to suggest that farmers need appropriate storage facilities that are not only effective, cost saving, labour-saving but also environmentally friendly.

An assessment study by (Komen et al., 2006) established the extent of maize post-harvest losses, the effectiveness of existing post-harvest grain management practices and evaluated economic losses due to maize post-harvest wastage. The study sites for the survey were Trans Nzoia and Uasin Gishu Districts. A multi-stage and systematic sampling technique was employed to select randomly 100 farm households for the survey. From their results, there was evidence of post-harvest losses that in turn, indicated that it would be avoided by effective control of pests. From their findings, post-harvest losses would be attributed to the length of grain storage, type and the capacity of storage facilities. The cost-benefit analysis on storage indicated that the storage problem was significantly caused by pest losses. Other causes of the storage problem were unpredictable returns due to price fluctuation, and limited credit access to construct effective storage structures. However, farmers would accrue benefits in the long-term (i.e. three months after harvest) by selling later when prices were relatively high.

2.4 Overview of Literature

Review of literature highlights the importance of effective storage techniques for maize storage at the farm-level in order to reduce postharvest losses. Most studies establish that the use of modern storage technology and especially the metal silo yields more economic benefits when adopted as the alternative for maize storage. However, there exists research gap on the need to establish the storage innovations along the maize supply chain aimed in mitigation of postharvest losses and their profitability. Most studies reviewed above focus more on on-farm maize storage innovations and their cost-benefit economic analyses. There is also need to understand the maize value chain in terms of activities, actors, and services within the continuum to advise on appropriate policy recommendations. Hence, it is against these eminent knowledge gaps that this study was undertaken to establish maize storage technologies at the production and marketing stages of the maize supply chain, and their profitability as well.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

There are five basic methods of economic analysis or measures of profitability according to (Hardaker et al., 2004) namely: cost-benefit analysis (CBA), partial budgeting analysis (PBA), cost effective analysis (CEA), cost-utility analysis (CUA) and gross margin analysis (GMA).

To determine the feasibility of the different technology alternatives, the methodology of financial cost-benefit analysis as outlined by (Gittinger, 1982) was employed. Three options are available to guide the decision making process of a CBA. Benefit cost ratio (BCR), internal rate of return method (IRR), and the net present value (NPV). In this analysis, we used both the NPV and BCR approaches.

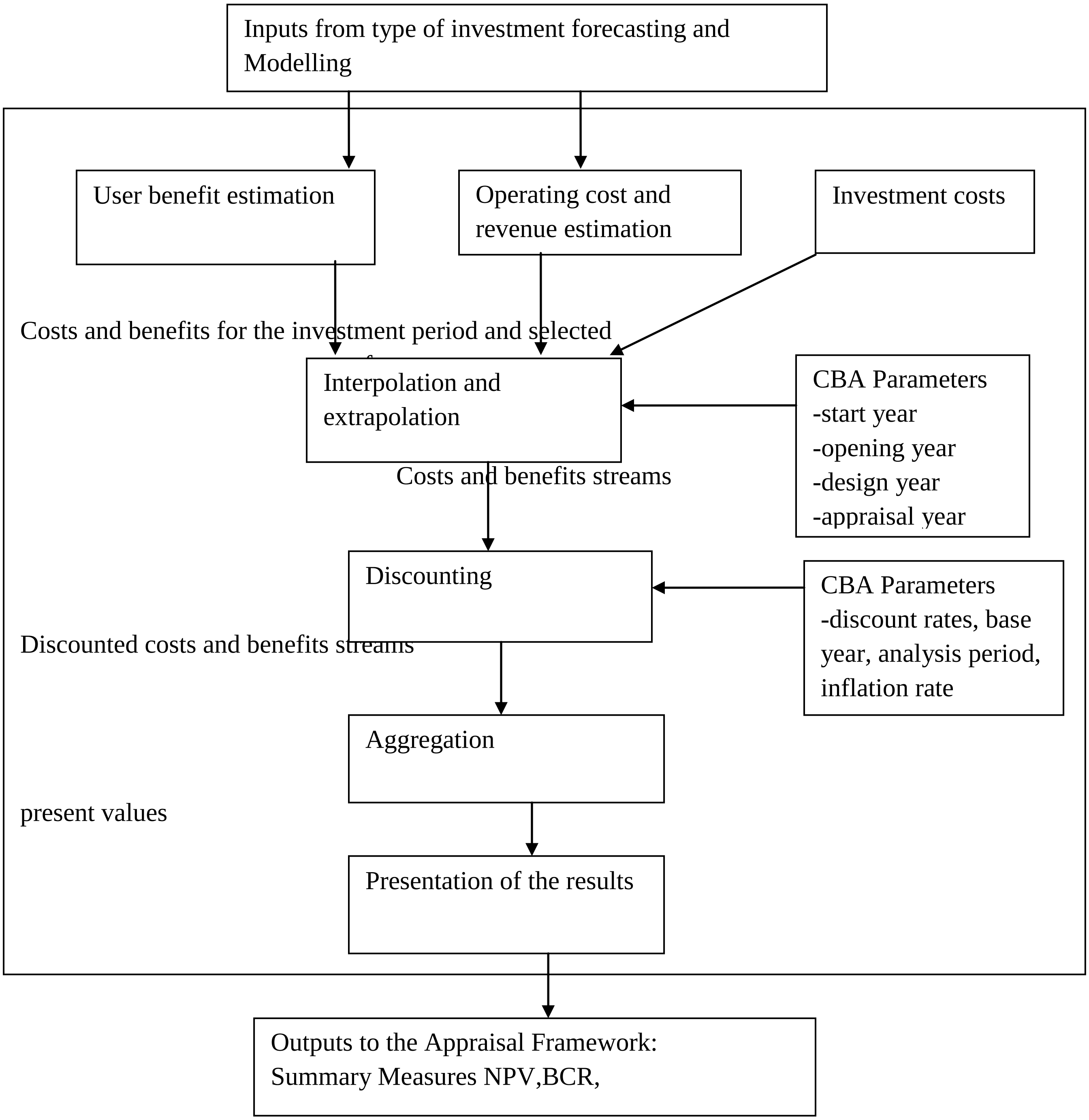
3.1 Theoretical Framework

The cost-benefit analysis has its theoretical foundations in the subject of microeconomics and in the fundamental principle of social choice (Nas, 2016). Cost-benefit analysis is a useful analytical approach to determine decisions or choices that influence efficiency and utility maximization in resource allocation. The process involves determining a specific course of action within a given set of alternatives, followed by valuation or measurement of social benefits and costs and then implementation of the appropriate decision criterion (Mackie, 2003).

