

Warehousing and Post-Harvest Storage Losses in Zimbabwe: The Significance of Warehousing in the Maize Value Chain

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Abstract

This study examined the significance of warehousing in the maize value chain in Zimbabwe. Maize is very important in Zimbabwe as it is the staple grain and a major source of animal feed. Zimbabwe is facing food shortages amidst the ever-increasing population hence the need to reduce maize post-harvest losses at each stage of the maize value chain. Primary data was collected from 225 Grain Marketing Board of Zimbabwe (GMB) managers, supervisors and employees in all its 'Class 1' depots, Zimbabwe, the Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development (MLAFWRD) and agricultural experts through questionnaires and in-depth interviews. The results of the study revealed that warehousing is very important in the maize value chain in Zimbabwe as it helps to ensure food security by conserving all the maize harvested in a particular season. The study also concluded that warehousing helps to reduce maize post-harvest storage losses and allows continuous supply of maize to all citizens thereby ensuring food security. The government's burden on food-related subsidies can be reduced significantly in Zimbabwe through prioritising the effective warehousing of maize. The key recommendations from the study include the need for the government of Zimbabwe to prioritise the provision of sound warehouse structures in order to reduce maize post-harvest storage losses and guarantee food security for all citizens.

Keywords: warehousing; grain quality; materials handling; storage; maize; post-harvest losses

Introduction

Currently, the Zimbabwean government's efforts have mainly been concentrated on boosting agricultural productivity for staple grains such as maize to feed the whole nation. Over the past ten years, the Government of Zimbabwe has invested heavily in various schemes aimed at boosting agricultural productivity, but the problem of food shortage remains a cause for concern. In the same vain, the Sustainable Development Goal (SDG) Number 3 of the United Nations aims to eliminate hunger, attain world food security and improved nutrition, while promoting sustainable agriculture (United Nations, 2018). The United Nations (2018) also notes that global hunger had declined over the past years but it has increased again in recent years as a result of conflict, world disasters linked to climate change and drought. One of the causes of global food shortages not included by the United Nations (2018) is post-harvest losses. In an effort to make global improvements of grain availability, an important factor to consider is post-harvest losses. Reducing post-harvest grain losses in the whole world is an important step in ensuring future global food security in a sustainable manner (Ayo, et al., 2017), and a key pathway to food and nutrition security in Sub-Saharan Africa (Affognon, et al., 2015). In developing nations such as Zimbabwe, the post-harvest losses in storage alone are estimated at 20-30% and this may rise to 40% when taking into account field, transportation, handling and processing losses (Mutambara, 2014). Maize is produced seasonally in most parts of the world and because of that, it is important to provide enough storage to be able to supply the whole country for the whole year.

According to Charlotra (2013), a warehouse can be defined as a facility where different materials required for maintenance, distribution and packaging are received, stored and issued. Baker (2007) on the same note states that inventory is any material and supply that either an organisation or company holds for sale or to provide inputs or supplies to the production facilities and processes. According to Weele (2000), because of the increasing need in demand for goods or materials by internal and external customers, it will not be well for any business or organisation to place the order for each material or item that is urgently needed for production or for meeting customer needs. In this regard, warehouses are a vital activity in ensuring that any materials required in production or satisfying customer requirements are just available to satisfy the exact need. According to Frazelle (2002), warehousing is necessary because of several reasons. These are:

Seasonal Production: Most of the agricultural produce such as maize is harvested during certain seasons, but they are required for consumption and use throughout the whole year. In light of this, suitable storage or warehousing facilities for these commodities are necessary so that they can be supplied as and when required.

Large-scale Production: In the manufacturing sector, material production is done in order to meet the customer's existing and future demand of the products. Therefore, manufacturing companies usually produce goods in large quantities in order to take advantage of economies of scale associated with large-scale production. To be able to achieve this, warehousing is needed for storage of the manufactured goods up until they are sold.

