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# The Warehousing Strategies Adopted to Contain Maize Post-Harvest Storage Losses in Zimbabwe

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## Abstract

*This study examined the warehousing strategies adopted in Zimbabwe to contain maize post-harvest storage losses. The government of Zimbabwe has invested heavily on various schemes aimed at boosting agricultural productivity for maize which is a staple grain for the populace. Despite all these efforts, the challenge of food insecurity has continued to confront Zimbabwe as a nation. On the same note, there have been various reports of maize losses in storage hence the study examined the warehousing strategies adopted to contain maize post-harvest losses in Zimbabwe. Primary data were collected from 225 employees in the Grain Marketing Board of Zimbabwe (GMB), the Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development (MLAFWRD) and agricultural experts through the questionnaire and in depth interviews. The study found out that the Grain Marketing Board has effective warehouse strategies for the containment of maize post-harvest losses. However, while there were effective warehousing strategies, the losses due to the absence of sound post-harvest storage practices remained a concern. The study recommended a change in organisational operational culture to sensitise all human resources involved in maize storage in the Grain Marketing Board of the criticality of reducing maize post-harvest storage losses in Zimbabwe.*

**Keywords**: warehousing strategy; post-harvest losses; maize; storage; storage technology.

## Introduction

The primary focus of many developing countries has been on economic growth and food security (African Union Commission, 2018). However, to ensure food security, effective warehousing is necessary because of the seasonal production of most agricultural produce. The United Nations (2018) notes that world hunger has been reduced significantly but it is on the increase again. Conflict, drought, and disasters associated with climate change were among the reasons causing this increase in world hunger (United Nations, 2018). Maize is produced seasonally; therefore, it is necessary to develop effective warehousing strategies to guarantee its availability all year round (Kumar Deepak and Kalita Prasanta, 2017). These warehouses can be grouped into four types which are agricultural warehouses, container terminals, air cargo complexes and industrial warehouses (Sharma, 2013).

Storage is a critical activity which involves holding and preserving the grains after harvesting until they are dispatched for consumption (Ugochukwu Albert and Peter Phillips, 2018). Warehouses are responsible for protecting and maintaining the quality of the maize to ensure availability throughout the year. Storage facilities are important in preventing the storage losses through reducing the effect of rodents, microorganism, pests and environmental induced factors to supply food to the increasing global population (Eme, 2013). Many innovations in maize storage have been developed for use at the farm level and for bulky national storage reserves. The storage of many food grains needs scientific and modern techniques because most grains are affected by biological activities and a variety of insect-pests (Makami, 2014).

According to Banasik et al. (2017), when grain is produced commercially, merchants often provide empty sacks to farmers for filling them at the farm. These merchants then collect the packaged grain from the farm, or the farmer will transport it to the nearest collection depot (Banasik et al., 2017). During this process, the farmer needs to store the bagged sacks of grain for a period of time before they are delivered to the collection depots (Banasik et al., 2017). In this process precautions need to be taken to maintain the safety and quality of the grains (Jakfar et al., 2021). Moisture and termites usually affect maize grains during this process and keeping the bagged maize of the ground and fumigation is necessary. According to Smitiri (2015), the risk of rain at the temporary storage stage requires the covering of storage bags with waterproof sheeting. Fumigation of the bagged maize is usually not necessary if the storage period is not long (Kondratjev, 2015). Used maize storage sacks must be inspected, cleaned and fumigated before use (Kondratjev, 2015).

Metal drums and plastic drums can be used for the storage of grains and notes that plastic drums are weaker as compared to metal drums (Madel, 2014). If constructed well and fitted with gaskets, these metal drums can be modified to be airtight. This makes them safe from rodents and effective against insects (Emeka, 2014). However, there is need for their protection from sunshine and heat to reduce condensation through locating them in shaded and well aerated places (Emeka, 2014). According to Makami (2014), in some countries, modern grain storage facilities have been developed for the warehousing of maize for a long duration. These include Concrete/cement silos which are made of cement and other imported materials. They are durable but expensive structures to construct. Significant resources are required for their erection (Makami, 2014). They are suitable for bulky storage and their distinguishing feature is that they are robust and provide many years of satisfactory service (Makami, 2014). Metal Silos can also be used for maize storage. These are suitable for storing large grain quantities

(over 25 tonnes) and are considered too costly for on-farm, small scale storage (Emeka, 2014).