The objectives are the desired goals or outcomes expected to be attained by the undertaking or investment. Alternatives are the possible combination of resources (time, people, materials), or possible approaches to employ to achieve a desired goal. Benefits are outcomes that make the society better in terms of welfare by increasing their gains and making them economically efficient. Costs are resources utilized by the undertaking. A model represents the interactions of possible combinations of resources and their consequences, useful to make a meaningful decision or choice. A criterion is the approach used to choose the best option or alternative within a given set of alternatives (McKenna, 1980).

A conceptual framework of the cost benefit analysis process is as shown below in Figure 2.

Figure 2: The CBA Process



Source: (Boardman & Boardman, 2010)

3.2 Empirical Model Specification

This formula adopted from (A. E. Boardman & Boardman, 2010) was used to calculate the NPV.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

Where:

NPV =Net present value, n =life time of the project, B_t =Total benefits from maize storage, C_t =Total costs of storing maize, r = real discount rate, t = storage year . During the period when the data was collected (i.e. July, 2015) the average current commercial bank's lending rate in Kenya was 15% according to statistics by (CBK, 2014), which was used as the discounting rate. In addition, with reference to (CBK, 2014) rates during the time of survey, the inflation rate was at 5%. Below are the equations adopted from (A. E. Boardman & Boardman, 2010) that were used in the cost-benefit analysis to present the NPV statistics:

$$PV(B) = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

$$PV(B) = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

$$NPV = PV(B) - PV(C) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [3]$$

$$NPV = PV(B) - PV(C) \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots [4]$$

Or

$$PV(B) \geq PV(C) \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [5]$$

Where; PV is the present value, B is the Benefits and C is the costs. In general the decision rule is that the project is profitable or feasible hence potentially Pareto efficient if the calculated NPV is positive when discounted at the opportunity cost of capital in reference to (Berlage & Renard, 1985).

The BCR is the ratio of sum present value of benefit to sum of present value of cost for a given discount rate (Gittinger, 1982). If the B-C ratio is greater than one, that indicates the viability of the investment. The Benefit-Cost ratio is mathematically expressed as follows;

$$\text{B - C Ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(i+r)^t}}$$

3.3 The Study Area

This study was conducted in Nakuru county, Njoro sub-county of Kenya. The County is one among the 47 Counties that were formed under the new Kenyan constitution. It covers an area of 1392.55km² and is located between Longitude 35 º 28\` and 35 º 36\` East and Latitude 0 º 13 and 1º 10\`. Nakuru County is also an industrial and a commercial centre and it is considered as the fourth major town in the country. Njoro sub-county has subsistence, commercial and horticultural crops (G.O.K, 2008). The choice of the area was purposive since the area is a major-maize producing zone of the country and hence bears the challenges of storage loss; also, there are various available maize storage facilities in the area.

3.4 Data collection

3.4.1 Survey

A simple random sampling technique was employed to select 380 respodents (i.e. 350 maize farmers and 30 marketers and processors) from Njoro sub-county, Nakuru County. Primary data was collected by personal interviews using a well structured questionnaire; data were collected on socio-economic characteristics of the respondents in the area, the types of storage techniques, quantities, and costs of all variable inputs and prices of maize. The survey collected important information on different aspects such as socio-economic characteristics, types of storage structures and their cost.

3.4.2 Focus Group Discussion

In order to map out the movement of maize from production to marketing, this study conducted four focus group discussions (FGDs) with the farmers, marketers and processors in four different areas (i.e. Njoro, Elburgon, Molo and Lare) from Nakuru County which were also randomly selected based on their active engagement in maize production, marketing and processing. The number of participants in the FGDs ranged from 11-16.

3.4.3 Sampling Procedure

The Cochran formula was employed to define an appropriate sample for the study. This gave a sample size of 380 respondents from the population study area and is expressed as follows;

$$1.\ n_0 = \frac{t^2 * (p)(q)}{d^2}$$

Where: n_0 =required return sample size according to Cochran's formula, t =value of selected alpha level of 0.25 in each tail=1.96, $(p)(q)$=estimate of variance=0.25 and d =acceptable margin of error for mean being estimated=0.5

$$\frac{1.96^2 * (0.5)(0.5)}{0.05^2} = 384$$

$$2.\ n_1 = \frac{n_0}{1 + n0/population}$$

Where: n_1 =required return sample size, because sample>5% of population

42322=the number of households in Njoro sub-County (Source: KNBS)

$$\frac{384}{1 + 384/42322} = 380$$

3.5 Data Analysis

The data collected was analyzed using STATA and Excel software to obtain descriptive statistics and Cost Benefit outcomes. Descriptive statistical analysis and cost benefit analysis approaches were applied to determine the socio-economic characteristics and evaluate the profitability of various storage techniques respectively. Qualitative data from FGDs farmers, traders, and key informants were synthesized and summarized to map the maize value chain.

