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STORAGE PRACTICES AND THEIR BEARING ON SMALLHOLDER FARMERS: POSTHARVEST ANALYSIS IN UGANDA

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ABSTRACT

The aim of this study was to describe smallholder farmers' perception of household maize storage. Household storage plays a crucial role in supplying maize between seasons. Despite their continued usage, they are not safe enough and cause high losses to smallholder maize farmers, thus forcing them to sell immediately after harvest. Consequently, they have to buy maize at higher prices for household use. The description of the different storage types used by smallholder maize farmers and their perception of using household storage as a strategy to increase their earning was done qualitatively. Through focus group discussions (FGDs), data was gathered from nine focus groups from 108 respondents in eastern Uganda. The results show that smallholder maize farmers use eight different storage types acquired either through purchase, construction or contribution. Some storage types were specific to certain districts. The cost of acquiring the storage type varied according to the type, size and location. Farmers used these storage types due to accessibility, flexibility, affordability, and ancestral attachment. Finally, the study concludes that the farmers' perception of using storage for business was positive.

Keywords: Smallholder farmers, household storage, storage losses, storage perceptions

1. INTRODUCTION

In Uganda, like in other Sub Saharan Africa (SSA) countries, smallholder farmers are the bulk of maize producers (Midega, Murage, Pittchar & Khan, 2016). The majority of these farmers use rudimentary tools to produce and store the maize. Consequently, a significant amount of maize produced in Uganda is lost during post-harvest handling. The loss of harvested maize has adverse effects to smallholder farmers' food and income security. Despite the food losses, Uganda's population, which currently stands at 44 million people, keeps growing at a rate of 3.2 children per woman (Worldometers, 2018).

Due to increasing population globally, Tefera, (2012) predicts that the world population will be 9.1 billion people by the year 2050. This will require food production to increase by 70%. Today, food production is lagging behind population growth (Tomlinson, 2013). Yet, there is evidence of food loss in much of SSA which will exacerbate the problem of feeding the increasing population (Affognon, Mutungi, Sanginga & Borgemeister, 2015).

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Food loss in SSA is higher (37%) than the global loss of 32% (Kaminski & Christiaensen, 2014). In SSA postharvest maize loss is at 14% minimum and 36% maximum (Tefera, 2012). In Uganda, on farm postharvest maize losses is about 6% of the quantity stored and increases in some instances up to 100% (Omotilewa, Ricker-Gilbert, Ainembabazi & Shively, 2016). Although agricultural extension aims to improve on agricultural practices through advisory services, many smallholder farmers still use traditional storage types. Moreover, there nature and structure have largely remained unknown and less discussed (Gitonga, De Groote & Tefera, 2015).

Thus, given the importance of traditional storage to smallholder maize farmers, this study explored the nature and structure of the storage types used in Uganda. Smallholder maize farmers were interviewed to elicit their personal lived experiences on the storage types used. It is within their lived experiences that smallholder maize farmers revealed the types of storage they use (Booth, 2014). This research area was, investigated because the issue related to storage of smallholder maize farmers is frequently overlooked (Ricker-Gilbert & Jones, 2015).

1.2. Definition of the problem

Storage at household level is critical to smallholder maize farmers. However, it has remained of low standard amongst many smallholder maize farmers. This factor regarding storage is among the leading causes of maize loss estimated at 20-30% in SSA (Midega *et al*., 2016). In fact, storage is important because it aids in the distribution, marketing and consumption of maize seeds through evening-out fluctuations in demand and supply (Proctor, 1994). Experts have demonstrated that maize losses are high in storage up to 30% (Ricker-Gilbert & Jones, 2015). In other words, the quality of maize grain depends on storage (Mugabi & Driscoll, 2016). Furthermore, poor storage causes maize contamination (Shabani, Kimanya, Gichuhi, Bonsi & Bovell-Benjamin, 2015). In SSA, this problem is aggravated by the fact that smallholder maize farmers continue to use traditional stores that increase the losses (Saha & Stroud, 1994). Thus, the study explored the different storage types being used and its impact on smallholder maize farmers. The objective of the study was to describe the storage types used, assess their impact and the perception of smallholder maize farmers on the storage types used as a strategy to increase their earnings and save on household food costs.