Quick Supply: Most commodities including maize are produced at specific locations of the country but they are consumed throughout the whole country. Because of this, these commodities need to be stored strategically in order to quickly respond to customer orders.

Continuous Production: In many production set ups, to be able to continuously supply the production function with raw materials, warehousing is required. For this reason, the materials needed for production purposes are kept in the warehouse to ensure the smooth flow of production processes.

Price Stabilisation: Warehouses are useful to maintain a reasonable level of the price of the products in the market by keeping sufficient materials in the warehouses. If the products are scarce in the market, their price may increase. On the other hand, excess production and supply of the products may also result in a fall in prices of the goods.

According to Sharma (2013), one of the major sectors contributing to a fast growth in the logistics industry is warehousing. The increase of international trade, aided by the rise in containerisation levels worldwide has led to a high demand in warehouses. Sainathuli et al. (2014) argue that warehouses play a critical role in mitigating variations in supply and demand, and in providing value-added services in a supply chain. Most modern supply chains rely heavily on the warehouse function for rapidly fulfilling customer requirements through retail, web-based and catalogue channels. Recently, warehouses which are often referred to as distribution centres, have awoken from their traditional passive role of serving as buffers to mitigate supply-demand variations to a more active role of providing value-added services such as consolidation/deconsolidation, assembling and kitting. Sayeed (2013) also points out that careful warehouse facility management is very important in modern supply chains.

Warehouses vary in nature and can be divided into four classes, which are agricultural warehouses, container terminals, air cargo complexes and industrial warehouses (Sharma, 2013). Most of the agricultural produce such as maize and wheat are harvested only in a certain season but the demand and consumption of these takes place all year round hence the need for agricultural warehousing. According to Charlotra (2013), a warehouse can be defined as an area in which all types of materials needed for production, distribution, maintenance and packaging are received, stored and dispatched. In the view of Komarova (2016), inventory entails any material and supply that a trader, business or institution carries for sale or to supply inputs or supplies to the production function. According to Henz (2017), because of the ever-increasing demand for materials by both internal and external customers, it will not be well for any business, trader or organisation to process an order for each material or item which may be urgently needed by the production function or meeting customer needs. Warehouses therefore, provide a key role of ensuring that any product required for production or satisfying customer requirements is just available to satisfy the exact need. In a similar vein, Sissinto et al. (2018) points out that warehousing is important because of several reasons. These are seasonal production, need for quick supply, to ensure continuous supply, large-scale production and price stabilisation.

Seasonal production means that agricultural commodities such as maize are harvested during certain seasons, but they are required for consumption or use throughout the year. Therefore, there is a need for suitable storage or warehousing facilities for these commodities, from where they can be withdrawn as and when required (Henz, 2017). Large-scale production implies that, for manufactured products, production occurs to meet the existing as well as future demand of the products. Some manufacturers also manufacture goods in large quantities to enjoy the advantages of large-scale production, which is more economical. Therefore, these finished products which are manufactured on a large-scale need to be warehoused properly until they are cleared by sales to the final consumer (Kumar and Kalita, 2017).

Warehousing is important to ensure quick supply of products. Both industrial as well as agricultural goods such as maize are produced at specific places but consumed throughout the whole country. Therefore, it is critical to stock these products near the place of consumption, so as to make sure that without making any delay these goods are made available to the customers at the time of need (Kiaya, 2014). The need for continuous production is another

factor that justifies the need for warehousing. Continuous production of goods in the factories needs adequate supply of raw materials. There is a need to store sufficient quantities of stock of raw materials in the warehouse facilities to ensure continuous production (Edelman et al., 2015). More so, warehouses are necessary for price stabilisation. In order to maintain a reasonable level of the product price in the market it is important to keep sufficient stock in the warehouses. Scarcity in the supply of the goods may increase their selling price on the market. Again, excess production and supply of the products may also result in a fall in the prices of the product (Richards, 2014).