CHAPTER FOUR

RESULTS AND DISCUSSION

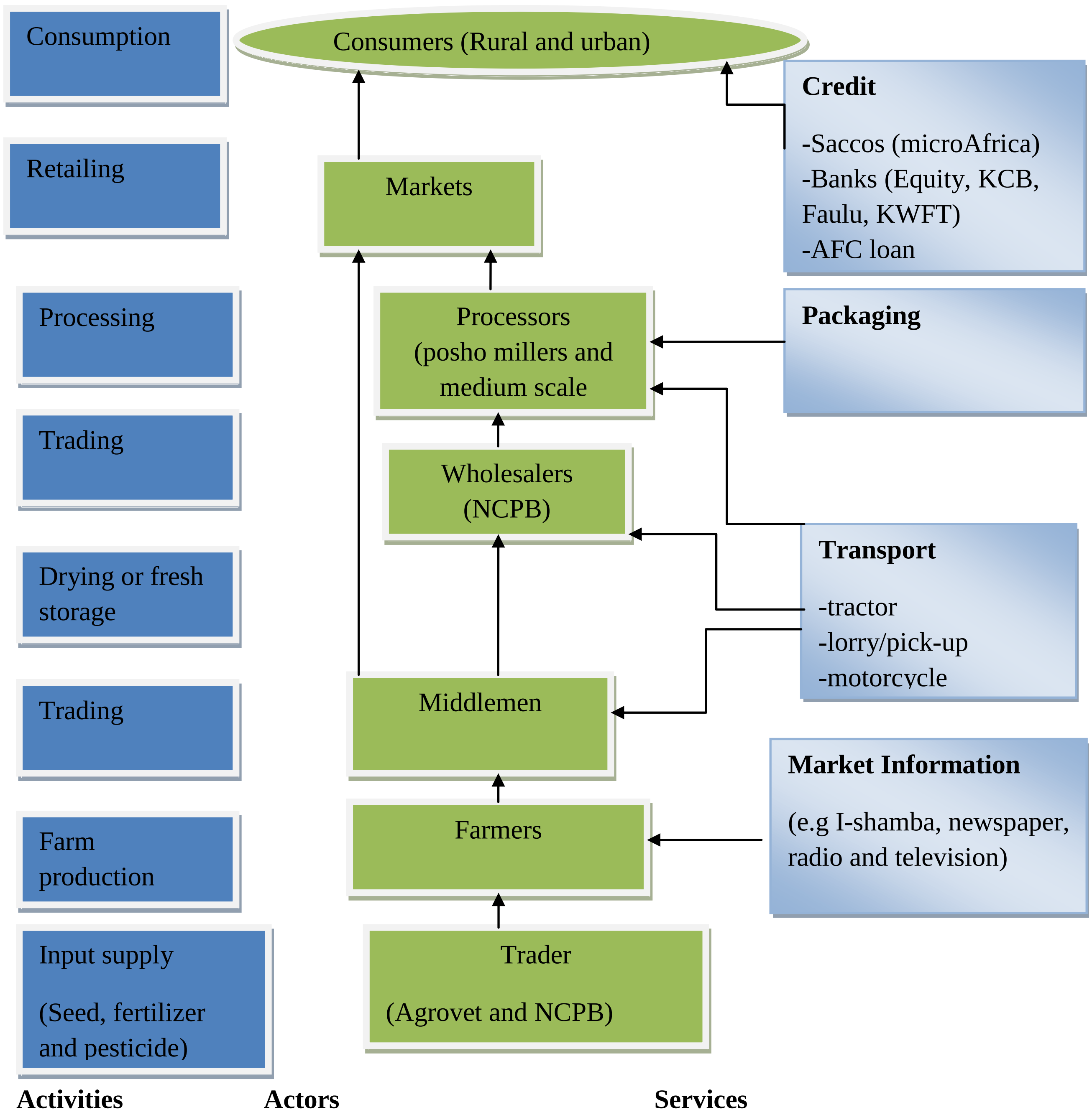
4.0 Overview of the Maize Value Chain

The maize value chain in Njoro sub-County is shown in Figure 3. Maize production in the area is dominantly small scale, with producers preferring to plant hybrid maize variety that yields better produce within five to six months. However, a small proportion also plants local seed varieties that they source from fellow farmers. The benefits for maize production stated were; use for home consumption either as threshed maize or milled flour; sales revenue proceeds that addressed their immediate cash needs; and also the use of maize stalks for animal feed.

There were several constraints in maize production that the participants stated, such as; lack of quality inputs (fertilizer and maize seeds), low price during harvesting, diseases (e.g. maize lethal necrosis), limited information on quality seed depending on area soil type and inaccessibility of markets due to poor roads. Concerning storage, most farmers store their maize for a period of three to six months as they anticipate selling at higher prices. Liquidity constraints amongst most farmers explain why they sell their maize at low postharvest prices to meet urgent cash needs such as paying school fees.

The maize value chain involved a number of actors with both forward and backward linkages. Small holder maize farmers are linked with input suppliers (backward integration). The inputs include maize seeds, fertilizers, manure and chemicals. The majority of FGDs reported that farmers source for their inputs from local agrovet dealers and also from the National Cereals Produce Board (NCPB). After harvesting, farmers may sell directly to consumers or sell through the middlemen, or to the cereals board. Under this channel, transporters have a function of transporting threshed maize or value added maize product to the retailers, wholesalers or consumers using different forms of transport such as the bicycle, motor cycle, lorries and tractors. There are a number of maize processors in the sites we conducted the FGD, including local posho millers and medium-scale processing millers. Some of the activities involved after processing included-transportation, retailing and distribution.

Figure 3: Maize Value Chain Map in Njoro Sub-County



4.1 Socio-Economic Characteristics of Respondents

Descriptive statistics of the socio-economic characteristics of sampled farmers and traders are summarized in Table 1 and Table 2 respectively.

Table 1: Household Social-Economic Characteristics of Farmers (N=358)

Variables	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Age of household head (years)	46	15	19	93
School years spent by household head	8	3	0	19
Household size	6	2	0	19
No. of school going children	3	2	0	10
Total farm size (Acres)	0.37	0.81	0	8
Maize production farm size (Acres)	1.59	1.40	0.06	15
Quantity of maize output	2076	2186	90	18000
Distance from the closest market (KM)	4	3	0.1	15
Time to closest market (Hours)	0.41	0.27	0.06	2
Duration of maize storage (Months)	3	2	0	10
Length of usage for storage structure (years)	7	7	0	43
Household Gender	**Frequency**	**Percent**	**Cumulative**	
Male	292	81.56	81.56	
Female	66	18.44	100	
Household head Education level	**Frequency**	**Percent**	**Cumulative**	
None	38	10.61	10.61	
Primary	195	54.47	65.08	
Secondary	98	27.37	92.46	
College/University	27	7.54	100.00	

Descriptive statistics on frequency distributions and percentages are presented in Table 1 and Table 2. As shown in Table 1, the majority of the household heads (81.56 %) were males, and 18.44 % were females. The results indicated that in most households men dominated as household heads. The result is as expected, because in most cultures men are responsible for making decision that affects their families.

The mean age of the farmers was 46 years. The implication of this finding was that most of the respondents were in their middle age which means they were still active in their farm production activities. Age is an important factor in influencing decisions such as the area to be cultivated and the technologies or innovations to employ for example, in storage to protect their output.

The educational background of the household heads revealed that 10.61 % had never been to school, 54.47 % had at least primary education, 27.37 % had some secondary school education and while only 7.54 % enrolled for tertiary education. The literacy level of the farmers is an indication that they had the advantage of improving their storage innovation, since education informs on improved maize storage technologies that would manage postharvest losses.