2. METHODS

2.1. Study focus and site

Uganda is divided into four administrative regions, namely: Northern, Eastern, Western and Central. The eastern region was purposively selected because it is the highest maize producing region (Uganda Bureau of Statistics. 2010). Also, most storage types are found in this region. Within the eastern region, the districts of Iganga, Manafwa and Katakwi were selected on the basis of the maize they produced in terms of high, medium, and low, respectively. The highest and lowest maize producing districts were selected easily while the medium producing district was selected by choosing the district whose production was close to the average production of all the districts in the region.

2.2. Sampling procedure and data collection

Using the Agriculture Census of 2008/2009, the districts for the study were Iganga (high), Manafwa (medium) and Katakwi (low). Three sub-counties from each district were

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purposively selected based on high, medium and low selection procedure described for districts. From each sub-county, the extension worker was asked to assist in identifying maize farmers who constituted the focus groups.

Powell & Single, (1996) have defined a focus group as a collection of individuals assembled to discuss and comment on personal experiences. It allowed the researcher to ask a group of people about their experiences in maize storage (Reisner, Randazzo, White Hughto, Peitzmeier, Dubois, Pardee & Potter, 2017). The process is based on interviews that generate verbal data through interaction (Millward, 1995:413). Wettergren, Eriksson, Nilsson, Jervaeus & Lampic, (2016) further state that this type of data collection, when participants interact in a moderated discussion, offers the possibility of transcending individual interviews. For ease of management the focus groups consisted of 12 participants; six of whom were male and six were female. Within each group the extension worker identified four high, four average and four low producing farmers. Upon accepting the appointment, they were requested to come to the sub-county where they were briefed as a group about the study and its purpose before the formal discussion began. Consent forms were given to participants to sign, as proof of their willingness to participate in the discussion.

Although there is no agreed sample size for qualitative assessment Burnard, (2014), and Goss and Leinbach, (1996) see 12 to 15 participants for focus group discussion (FGDs) was adopted. Thus, a total of 108 respondents were identified for FGDs. Smallholder farmers in these discussions were selected to represent smallholders in the three selected districts. FGDs consisted of men and women which helped engendering the questions. Nine FGDs, one at each sub-county in the selected districts, was conducted. Participants were informed that both recording and note-taking would be done. The researcher and the research assistants were introduced, an overview of the topic was given, and ground rules for conversation were established. Participants were encouraged to sit in a semi-circle to maximize face-to-face interactions.

The FGDs were facilitated by three trained research assistants recruited from the Economic Policy Research Centre (EPRC), Makerere University. These research assistants were students pursuing their Master of Business Administration (MBA) course. They did not only possess data collection skills but had knowledge of the local language which greatly eased the interpretation of questions, especially to farmers who did not understand English. The quality of the translation was checked for accuracy using an independent English expert who knew the local language. The researcher led the discussion using the FGD Guide. The research assistants acted as note-takers and recorded group dynamics and other behaviours that could not be captured by the voice recorder. The FGDs also offered insights into farmers' perception of their storage and how it influenced their everyday lives.

2.3. Data analysis

The data that were gathered were analysed qualitatively. Qualitative analysis commenced with the careful organisation of the raw data, and the reading of transcripts and interviews from the field to obtain a general sense of the information that was collected to identify key issues and concepts that helped to provide clear understanding. The ideas were organised into themes and were used in the FGDs. Recorded information was listened to again to adduce more meaningful insights which were added to the write-up. Pictures were assembled and attached to the matching data. NVIVO 10 software was then utilised to perform thematic analysis. Verbatim quotations from participants were used to emphasize the point made during discussion.

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3. RESULTS

3.1. Social-economic and farm characteristics of respondents

In the study, gender representation was equal out of a total of 54 participants. The average age of smallholder maize farmers was about 41 years. The minimum age recorded was 16 years and the maximum age was 90 years. Generally, smallholder maize farmers had primary level education.