Moreover, effective warehousing of products is regarded as a competitive weapon as the wider market demands the continuous supply of goods in authentic condition (Webber and Labaste, 2014). The quality of the goods is protected by warehousing/storage methods, facilities and techniques used by the organisations. Managers can increase the profitability of their business by adopting effective warehousing management control methods, devices and competitive strategies thereby increasing supply chain efficiency. Warehouses are placed at the final point in the supply chain to perform order assembly, value added services and despatch to the final customer and it represents approximately 20-24% of total logistics costs (Charlotra, 2013). Warehouses are necessary for the achievement of customer service levels in the supply chain (Henz, 2017). They act as the nodes along the supply chain where all customer orders are assembled and dispatched. Warehousing management in the supply chain can lead to sales growth, reduced space requirements, increased volume capacity, control of inventory and increased customer service (Charlotra, 2013).

In Africa, post-harvest losses of agricultural commodities are estimated at approximately 15-20 million tonnes of grains, accounting for more than US\$4 billion or 15% of the total production value (Sissinto et al., 2018). It is also important to note that the magnitude of food loss exceeds the value of the total food aid received in SSA between the years 2000 and 2010, and this further equates to the annual value of grain imports to SSA (Africa Union, 2018). In addition, such losses in food are estimated to be equivalent to the annual caloric requirement of 48 million people (Affognon et al., 2015). Sissinto et al. (2018) also argue that about 47% of USD 940 billion needed to end hunger in SSA by 2050 will be needed in the postharvest sector. Accordingly, reducing post-harvest grain losses is a key pathway to food and nutrition security in SSA. Moreover, reducing grain post-harvest losses has positive impacts on the environment and climate because it enhances farm-level productivity and reduces the utilisation of production resources such as water or expansion into fragile ecosystems to produce food that will be lost and not consumed.

In Zimbabwe, the government has come up with many schemes in the past 10 years aimed at boosting agricultural productivity for staple grains such as maize. These schemes include the mechanisation programme, Command agriculture and Pfumvudza. These schemes resulted in increased maize production all around the farming areas in Zimbabwe. All the maize produce of these schemes has been delivered to the Grain Marketing Board of Zimbabwe (GMB) whose responsibility is to ensure food security in Zimbabwe through the provision of grain storage facilities. However, the problem of food shortage in Zimbabwe has persisted hence the objective of this study was to examine whether warehousing is a significant activity which can add value to all the efforts being made by the government of Zimbabwe to ensure food security. The study sought to answer the basic question, 'What is the significance of warehousing in the maize value chain?' The study also sought to prove the null hypothesis that is; 'Warehousing is not a significant activity in the maize value chain', with the opposite being the alternative hypothesis.



Methodology

The study was conducted at the Grain Marketing Board of Zimbabwe (GMB) which has the monopoly for grain storage in Zimbabwe. GMB has 78 storage depots scattered around the country which are categorised as Class 1, Class 2 and Class 3 depending with the level of activity in each depot and storage capacity. The class 1 depots have the largest storage capacity and the highest level of activity. The depots in this category were 15 in total and this study targeted these depots because they provide the largest storage capacity for maize in Zimbabwe. In Zimbabwe, all farmers, except those on contract farming, are compelled to deliver all their maize to the GMB.