The household size or composition determines the input of labor in farm production, total area cultivated to different crops, farm output retained for home consumption, and the marketable surplus (Chayanov, 1926). However, when the crop yields are low, households with more members are unlikely to store or sell their output due to limited access to sufficient food. The mean household size was six members according to the results presented in Table 1. The mean area of farm size under maize production in Njoro sub-county is 2 acres with an average output of 23 bags. Hence, there would be the need for proper storage technique to ensure food security.

Once maize is harvested, most farmers in the area store their produce for home consumption. While in store, the length of storage can affect the extent of grain damage since maize is more likely to be attacked by pests and diseases (Boxall, 2002). However, to overcome the problem some farmers apply insecticides and use rodent traps.

According to grain storage economics, the crop storage period normally increases with distance. When producers are widespread, those who are closer to the market tend to sell first because their higher grain prices result in higher opportunity cost of forgone interest relative to producers farther from the market who have lower prices, hence lower returns to storage.

From the results in Table 1, the mean duration of maize storage is three months, whereas the mean distance from the closest market is four kilometers. The mean distance from the closest market explained why most farmers sell their maize produce during the initial months of storage.

Table 2: Social-Economic Characteristics of Traders

Variable	Mean	Standard Deviation	Minimum	Maximum
Age of trader (years)	43	11	25	73
Years spent in school by trader	10	3	2	15
Duration of maize storage	3	2	0	8
Years of maize trading	10	7	3	26
	Frequency	**Percent**	**Cumulative**	
Primary	14	46.66	46.66	
Secondary	11	36.66	83.32	
College/University	5	16.67	100.00	
Category of Trader	**Frequency**	**Percent**	**Cumulative**	
Retailer	10	33.33	33.33	
Wholesaler	16	53.33	86.66	
Processor	4	13.33	100.00	

The results from Table 2 above showed that the mean age of maize traders was 43 years that indicate that many of the traders were fairly aged. The mean education level was found to be ten years of schooling, based on the Kenyan education system this implies that they have secondary school education. This also implies that traders have basic education and can be considered literate. Education would enhance the ability of the trader to be more innovative and consequently facilitate the adoption of new and effective storage technologies with ease.

Concerning the category of maize traders in the study area, most of the traders (53%) were wholesalers, (33%) were retailers and (13%) were processing maize into final products such as maize flour, animal feeds and cooking oil. On average, maize traders stored maize for a duration of three months before selling it at a profit. Most traders had engaged in this commercial activity for an average period of ten years.

4.2 Maize Storage Practices Used by Farmers and Traders, Capacities of Storage Structures and Duration of Storage

As shown in Figure 4, farmers used different storage structures to store their maize, which included: improved granary + polypropylene bag (48%), house + polypropylene bag (41%), traditional granary + polypropylene bag (4%), improved granary and house (3%) for unshelled maize, and metal silo and rented room (0.3%). Farmers who stored their maize in houses did so due to the problem of theft in the area.

The overall mean of maize storage duration was three months as summarized in Table 3. The longest period was reported in traditional granary (11months) whereas metal silo had the shortest period of three months. The overall storage capacity mean was (5.1 tonnes) with the rented room having the highest capacity of (45 tonnes) and house form of storage with the lowest capacity of (1.3 tonnes).