Organisations planning for a new grain store should make an effort to seal it effectively and make it air-tight (Jarkfa et al., 2021). The advantages of sealed maize storage facilities are many such that the low costs incurred during construction should not be considered (Jarkfa et al., 2021). The fumigation costs of stored grain are much cheaper and effective as compared to the use of chemicals (Smitiri, 2015). The grain stored in sealed storage facilities can be protected from insects because the sealing restricts pest access for re-infestation (Kondratjev, 2015). Total grain protection can only be possible if the grain is fumigated in well-sealed storage facilities [9].

Adequate air supply in grain storage facilities is necessary in grain storage and warehousing (Jarkfa et al., 2021). During storage, there is need for ambient aeration, which entails injecting air through grain to maintain required temperature (Makami, 2014). This is very critical in grain storage management as it preserves grain from infestation and deterioration in conditions where the moisture content of the stored grain is more than its safe level (Makami, 2014). Airtight storage techniques used for providing storage for food grains in the absence of oxygen are effective because insects-pests are eliminated in the storage facility (Jarkfa et al., 2021). This can be in the form of hermetic storage which is yet another way for the warehousing of grain and containing post-harvest storage losses. Hermetic storage technology shields the stored grains from moisture migration, rodents and insect-pest (Makani, 2014). This is achieved through creating favourable storing conditions in the storage facilities. Hermetic storage technology has been proved to be effective and efficient to store grains without affecting their quality aspects for long periods (Smitiri, 2015). Hermetic storage facilities are large with storage capacity ranging from ten to thirty thousand tonnes and their use started in the last decades of the 20$^{th}$ century (Singh et al., 2017). Hermetic storage facilities have been proved to be suitable for the storage of grains with recommended moisture content for up to four years without deterioration (El Taliawi Ola and Zeger Van Der Wal, 2019). Hermetic storage structures are very reliable in protecting the grains and reduce the storage losses up to 0.15% (Singh et al., 2017).

Grains stored in hermetic storage structures do not require any chemical protection and fumigation as an effective storing condition would have been developed by modifying the storage structure atmosphere (Jarkfa et al., 2021). Construction of hermetic storage facilities is based on the amount of maize grain which needs to be stored. The capacity range of the facilities varies between 0.59 to 1 tonnes for super grain bags, 5 to 30 thousand tonnes grains can be stored in the hermetic storage facilities called bunkers and cocoons (Singh et al., 2017).

Fumigation and treatment of the stored grains should be done at regular time intervals to reduce pest infestation (Makami, 2014). This is based on the fact that if insects in the stored grain are left untreated, the grain quality will deteriorate and become unsalable in the market and in some cases it can be reduced to dust because of the pests feeding on it (Makami, 2014). The stored grains can become mouldy as a result of the heat and moisture caused by the insects in the storage facilities. Grain insects and pests are usually present on most farming areas, harvesting equipment, stock feed, old seed, grain spills and these can enter storage facilities easily (Eme, 2013). In some cases, insects are moved into storage areas through the grain handling equipment (Eme, 2013). This validates the need for insect control systems to be put in place so as to reduce grain post-harvest storage losses (Eme, 2013). Effective use of insect control systems maintains grain quality and value (Eme, 2013). Grain fumigation chemicals protect grains in all storage types but they need to be sprayed evenly to grain and storage facilities for positive results (Eme, 2013). This can be achieved by making use of correctly calibrated grain chemical application equipment. Training of warehouse employees is necessary to ensure that the correct quantity of the chemical is used during fumigation as under-dosing can lead to reduced protection, while overdosing is costly (El Taliawi Ola and Zeger Van Der Wal, 2019).

It is important to note that in Zimbabwe, all grains are stored and managed by the Grain Marketing Board (GMB) which is a State Owned Enterprise. All farmers are required to deliver their maize for storage to the GMB except for contract farmers. Most of the agricultural goods such as maize and wheat are produced only in a certain season but the consumption of these take place all year round hence the importance of agricultural warehousing. In order to ensure food security in Zimbabwe, maize storage plays a critical role through the reduction of quantity and quality losses. Adopting proper and effective warehousing strategies will also reduce the government's burden on food subsidies in Zimbabwe. The main objective of this study was to examine the warehousing strategies adopted to contain maize post-harvest storage losses in Zimbabwe. The study sought to answer the question, 'How sound are the warehousing strategies adopted for containing maize post-harvest storage losses in Zimbabwe?' This study also sought to prove the null hypothesis that is; 'Zimbabwe does not have effective warehousing strategies for containing maize post-harvest losses', with the opposite being the alternative hypothesis.

# Material and Methods

## Study area

The study was conducted in the Grain Marketing Board of Zimbabwe (GMB) which has 78 storage depots scattered around the country. These depots are

categorised as Class 1, Class 2 and Class 3 depending on 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 provided the largest storage capacity for maize in Zimbabwe. 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 possessed knowledge about maize warehousing.