The study used both the quantitative and qualitative paradigms because a pure quantitative research is objective but lacks explanatory value. Qualitative research is also able to provide detailed explanations but is subjective (Kothari, 2004). The use of both techniques helped the researcher to maximise on their strengths while overcoming the limitations. According to Kato (2002:45), business and management research always involves both quantitative and qualitative analyses. The target population for this study was made up of the managers and employees of GMB in all its 'Class 1' depots. The Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development (MLAFWRD), as the parent ministry, was also part of the study. There were also agricultural experts who possess knowledge on grain warehousing. Quota sampling was used to select these institutions, purposive sampling was used to select the Class 1 depots and snowball sampling was used to select respondents in the GMB, Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development (MLAFWRD) and agricultural experts. The rationale for selecting these institutions was that they were good prospects for required information since they are knowledgeable about grain storage in Zimbabwe. Descriptive statistics, in particular, the frequencies, measurement of dispersion (mean and standard deviation) were used to analyse the data. The Relative Importance Index (RII) was also employed to describe the relative contributions of variable with regards to objectives of the study. The Formula for $RII = \sum_{x=1}^{x=5} n / (63 \times 5)$ where x represents the response for example 1 = strongly disagree and 5 = strongly agree, while n is the frequency of people who are respondents to x. One Sample Chi-square was the inferential statistics that was used to test the hypotheses of the study. Qualitative data was analysed thematically. Table 1 shows an analysis of the target population.

Table 1: Sample Size Summary

Participants	Target Sample	Data Collection Tool
MLAFWRD (AGRITEX Officers)	18	Interview
GMB's Board Members	3	Interview
Top Management (Operations; Corporate Secretary; Strategy and Business Development; Enterprise Risk; and Training and Development)	5	Interview
Depot or Assistant Managers	5	Interview
Agricultural Experts	5	Interview
Total Number of Interviews	36	
Respondents From 15 GMB's Class 1 Depots		
Depot Managers or Assistant Managers	15	Questionnaire

Supervisors	30	Questionnaire
Fitters	45	Questionnaire
Handy Persons	45	Questionnaire
Clerks	45	Questionnaire
Silo Operators	45	Questionnaire
Total Number of Questionnaires	225	

The variables that were measured in this study were: (1) Warehousing ensures that there is appropriate storage to preserve the quality and quantity of the grain (2) Warehousing ensures that maize is readily available when required (3) Maize is produced seasonally and warehousing helps to ensure continuous availability of the commodity.

Results

The focus of this section is to present the study results. Results relating to the significance of warehousing in the maize value chain are presented first followed by the hypothesis testing of whether warehousing is a significant activity in the maize value chain.

Significance of Warehousing in Zimbabwe's Maize Value Chain

The importance of warehousing in the maize value chain in the GMB is covered in this section. Descriptive statistics: mean and standard deviation were employed to examine the significance and extent of warehousing in the Maize Value Chain, based on a five Likert scale of 5 ranging from 1 (no significance) to 5 (most significant), and a mean close of 3 or close to 3 implying no decision made.

Table 3: Importance of Warehousing in the Maize Value Chain

	Mean	Std Dev	Strongly Disagree	Disagree	Agree	Strongly Agree
Warehousing ensures that there is appropriate storage to preserve the quality and quantity of the grain	3.80	1.25	21 (10.0%)	25 (10%)	127 (60.2%)	42 (19.9%)
Warehousing ensures that maize is readily available when required	3.70	1.19	21 (10.0%)	21 (10%)	106 (50.2%)	63 (29.9%)
Maize is produced seasonally and warehousing helps to ensure continuous availability of the commodity	3.60	1.36	42 (19.9%)	0 (0%)	127 (60.2%)	42 (29.9%)

Table 3 indicates that the warehousing of maize is important in the maize value chain in Zimbabwe. Warehousing ensures that maize produced seasonally with appropriate storage, the quality and quantity of grain is preserved (mean=1.25, Std Dev=1.25), readily available (mean=3.70, Std Dev=1.19) and continuously available (mean=3.60, Std Dev=1.36) when required. The majority of the respondents, 80% agreed that warehousing preserves the quality and quantity of the grain and ensures continual availability of the grain, while 80.1% indicated warehousing ensures continuous availability of the commodity produced seasonally.