3.2. Storage types at household level

Maize at smallholder level is stored for three major reasons; selling to earn income, food consumption, and planting. The decisions to sell immediately after harvest by smallholder maize farmers are prompted by four major reasons; inadequate storage, immediate need for money, high storage costs and due to good prevailing prices. Maize that has been properly stored to remain clean and dry commands a higher sale price and increases smallholders' share of the marketing margin. The decision of where and how much to store among the household maize farmers was mainly made by the household head. Almost all the participants agreed with the one who stated that "*due to the nature of the storage, smallholder maize farmers try to protect the maize from damage by sun-drying, use pesticides, use domestic animals like cats to chase the rats or use rat traps, use Neem tree leaves (Azadirachta indica) and smoking".* Thus, the struggle to protect the maize clearly demonstrates the need for better storage types.

These types of actions due to improper storage types contribute to significant maize loss in Uganda. The significance of storage as a significant aspect of maize production and marketing was voiced by one respondent as follows: *"We smallholder maize farmers must store to sell at a high price. That is to say, without good storage one may never sell maize at a high price and will therefore receive a low price, leading to low share of the marketing margin especially because maize is a crop which tends to get damaged so fast… if not properly stored. But we lack good stores"* (Male farmer, Bualamagi sub-county, Iganga district).

3.3. Farmers' storage decision-making

In assessing the impact of maize storage at household level, it was pertinent to understand who makes the decision in order to understand smallholder farmers' storage challenges. In a few households, decisions about maize storage are made by both the household head and spouse, because they are both involved in growing the maize. Participants explained that in some few families, all family members were involved in making the decision, meaning that everyone is obliged to carry the responsibility for storing and/or drying maize. However, in many homes, the household head was considered as the sole decision-maker regarding both storing and selling maize. The decisions for storing the maize to sell later depended on the perceived cost of storage, immediate need for money, and availability of storage. However, the decisions for keeping the maize to sell later depended on the perceived cost of storage, immediate need for money and availability of storage. One participant reported: *"Maize storage decisions vary from farmer to farmer. There is no one single way of reaching a decision on how to store maize grains. Even in households where the husband and wife stay together, sometimes a decision of where to store and when to sell is done individually. In my home it is me who makes the decision for my maize because I store for consumption and selling the surplus. My husband also stores for selling and planting but when we have no food we can ask him to spare some for*

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consumption (Female farmer, Ngariam sub-county, Katakwi).

Table 1 shows how storage decisions were made. It is argued that agricultural extension service, if strengthened, can improve the decision making through advice. However, there is a dearth of extension services across the three sampled districts. One sub-county extension worker was serving in the entire district of Katakwi.

Table 1: Storage decisions, influencing factors and storage improvement methods.

Storage decision made	Reasons for the decision made	Storage decision influencing factors		Storage improvement methods
		Pro- storage decisions	**Counter storage decisions**	
Both husband and wife	They both dig together	• When the amount harvested is greater than what the family can consume • When there are no immediate financial needs • To ensure food availability or food security • To ensure availability of seeds during the next season • When the storage space and materials (e.g. tins or sacks) are available • When they are aware of a safe storage type. • For prestige, being known for having food all the time. • To have a continuous maize supply in the home. • It's a business, you can buy and store and then sell when the prices go up.	• When the prices go up • When there are money emergencies • When maize is getting rotten or affected by pests. • Fear of thieves • When the husband demands • When the next season is approaching; to clear the old stock, and prepare for the new harvest	• By constructing good communal stores • Provision of pesticides • Sanitation in the storage facilities • Use of quality preservatives • Use of modern technology such as metal and plastic silos • Constructing safe and permanent cribs • Government to subsidise modern storage materials
The entire family	To make all family members responsible for food security			
Husband only	He is the head of the household			
Wife only	Where a household is headed by a female member			
Farmer makes a decision with parents	Some farmers are young, and they need parent's advice			

Source: Primary data

3.4. The different storage types used

The study found out that different storage types were used by smallholder maize farmers in the second harvest season of 2014/2015. Farmers explained that the use of different storage types is a result of having no calibrated storage that all farmers may use. Even the recommended storage types are quite expensive besides being scarce. Table 2 shows the different storage types that smallholder maize farmer's use, challenges and copying mechanism.