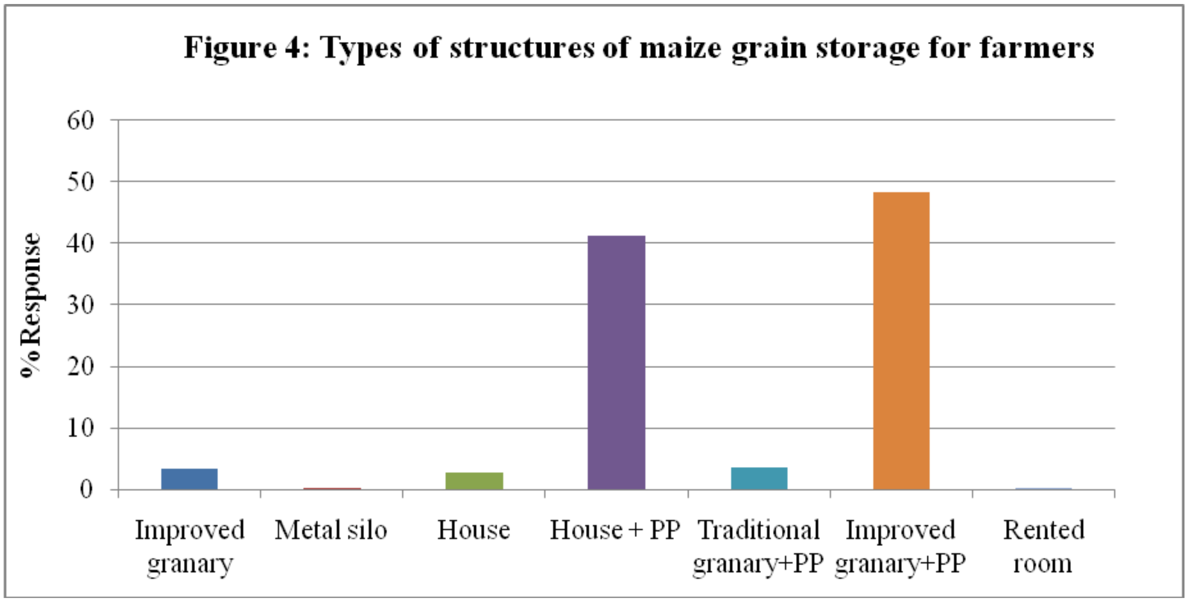


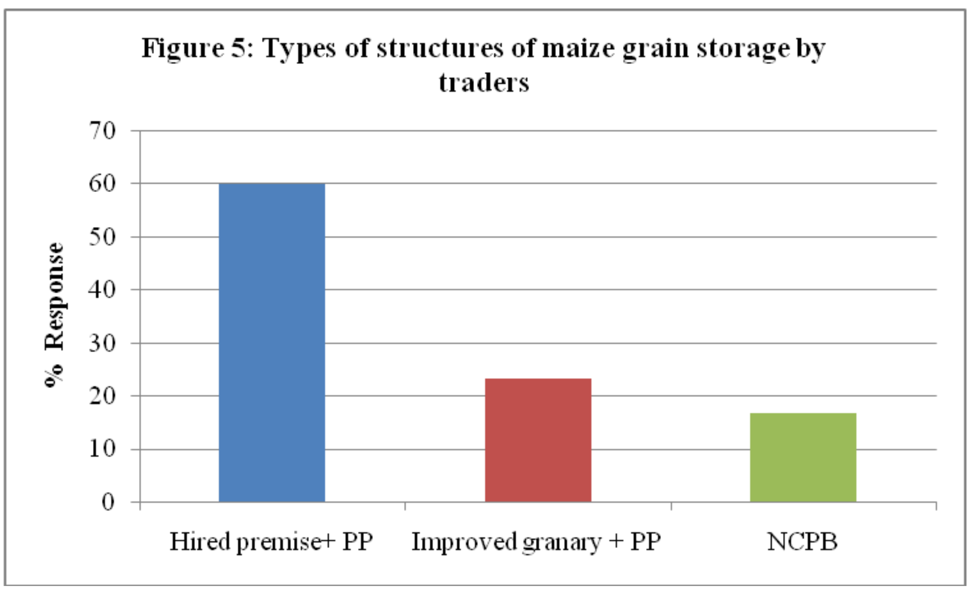
Table 3: Storage Structures and Duration of Maize Storage by Farmers

Storage structure	Frequency	Percent	Length of maize storage (Months)	Capacity of storage structure (Kgs)	Years of existence
Improved granary	12	3.35	4	4466	4
Metal Silo	1	0.28	3	9000	3
House	10	2.79	9	1330	9
House + polypropylene bag	148	41.34	6	2692	6
Traditional granary + polypropylene bag	13	3.63	11	4215	12
Improved granary + polypropylene bag	173	48.32	8	7244	7
Rented room	1	0.28	2	45000	2

From survey statistics as presented in Table 4 and Figure 5, most traders (60%) preferred to store their maize in hired premises using polypropylene bags. The main reason for this was due to their location need of their commercial activity, whereby most of them were located in towns and along major roads connecting different towns. Other forms of storage used were improved granary (23%) whereas others (17%) paid for storage space at the NCPB storage facility. In their work, (Strahan and Page, 2003) confirmed the finding that traders who deal on the commercial level usually prefer improved storage techniques for proper preservation, quality, and quantity maintenance.

Table 4: Storage Structures and Duration of Maize Storage by Traders

Storage structure	**Frequency**	**Percent**	**Length of maize storage (Months)**
PP + Hired premise	18	60	2
PP + Improved granary	7	23.33	4
NCPB	5	16.67	5



4.3 Feasibility Analysis

The financial feasibility analysis for different maize storage structures was calculated and results presented in Table 5 and Table 6 for farmers and traders respectively. To evaluate the financial feasibility of investment, the project evaluation criteria of Net Present Value (NPV) and Benefit Cost Ratio (BCR) were employed.

Table 5: NPV and BCR of Storing A Kilogram of Maize by Farmers

Type of storage structure	**NPV (Kshs)**	**BCR**
Improved granary	34	1.8
Metal Silo	44	4.4
House	25	0.9
House + polypropylene bag	26	1.4
Traditional granary + polypropylene bag	22	0.8
Improved granary + polypropylene bag	38	2.4
Rented room	33	1.6

From the BCR results in Table 5, metal silos, improved granary using polypropylene bag for shelled maize, improved granary and rented structures are more viable with BCR's of 4.4, 2.4, 1.8 and 1.6 respectively. The NPV for metal silos was the highest at Kshs.44 per kilogram of maize which depicted the viability of investment in metal silo as the most effective alternative of maize storage against rodents and insects damage.

Table 6: NPV and BCR of Storing Maize by Traders

Type of maize storage structure	**NPV (Kshs)**	**BCR**
PP + Hired premise	2443	1.3
PP + Improved granary	1275	0.1
NCPB	1574	0.6

The results presented in Table 6 above shows Storage techniques used by traders, their NPV, and BCR output measures. The results reveal that all the storage innovation used by the traders had positive NPV outcome. However, BCR is highest for the hired premise with PP bag (1.3), and lowest for improved granary with PP bag (0.1). In economic theory, an undertaking with a BCR of above 1 is considered attractive for investment.

4.4 Challenges in the Uptake of New and Improved Storage Technology and Innovations for Producers and Traders

Reducing postharvest losses in maize would require significant scale-up on adoption of technologies and innovations especially during storage. Much as losses would reduce farmers are likely to benefit from increased income on return to storage especially in future. While conducting the focus group discussion, we sought to identify extent of uptake of technologies such as Purdue Improved Crop Storage (PICS) bag, metal silo and synthetic chemical application of stored maize in the area under study. Metal silo and PICS bag use hermetic storage technology, such that the triple layered PICS bag and metal silo are airtight from oxygen thus pests and insects damaging grain are unable to survive in the highly concentrated carbon dioxide levels.

Participants in the focus group discussion cited several challenges that constrained popularity and adoption of the new storage technology and innovations in the area. In nearly all the cases, high capital cost was a common challenge. Based on (Hubbard, 1997), the higher the cost of capital the lower the capital stock, hence the downward sloping demand curve depicting the relationship. Due to low incomes most producers however willing to minimize storage losses were unable to acquire metal silo and the few who were using them purchased as a group.

Economic viability of using them was also affected by the size of owned land, since most were on small and medium sized land their output was to cater for their home consumption and immediate cash needs. Hence no need to store their grain for long periods. Traders also opted to store shelled maize in polypropylene bags and grain kept off the ground on either tarpaulins or plastic sheet which were affordable and easily available. According to the prices the average prices given, the PICS bag were retailing for ksh.250 compared to polypropylene bag sold at an average of ksh.50.

An efficient market system is considered to have a perfectly competitive input and product market (Dwivedi, 2009). Information imperfections affect decision making for economic agents who are key players operating in those markets. Most have limited knowledge on where to source for the new storage technologies, challenges on proper training on how to use them and the economic productivity from investing in such. Infrastructure inefficiency also increases the cost of accessing construction and labor inputs especially in the case of metal silo technology.