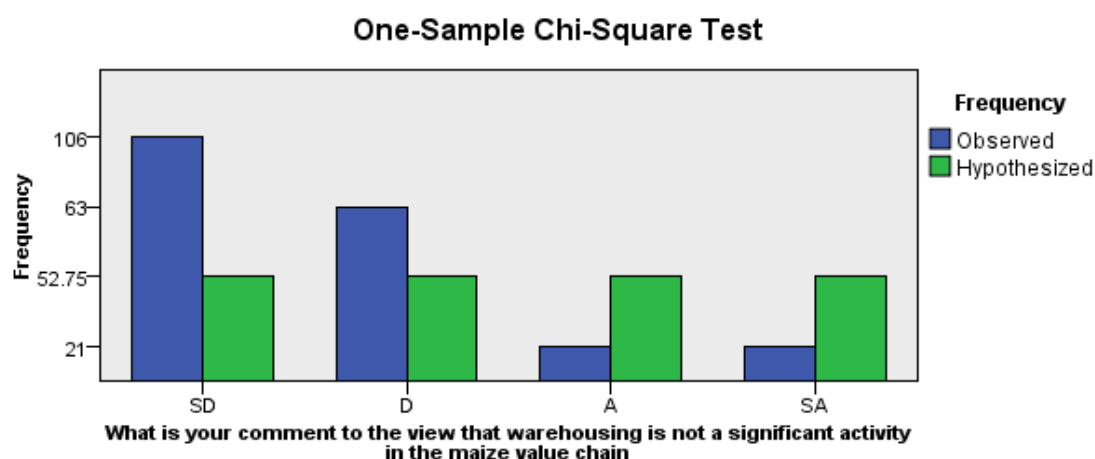
According to Table 3, 21 out of the 211 respondents (10%) 'strongly disagreed', 25 (10%) 'disagreed', 127 (60.2%) 'agreed', while 42 (19.9%) 'strongly agreed' that warehousing ensures appropriate storage to preserve the quality and quantity of the grain. These statistics point out that there was overwhelming agreement that warehousing is a significant function in the maize value chain. One of the interview participants had this to say, "*all the produced maize grain is kept in warehouses, where the risk of deterioration is minimised*".

Table 3 also shows that 169 respondents (80.1%) were in agreement with the assertion that warehousing ensures that maize is readily available when required. Maize is a seasonal commodity, and warehousing allows it to be stored in large quantities for future use. Therefore, it is important to have proper storage or warehousing for maize grain, from where the commodity can be supplied as and when required. One of the agricultural experts said that maize is a staple food for Zimbabwe, which is required on a daily basis, and sound warehousing ensures its availability, all year round.

Hypothesis Testing: Significance of Warehousing in the Maize Value Chain in Zimbabwe

The study sought to prove the null hypothesis that is; 'Warehousing is not a significant activity in the maize value chain'. The hypotheses of this study were tested using One Sample Chi-square. The One Sample Chi-square test assumes that there are no significant differences between observed frequencies and the expected frequencies. If the expected Chi-square value is not statistically significant ($p > 0.05$), then the observed frequency and the expected frequency do not differ significantly and hence adopt H_0 . If statistically significant ($p < 0.05$), then reject H_0 , and adopt the alternative.

With regards to whether warehousing is a significant activity, One Sample Chi-square test, a non-parametric test was used to examine the assumption. The test statistic was adopted at the expense of the more powerful One Sample t-Test because the parametric test had violated the assumption with regards to the sample size. T-test requires samples less than 30. The One-Sample Chi-Square Test, in Figure 2, illustrates the results of the findings.



Total N	211
Test Statistic	93.967
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.000

1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 52.750.

Figure 2: One-Sample Chi-Square: Significance of Warehousing in Maize Value Chain

Results in Figure 2 indicate significant differences in the hypothesised frequencies ($N=52$) and the expected frequencies ($X^2(3)=93.967$, $p<0.01$). Higher frequencies were observed in people disagreeing with the assumption that warehousing is not a significant activity in the maize value chain ($N=169$), while lower frequencies were observed in the number of people agreeing ($N=42$) than the hypothesised ($N=52$). Findings imply that respondents perceive warehousing as a significant activity in the maize value chain.