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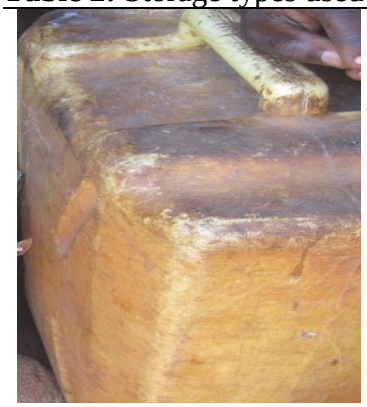
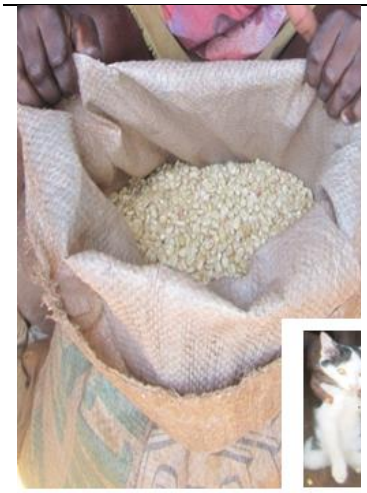
Table 2: Storage types used by smallholder maize farmers.

	**Usage of old Jerry-can** A female farmer from Bulamagi sub-county, Iganga district, observed that: "Using the jerry-can is the best way to keep my maize because it cannot easily be attacked by rats". Farmers use old jerry-cans which can no longer fetch water. Sometimes they buy new ones at a cost of UGX 5,000/=. A jerry-can can be used for 3-4 years if nothing happens to it. **Benefits:** Maize cannot be attacked by rats quickly. A female farmer, from Bulamagi sub-county, Iganga district, observed that: "Rats think the jerry-can is carrying water. You can easily lift the jerry-can in case of sun-drying. It enables the farmer to tell his or her quantity of maize easily". **Challenges:** Maize can still be damaged by pests, and the closed container can encourage the growth of mould if the grain is not sun-dried. **Coping mechanism:** Farmers regularly sun-dry the maize.
	**Usage of Sacks** Most farmers have used sacks for over ten years. They buy them from the nearby markets or shops at a cost between UGX 1,300/= and UGX 1,500/=. **Benefits:** On the benefits of sacks, a female farmer from Omodoi sub-county, Katakwi District, observed that: "Sacks are accessible and affordable. Sacks may be used to store maize for six months to one year before replacing it. You can keep maize in a sack and put it inside the house, unlike the granary which is constructed outside the house. Hence, no one can steal your maize since it is kept inside the house apart from the household members who may mishandle them". **Challenges:** One has to keep sun-drying the maize every after a few days or else it rots, and sacks are also highly attacked by rats and pests. During the process of drying, the farmer can lose some kilograms as the maize is eaten by birds. **Coping mechanism:** Many farmers buy cats to eat rats, use neem tree leaves, ash mixed with water, red pepper and pesticides to prevent pest damage.
	**Usage of Closed crib made of poles** On this storage type, a male farmer from Bubutu sub-county, Manafwa District, observed that: "A crib of this kind is built using poles, nails and iron sheets. Poles are more accessible compared to wire mesh because they can be obtained at no cost from the forest, or bought more cheaply than wire mesh. Such a crib can last for five years without major renovations. However, it is more expensive to construct than a granary". **Benefits:** It is possible to store many kilograms of maize in the crib and you do not need to carry maize for drying on a regular basis, because it enables continued drying. **Challenges:** It can be attacked by termites and thieves because it is outside the house, but it is also very hard to control pests through use of pesticides in the crib.