Credit market constraints, the high interest rates prevailing in the market reflect the fact that many producers and traders have to spend significant transaction costs on borrowing. Producers only risk to seek credit for their production inputs such as planting seed and fertilizer and thereafter prefer to use their existing storage technologies since they argue that the returns from new innovations is not immediate and they are expected to repay their credit. Traders on the other hand opt to borrow money to purchase stock on maize and transport of maize to and from their premises.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Summary

The main aim of this study was to evaluate the cost-benefit outcome of various storage structures used at different levels of the maize value chain. The specific objectives of the study were mapping out the maize value chain and identifying the maize storage structures. Analysis of socio-economic characteristics described maize farmers and traders in Njoro sub-County. To evaluate the profitability of the storage innovations used in the area of study, the cost-benefit approach was used to conduct the financial feasibility for each technique.

Socio-economic analysis showed literacy status across the three categories (farmers, processors and marketers) of the post-harvest maize value chain. The average education level was of primary level. The age distribution of actors indicated that on the average they were in their mid-forties implying that they were in their active age group.

Measures of project worth, that is, NPV and BCR were used to analyze the expected future net benefits from investing in various maize storage technologies by both farmers and marketers. A discount rate of 15% was used to conduct the financial feasibility analysis. The results revealed that use of modern management technique (metal silo and improved granary) of maize storage at the farm level contributed to more profitability than the use of traditional technique

(Room in the house, separate rented structure and traditional granary).

5.1 Conclusions

Our findings present the proportion of population using the different types of storage structures and how profitable the structures are in controlling postharvest losses due to insects and rodents. Using data from Njoro sub County in Kenya, this article analyzes the cost benefit estimates for each storage technique used by farmers in the area. As well, this paper reveals that traders in that area store their grain for shorter period and hence their most profitable technique of storage management is the use of a hired premise. Unlike the farmers, traders use less of synthetic chemical on their grain.

It was observed that most farmers were in maize organisation groups following information received from active agricultural extension workers working in that area. The farmer groups enhanced sourcing of raw materials mostly quality seed and fertilizer; provided assistance to access credit at a lower interest rates and also enhanced access to grain market. Ultimately, if the farmer groups are enhanced to become more effective they would also facilitate for better maize storage option for their farmers or acquisition of modern storage techniques that are mostly lacking in the area. Alternatively the farmers groups could hire storage from commercial grain reserves, which in turn guarantees on grain quality and saves on handling and transportation fees when the grain is sold to the same commercial reserve.

In addition this study conducted mapping of the maize value chain in Njoro sub-County Kenya. Combining our results with findings in (Tobin et al., 2016) indicate that participation of smallholder farmers in value chain provides market opportunities, increases production and provides greater access to resources. Additional benefit to both maize farmers and traders in value chain is increased income which in turn would help overcome significant storage losses due to insects and pests by financing for construction of modern storage structures; use of hermetic storage bags and acquisition of control chemicals.

The implication of the results from this article is important since the adoption of proper storage technology helps to control the extent of postharvest losses incurred. The cost benefit analysis showed that metal silo was the most viable storage technique for farmers in the long run. Evaluation of storage techniques used by traders showed that hired premise was the most attractive option. The study concludes that proper maize storage is important to both farmers and traders in reducing storage losses incurred due to insect infestation and rodent's damage.

Efficient linkages within the maize value chain would be effective in enhancing activities relating to production all through to consumption. This means that producers are able to get quality input at cost effective prices; accessibility to markets; improvement in communication infrastructure and availability of credit services.

The study has revealed that the maize value chain in Njoro sub-County faces a range of constraints that require concerted effort both on the production and marketing sides. On the production side, adequate supply of quality inputs, dissemination of information on appropriate seed and farm inputs, and access to capital for production. On the marketing side, there is need to enhance maize production practices, to enhance not only the productivity but also the quality that enters the market. In addition, the government should also improve the infrastructure in the area to facilitate market accessibility.

To mitigate storage losses from insect attack and pest infestation acquisition of proper storage technique is important for both the producers and marketers. Further, value addition strategies would enable producers and marketers to profit by market prices when they are at their best. In turn, the increase in income would provide both actors with financial resources for investment in improved storage technology that help reduce post harvest food losses.

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The study concludes that proper maize storage is important to both farmers and traders in reducing storage losses incurred due to insect infestation and rodent's damage. Efficient linkages within the maize value chain would be effective in enhancing activities relating to production all through to consumption. This means that producers are able to get quality input at cost effective prices; accessibility to markets; improvement in communication infrastructure and availability of credit services.

5.2 Recommendations

The study has revealed that the maize value chain in Njoro sub-County faces a range of constraints that require concerted effort both on the production and marketing sides. On the production side, adequate supply of quality inputs, dissemination of information on appropriate seed and farm inputs, and access to capital for production. On the marketing side, there is need to

enhance maize production practices, to enhance not only the productivity but also the quality that enters the market. In addition, the government should also improve the infrastructure in the area to facilitate market accessibility.

To mitigate storage losses from insect attack and pest infestation acquisition of proper storage technique is important for both the producers and marketers. Further, value addition strategies would enable producers and marketers to profit by fetching higher market prices depending on supply and demand dynamics. In turn, the increase in income would provide both actors with financial resources for investment in improved storage technology that help reduce post harvest food losses.

The results of this study also point out on the need for producers and marketers to form cooperatives in order to address transportation, labour and storage problems. This approach will also facilitate credit provision and also help reduce costs.

5.3 Limitations of the Study

The value chain engages many different actors and also involves different activities. Postharvest innovations are interventions intended to improve the efficiency of the value chain on any given crop. There exist gaps of research in the economic analysis of these innovations on other agricultural commodities both staple crops and cash crops value chains. It would be equally important to establish other causes of postharvest loss in addition to storage losses which this paper has identified and document their impact at every step of the value chain. Based on each postharvest innovation identified, further research should assess qualitative postharvest losses and contribution of such innovations to the loss of produce after harvest.

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APPENDICES

APPENDIX I: MAIZE PRODUCER SURVEY QUESTIONNAIRE

A cost-benefit analysis of maize storage techniques: A case study of Njoro sub-county

STRICTLY CONFIDENTIAL

This survey is being administered through the collaboration between University of Nairobi and International Centre of Insect Physiology and Ecology (ICIPE). The information provided will be held strictly confidential and used for statistical purposes only.

PRODUCER QUESTIONNAIRE

INTRODUCTION OF THE SURVEY TO THE RESPODENT:

ICIPE is currently undertaking a farmer/trader survey to learn about the types of the storage innovations being used for maize, and understand their cost benefit relationship to the holder. You have been randomly selected as a survey participant.