Discussion

The study has shown that warehousing is a significant activity in the maize value chain hence in light of the maize storage losses in Zimbabwe, warehousing is an option for reducing the wastages. The study also revealed that warehousing ensures that there is appropriate storage to preserve the quality and quantity of the grain. According to Watson et al. (2016), while the quality of a product cannot be improved after harvest, it can be maintained with proper post-harvest sanitation, cooling, packaging, handling, storage and management. Warehousing is the keeping of the quality of agricultural materials and preventing them from deterioration for specific periods, beyond their normal shelf life (Kiaya, 2014). According to Chebanga et al.

(2018), throughout the world, the population explosion is a major concern and is expected to reach 10.5 billion by 2050. This explosion in population demands an increase in the agriculture and food resources. The food supply should increase by at least 60% in order to meet the food demand in 2050. According to Chebanga et al. (2018), improper storage is one of the reasons for the high level of post-harvest losses. Storage is a component within a farming system, a trading enterprise, or a government policy, and may be undertaken because of its contribution to other activities or objectives within these broader contexts. Much of the post-harvest losses usually occur during storage and marketing (Chebanga et al., 2018).

The study also revealed that warehousing ensures that maize is readily available when required. According to Sainathuli et al. (2014), warehouses, now often referred to as distribution centres, have emerged from their traditional passive role of serving as buffers to mitigate supply-demand variations to a more active role of providing value-added services such as consolidation/deconsolidation, assembling and kitting. Sayeed (2013) also points out that careful warehouse management is important in modern supply chains. Sainathuli et al. (2014) argue that warehouses play a vital role in mitigating variations in supply and demand, and in providing value-added services in a supply chain. Both industrial as well as agricultural goods are produced at some specific places but consumed throughout the country. Therefore, it is essential to stock these goods near the place of consumption, so that without making any delay these goods are made available to the consumers at the time of their need (Kiaya, 2014).

The need for maize warehousing arises because maize is produced only in a particular season but its consumption takes place all year round. In this regard, Webber and Labaste (2014) argued that effective warehousing is regarded as a competitive weapon as the wider market demands continuous supply of goods in authentic condition. The warehouses provide a safe way for protecting the maize, thus reducing post-harvest storage losses. A viable warehouse system encourages storage of agricultural commodities in well-run storage facilities and can, therefore, help to ensure a significant reduction in maize post-harvest storage losses.

The results of the study and related literature confirm that warehousing is a significant activity in the maize value chain. In order to feed the whole country, maize must be held in storage for periods varying from one month up to more than a year. Maize storage therefore occupies a vital place in the economy of Zimbabwe in order to guarantee food security. Safe maize storage methods are critical in preventing storage losses which are mainly caused by weevils, beetles, moths and rodents.

Conclusion

The study concluded that warehousing is a significant activity in the maize value chain and can help to reduce maize post-harvest storage losses. Since maize is produced seasonally and consumed all year round, warehousing helps to ensure continuous availability of the commodity thereby ensuring food security in Zimbabwe. In order to reduce maize post-harvest storage losses in Zimbabwe, it is recommended that the government of Zimbabwe prioritises the provision of sound warehouse facilities for maize storage. These may include metal silos, concrete silos, hermetically sealed storage facilities, super grain bags and properly constructed storage sheds. This study provides a basis for further research in grain warehousing at national level. Most studies in warehousing and post-harvest losses have been conducted at farm level without much attention to national grain warehousing. Because of the implications that warehousing has on national food security, this study provides a starting point to unpack the

warehousing strategies adopted in the containment of post-harvest storage losses and the challenges faced in this regard in Zimbabwe. It is also important to note the study's limitations. The study only focused on 15 GMB depots in Zimbabwe from a total of 78 depots. With more funding, the study can be extended to all GMB depots countrywide to help understand the significance of warehousing in the maize value chain in Zimbabwe.

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