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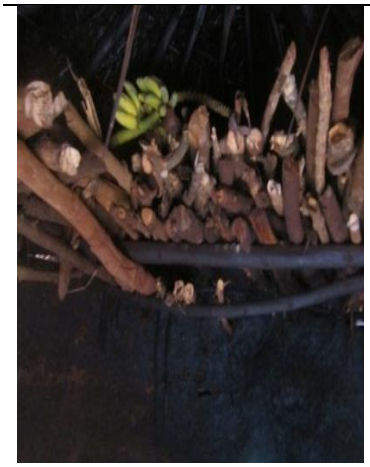
Coping mechanism: Farmers continually add pesticide to prevent termites and rats; some buy dogs to alert them in case of thieves, and cats to eat the rats.



Above the fire

Farmers discovered that maize for planting can be kept above the fire for a very long period of time. Some farmers have therefore constructed platforms above the cooking place to keep their maize, so that rising smoke and heat keeps drying the maize. They use poles and nails or sisal to create a table-like platform. This platform is multi-purpose as it can be used to keep other items such as firewood when there is no other storage space. It costs about UGX 30,000/= (depending on the size) to construct.

Benefits: "When maize is kept above the fire, it does not get attacked by insect or pests and it germinates quickly when it is planted" (Male farmer, Omodoi sub-county, Katakwi Distict).

Challenges: Maize loses its original colour due to smoke and can only be used for planting.

Coping mechanism: Building a better cooking place to enable the construction of a bigger platform**.**



Usage of pots

The use of pots to store maize is an ancestral technology that has been adopted by some smallholder maize famers. "*The pot's mouth is closed with a smaller pot and is usually smeared with cow dung to keep away pests and deter rat penetration"* (Female farmer, Katakwi sub-county, Katakwi district). The pots are placed on short logs or put on stones to raise them above the ground. A pot like the one in the picture sells for UGX 20,000/= from the market. The biggest pots sell at UGX 40,000/=

Benefits: Pots are safe and can keep the maize clean and free from rats and pest damage.

Challenges: Pots need to be handled carefully because they are fragile and can easily break. However, when properly handled, a pot can last for over 10 years.

Coping mechanism: Pots are used by adults only and kept away from children.



Usage of Granaries

Granaries are also used to store maize. They are made of local materials such as grass, reeds or small sticks, poles, stones, mud, clay and water. Some farmers smear granaries with cow dung. "*A well-constructed granary can last for three to five years"* (Male farmer, Ngariam sub-county, Katakwi District). A granary costs about UGX 250,000/= depending on the size and use.

Benefits: Granaries allow for the continuous drying of maize without taking it out of the granary. "*If you have many granaries, you can store a lot of maize"* (Female farmer, Omodi sub-county, Katakwi District).

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	Challenges: Maize can be stolen by thieves because the granary is never locked and is constructed outside the house. A granary offers easy access to termites, pests and rats. **Coping mechanism:** Buy cats to eat rats and dogs to scare thieves.

Source: Primary data. *The exchange rate was one United States dollar to UGX 3300 at the time of data collection.*

The findings show that the majority used sacks, followed by granary and very few smallholder farmers used pots. The poor nature of storage demonstrates the need to increase extension services, because this may alleviate the challenge. Poor storage exposes farmers to a number of drawbacks. Firstly, it aggravates losses consequently leading to inadequate maize available for consumption, sell and planting (Omotilewa *et al*., 2016). Secondly, it forces to sell immediately after harvest at low prices (Midega *et al*., 2016). Also, seeds for planting become a challenge as damaged maize cannot germinate.

3.5. Smallholder farmers' perception of the current storage types

The interaction with smallholder maize farmers revealed the importance of storage at household level. Participants described how in situations of sickness, death or school fees, selling maize is one way to solve the problem. A male farmer stated thus: "*Maize is our problem-solving crop for many financial needs. In the home, once I have my maize then I will find someone to buy easily when there is a problem. The bad thing is it is very difficult to store for long and also because of money needs we sell easily sometimes at very low prices"* (Male farmer, Khabutoola sub-county, Manafwa District).