I would like to ask you a few series of questions, all of which will be held in complete confidence. The answers you provide will only be used by the interviewer for the above stated study objective. The results will help to improve storage options for maize farmers and traders. Your participation in this interview is completely voluntary. Do you have any questions about anything I have mentioned, or any further clarification? May I continue with interviewing you?

GENERAL INFORMATION

01.	Date of Interview	02.	Questionnaire No.
03.	Enumerator Number	04.	Region
05.	County	06.	Town/Village
07.	Closest market	08.	Distance from closest market (Kms) _________
09.	Mode of transport to closest market	10.	Time to closest market

DEMOGRAPHIC INFORMATION

11. Name of the respondent:	12. Household head name (If different)
13. Gender of the household head: 1=Male (____) 0=Female (____)	14. Age of the household head (____) (in years)
15. Education (0)None (____) (1)Standard (Primary) (____) (2)High school (Secondary) (____) (3) College/University (____)	16. Household size (total persons): _____________

17. Household Composition

Age	**Male**	**Female**
0 year to 5 years		
6 year to 14 years		
15 years to 64 years		
More than 64 years		

18. How many children go to school? ___________

SECTION A: LAND TENURE AND LAND USE

19. Please provide information about all the land used by your household during the last 12 months. Please include land you cultivating that belong to other households, or left fallow

	Total agricultural cultivated land				Land given to other family members	
	a. Own land	**b.** Rented-in		**c**. Own land left fallow	**d**. Rented out	**e.** gift
Acres						

20. If you rented in land, how much did you pay in the last 12 months? Ksh_________________

21. What size of your farm is allocated to maize farming? _________ (Acres)

SECTION B: TECHNOLOGY OF MAIZE STORAGE

22. When did you harvest your maize? Day/Month/year/_________/_____________/_________/ (***if farmer cannot recall the day, ask the Month and Year) (Please write name of month)***

Activity	**Estimated cost**
A. Construction materials (*Fill only if the farmer has incurred the cost)*	**Cost (Ksh)**
1. Wood &/ bamboo poles, posts etc	
2. Mesh wire	
3. Stones, concrete material &/ bricks	
4. Roofing material (iron sheet &/ grass thatch)	
5. Metal silo	
6. Jute or Sisal bags	
7. Polypropylene bag	
8. Tarpaulin (mat)	
9. Other (specify)	
B. Crop protection	
10. Labour	
No of workers hired to construct the structure (___________) How many days did they work ___________)	
No of Family labor (______) How many days did they work (______)	

C. Crop protection: Insecticides	
1) Acetylic super **(*specify quantity):**	
2) Ash	
3) Botanicals	
4) Rodenticides/raticides	
5) Rodent trap	
6) Other (specify)	

23. How many kilograms of maize did you harvest? __________(Kgs)

248. How many kilograms of maize harvested are **usually reserved** for home consumption? __________

25. How many kilograms of your harvested maize did you **sell durin**g the last season? __________

26. When did you sell your maize? Day/Month/year/_________/_____________/_________/ (***if farmer cannot recall the day, ask the Month and Year) (Please write name of month)***

27. What do you use to store your maize?

	(1). Traditional granary (______)		(2). Improved granary (______)
	(3). Polypropylene bag		(4). Jute or sisal bag
	(5). Metal silo (______)		(6). House (______)
	(7). Others (specify)____________		

28a.What quantity of maize your storage technology can hold? (PLEASE SPECIFY IN KG)_________

29b.How long has the farmer used the storage technology? (PLEASE SPECIFY IN YEARS) _________

30. Which of the following costs have you incurred in establishing the storage structure?

SECTION C: MAIZE MARKETING

31. Did you sell any maize produce last season? 1 = Yes [____] 0 = No [____]

32. If yes, specify after how long you sold, quantity sold, price per unit and total income in the table below.

No.	**Sale number**	**After how many months of storage did you sell?**	**Quantity sold (Kg)**	**Price per Kg (Ksh)**	**Total income from sale (Ksh)**	**Marketing channel***
1.						
2.						
3.						
4.						

***Marketing channel: 1= sold at farm gate, 2=sold at local market, 3=sold to middlemen, 4=Exported 5=Others (specify)**

SECTION D: HOUSEHOLD INCOME

33. What are the main sources of income of the household? PLEASE RANK	(1)Farming (crop production) /___/ (2)Livestock keeping /___/ (3)Employment /___/ (4)Business/commerce /___/ (5)Remittance /___/ (6)Other (specify) /___/ ___________
34. Please estimate the income (Ksh) of the household for the last 12 months from each of the following?	(1)Livestock keeping /___________/ (1) Farming (crop production) /___________/ (3)Employment /___________/ (4)Business/commerce /___________/ (5)Remittance /___________/ (6)Other (specify) ___________ /___________/

35. Did you or your spouse receive any form of credit/loan in the last 12 months? // *1=yes, No=0.*

36. If yes, please fill the table below.

Source of credit. (Use code A)	Amount received Ksh.	Form of credit. (Code B)	Interest rate	Purpose of credit. (Code C)

Code A.Source: 1= Farmer group, 2= other self-help group, 3= Friends/Relative, 4= Bank, 5=Microfinance, 6=AFC, 7= other, specify…………………………………………….

Code B. Form: 1= in kind e.g. inputs, 2=money, 3=other (specify…………………………………….…………………….)

Code C. Purpose: 1= to purchase seeds, 2= to purchase fertilizer, 3= to purchase storage structure, 4= to purchase pesticides, 5= to rent additional land, 6= to expand crop area, 7= other (specify).

APPENDIX II: MAIZETRADER SURVEY QUESTIONNAIRE

A cost-benefit analysis of maize storage techniques: A case study of Njoro sub-county

STRICTLY CONFIDENTIAL

This survey is being administered through the collaboration between University of Nairobi and International Centre of Insect Physiology and Ecology (ICIPE). The information provided will be held strictly confidential and used for statistical purposes only.

TRADER QUESTIONNAIRE

INTRODUCTION OF THE SURVEY TO THE RESPODENT:

ICIPE is currently undertaking a farmer/trader survey to learn about the types of the storage innovations being used for maize, and understand their cost benefit relationship to the holder. You have been randomly selected as a survey participant.