Smallholder maize farmers' perceived household storage as indispensable. Storing to sell at a later stage when prices are high was central. One participant stated that: *"Prices of maize fluctuate regularly and we are aware of when prices are high, but we cannot keep our maize to the time when prices increase. Even when we want to protect our maize by sun-drying, the maize is eaten by birds in the process. However, if I was able to store for long I would keep mine and probably buy from other smallholder farmers in the community and sell to traders' which will increase my earning but also reduce the costs of buying maize for my home consumption"* (Male farmer, Ibulanku sub-county, Iganga District).

Another participant said: *"Our challenge for long has been finding safe stores, the reasons we sell immediately is because of poor storage that becomes an inconvenience. Just imagine one has to put 1000 kilograms of maize out every week to sun-dry it is limiting because we have other things to do and we do not get the time. Also, you are not sure if the price will increase to your expectation therefore some who sell are sometimes better off and that is why me I sold off all mine immediately after harvest"* (Male farmer, Bubutu sub-county, Manafwa District).

In one of the FDGs farmers strongly agreed with the participant who stated: *"having a safe store is likely to reduce the costs of storage significantly and is a form of quality management*

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which may result into selling when the prices are high and in the long-run increase the marketing margin share" (Female farmer, Makuutu sub-county, Iganga District). One FGD participant asserted: *"We wish to be guided on how to protect and possibly reduce costs of storage, to store for long so as to take advantage of increase in price* (Female farmer, Ngariam sub-county, Katakwi District). This advice can be provided through extension service. However, because of poor extension service smallholder farmers continue to lose their maize in storage which adversely affects their potential to bargain for higher prices.

Another participant noted: *"We the farmers are not helped much because we hardly get the advice from anybody to tell us about storage and markets for our maize. Once my maize is harvested then it must be sold so that I can get money. After all, even storing for long is costly because much of the maize is lost or damaged and when traders come they buy the damaged maize at low prices, therefore, I find selling immediately as an option to avoid storage loss"* (Male farmer, Makuutu sub-county, Iganga District).

The findings concur with Odegard & van der Voet, (2014) who emphasises storage of agricultural produce for future use. In fact, participants argued that storage can be used as a strategy to boost their income potential due to increased prices. A participant noted that "*they sold their maize individually which denies them the potential of collective bargaining and this weakens their bargaining power. Also, we cannot agree on the same price since each farmer is approached individually by the buyers*." It is argued that if farmers agree to cooperate they can build a strong bargaining power within their communities and negotiate for higher pay for their maize, but this can be fostered by strong extension service provision. Figure 1 below illustrates the perceptions farmers have of improved maize storage as a business strategy to reduce household poverty, despite the challenges.