I would like to ask you a few series of questions, all of which will be held in complete confidence. The answers you provide will only be used by the interviewer for the above stated study objective. The results will help to improve storage options for maize farmers and traders. Your participation in this interview is completely voluntary. Do you have any questions about anything I have mentioned, or any further clarification? May I continue with interviewing you?

MODULE A: GENERAL INFORMATION

A.01	Date of Interview	A.02	Questionnaire No.
A.03	Enumerator Number	A.04	Region
A.05	County	A.06	Town/Village

MODULE B: DEMOGRAPHIC INFORMATION

B.01 Trader name: B.02 Phone No:____________________/	B.03 Gender of the respondent: 1=Male (____) 0=Female (____)
B.04 Age of trader (_____) (in years)	B.05 Education (0)None (____) (1)Standard (Primary) (____) (2)High school (Secondary) (____) (3) College/University (____)
B.06How many years did the trader spend in school? ________________/ (in years)	B.07 Category of trader: (1)Retailer (2) wholesaler (3) Processor (4) Other (specify)

MODULE C: MAIZE MARKETING AND STORAGE PRACTICE

C.01 Name of market/place of interview:	C.02 From whom do you buy maize from? (1). Farmer (______) (2). Middleman (______) (3). Others (SPECIFY) _________
C.03 Do you prefer to buy maize directly from farmers? (1). Yes (______) (0). No (______)	C.04 If yes, give reason? Reason: If No, give reason? Reason:
C.05 (If C.03 is Yes) What are the requirements that farmers need to fulfill? (1). Quality (______)(4). Stability in supply (______) (2). Price (______)(5). Others (SPECIFY) _________	C.06 Do you pay higher price if buying from middlemen in comparison with buying from farmers? (1). Yes (______)(0). No (______)
C.07 Do you store your maize? (1). Yes (______) (0). No (______)	C.08 How long do you store your maize before selling? ________ (Months)

C. 09	What type of storage structure do you use & what was its cost?	C.10 Estimate its cost in Ksh	
1.	Traditional storage		
2.	Improved granary		
3.	PPP bags		

4.	PICS		
5.	Metal silos		
6.	Others (Specify)		

C.11 Why do you store maize? (1). Waiting for higher price (______) (2). Selling in big amounts (______) (3). Others (SPECIFY) _________	C.12 Do you have to hire a premise for storage? (1). Yes (______) (0). No (______)
C.13 *If Yes in C.12*, How much do you pay for the storage cost? (in Ksh) ________________	C.14 How do you finance for the storage cost (1). Own income ( ) (2). Credit ( ) (3). Family support ( ) (4). Gift ( ) (5). Other (specify) _________
C.15 Do you use any grain chemical to protect your maize against insect/rodent damage during storage?	C.16 (*If Yes, in C.15)*, What type of chemical do you use?

(1). Yes (______) (0). No (______)	(1). Actellic super(______) (2). Sophagrain (______) (3). Ash(______) (4). Others specify_____________
C.17 How much did it cost you to purchase the specified grain chemical? (in Kshs) _____________	
C.18 Where did you get information about price for your transaction? (1). Input dealer ( ) (3). Cell phone call ( )	C.19 Did you sell within the district where you purchased your grain? (1). Yes (______) (0). No (______)
C.20 How long have you been a maize trader in the market? _________ (Years)	C.21 How do you transport maize to retail site? (1) Vehicle (5) on donkey back (2) Tractor (6) on human

MODULE D: SAVINGS AND CREDIT ACCESS

D.01 Did you have some savings at the beginning of the past harvest season?	D.02 (If Yes, in D.01) What was the amount of your savings at the beginning of the past harvest season?(in
D.03 Do you have access to credit throughout the year?	D.04 (If Yes, in D.03) What are the source of your credit? 1. Bank loans (____) 2. Microcredit(____)
D.05 Do have to pay interest on credit you borrow?	D.06 (If Yes, in D.05) How much do you pay as an interest? __________

APPENDIX III: FOCUS GROUP DISCUSSION GUIDE

Name of location: Njoro and Molo Sub-counties (Nakuru County)

Objective 1: Mapping the maize value chain

Maize production in the area:

1. Production; varieties, seasonality, yield
   What are the most commonly planted maize varieties?
2. Benefits and constraints of maize farming

Actors, Activities and Relations within the Value Chain

3. Who are the major actors involved in these processes and what do they actually do?
4. Where do you source your inputs? i.e. fertilizer, seed, manure
   [preferably give the name of the input dealer e.g Govt (MOA, KARI), fellow farmers, traders]
5. Where do you source you labour during maize production i.e. land preparation, planting, weeding and harvesting? (*family or hired labour)*
6. Who purchases maize from you (farmer)? (*broker, retailer, wholesaler or processing unit)*
7. What is the average price per kg bag of maize of maize through different channels?
8. How do you determine your selling prices?
9. What form of transport does the seller use to transport maize from the farm gate?
10. Which is the nearest maize processing plant/maize miller from this area?
11. Where is the maize purchased in this area sold to? (*Name of the market)*
12. How do products, information and knowledge flow through the value chain?
    (i) On a scale of 1to 5 please indicate whether the uptake of mobile phones has improved access to information ____

(*1=no difference, 2=small improvement, 3=moderate improvement, 4=large, improvement, and 5=the most important development in the past 20* years)

(ii)Have you received any form of training to better understand market behavior?

1=Yes [____] 2=No [____]

13. Are you actively involved in any farmer's union/co operative?
14. What are the overall purpose and objective of the co operative?
15. How regular do you meet for your union activities?
16. Are you able to access credit services and at what interest rate?
17. What key constraints exist at various levels in the chain and what are potential solutions to those constraints?
18. What actions are being undertaken by the public sector to overcome production and marketing problems?

Post harvest

19. What type of storage facility do you use to store your maize?
    (*price of each structureand different storage structures for each actor)*
20. Proportional pilling for storage structure by different actor (*Demonstrate*)
21. What do farmers use to control insect infestation and rodents attack in stored maize?
    (type, cost and frequency of use in a season)
22. How long do you store your maize before selling?
23. Estimate losses of each structure using proportional pilling (Demonstrate)
24. What are the limiting factors for maize storage?
    (i) Losses due to insects and rodents (ii) liquidity constraints (iii) capacity
25. What challenges hinder the uptake of new innovations and technology for maize storage in the area?