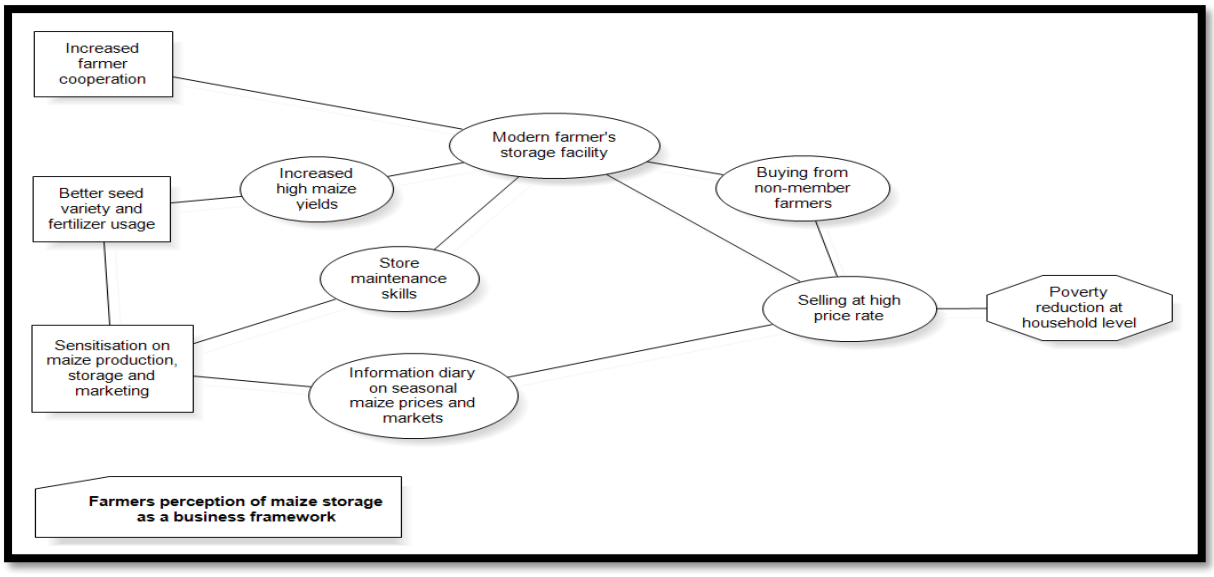

Figure 1: Maize storage businesses framework (Source: Primary data).

Participants perceived that storage can be used as a business strategy to increase their share of the maize marketing margin, because you can buy maize at a lower price during the harvesting season, keep it and sell it later at a higher price during the planting season provided you have a good and safe store. Farmers who can either grow and store or buy and store are in position to sell to those many other farmers who have nothing in store yet still need to consume or plant.

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Other than using storage to keep maize for selling, farmers can keep maize for home use and so they would not spend money to buy maize for their household consumption. This saves the money that would otherwise be spent on maize purchases, which can thus be put to other household financial uses. In addition, a household assured of food is better able to concentrate on other economic activities without stress. This finding is consistent with the findings of Tefera, Kanampiu, de Groote, Hellin, Mugo, Kimenju & Baziger, (2011) that safe household storage directly affects food and income security, and also provides robust support for the view that marketing margin and smallholder storage are closely connected.

4. DISCUSSION

The use of different storage types (sacks, granary, pots, jerry-can, above the fire, and cribs) demonstrate the need to store maize for future use (Odegard & van der Voet, 2014). Thus, this exposes the smallholder farmers to losses (Tefera, 2012). Moreover, farmers perceived storage as the quick way to safeguard themselves from food and income insecurity. They regard the maize crop to be their major cash crop to address short and long financial distress. However, this was being jeopardised by poor storage. Besides, there was little support from extension services. Storage at household is vividly important and smallholder farmers prefer to store at household level (Park, 2006). The dearth of good storage farmers are forced to sell their maize immediately after harvest often at low prices thereby affecting revenue (Gitonga *et al*., 2015; Tefera *et al*., 2011). Thus, farmers can only reap much from their maize if improvement of storage at household level is tackled (Thamaga-Chitja, Hendriks, Ortmann & Green, 2004). Therefore, if storage is able to maintain quality the selling at a higher price is possible and this will bring more income to the smallholder farmers while ensuring food security at the same time.

5. CONCLUSION AND RECOMMENDATION

Although it is relatively simple and cheap to construct and maintain, traditional storage types lead to substantial post-harvest losses to smallholder maize farmers in Uganda. The losses in quantity and quality significantly reduce the maize available for sell, consumption and planting. This affects the income and food security of smallholder maize farmers and consequently erodes revenue. Taking consideration of the storage types used in this study, it can be concluded that they are inefficient because they cannot store maize for long without deterioration and yet storage efficacy is determined by storage length and losses incurred. Therefore, this confirms the assertion that farmers cannot reap much with the current storage types and so requires urgent attention. Agriculture extension workers need to campaign information sharing about maize price and available markets. The government should increase on monitoring and evaluation of the policies formulated to ensure it delivers to their expectations. Furthermore, the study demonstrates the urgent need for immediate improvement in storage to be instituted so as to enable smallholder maize farmers to get better storage at household level.

6. ACKNOWLEDGEMENTS

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