## Method of Data Collection

Questionnaires and in depth interviews were used to collect data. 225 questionnaires were administered and 36 in depth interviews were conducted in this study.

## Sampling Techniques

Quota sampling was used to select the institutions in this study. 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.

## Data Analysis

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 variables with regards to objectives of the study. The Formula for RII $=x=1x=5n/(63x5)$ where x represents the response e.g. 1 = strongly disagree and 5 = strongly agree, while n is the frequency of people who respond 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) Sound management of assets and premises used in maize warehousing (2) Effective organisation of the warehouse processes (3) Use of appropriate technology in the warehouses (4) Capacity building and sound leadership in maize warehousing (5) Sound planning of the warehouse processes

# Results and Discussion

## Response Rate

There was a remarkable response from the participants and respondents. Table 2 show the response rate.

**Table 2: Questionnaire Response Rate**

| **Respondents From 15 GMB 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** | |

According to Table 2, the sample target for the questionnaires was 225, and there were responses from 211 people (94% response rate). The response rate for questionnaires, of 94%, is very high considering that Saunders et al., (2015) set the minimum acceptable response rate at 67%. Data were also collected using interviews. Table 3 shows the interview response rate.

Table 3: Interview Response Rate

| **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** | |

According to Table 3, out of the targeted 36 interviews, the researcher managed to conduct 23, indicating a response rate of 64%. Interviews are difficult in terms of making appointments and agreeing on time and Saunders et al., (2015) argue that an interview response rate of at least 50% is acceptable. Therefore, a 64% response rate for this study was above the minimum limit.

Demographic Profile of Respondents

Gender, age, highest educational qualification, and the number of years the respondent was working for GMB are the respondent characteristics presented. Respondent characteristics are paramount in that they are an indicator of the quality of responses the research is likely to get, a key determinant of the validity of the final results.

The 211 questionnaire respondents were required to indicate their gender. The question on gender was asked in order to determine the extent to which GMB enhances gender equity. Gender balance has an influence on a company's performance as any strategies can be subjected to close scrutiny by both the males and females, who are also part of the maize value chain actors. Figure 1 shows the findings on gender.

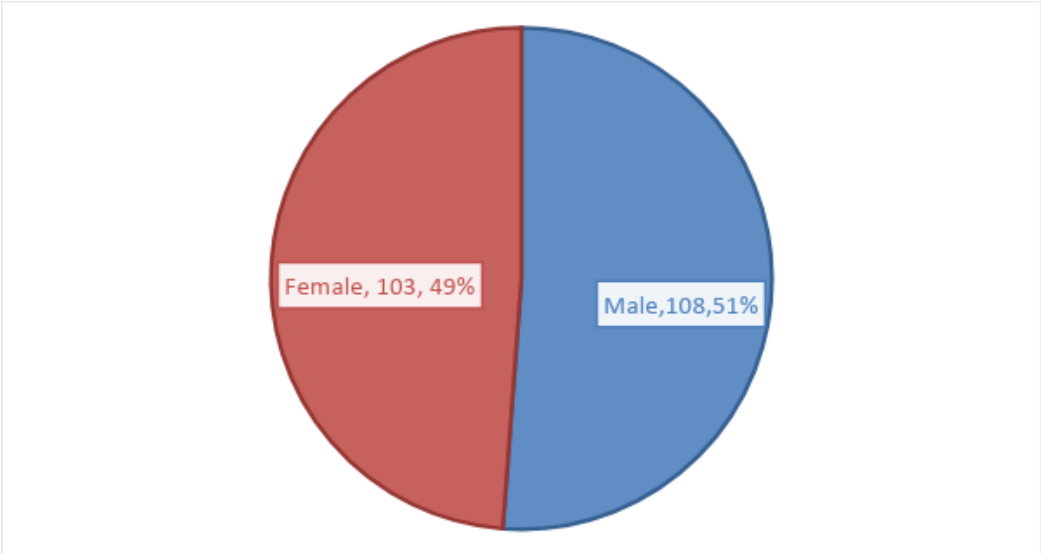



Figure 1: Gender of Respondents

Figure 1 shows that, out of a total of 211 respondents who participated in this study, nearly an equal number of males (51%) and females (49%) participated. This could also imply that GMB is a gender-balanced organisation, which could have a positive implication on performance, including warehousing operations. Having adequate gender balance is essential for enhanced organisation performance as there is sharing of ideas.

The respondents were also required to indicate their ages. The question on age was asked in order to establish the level of maturity of the people who provided the answers to the questions.

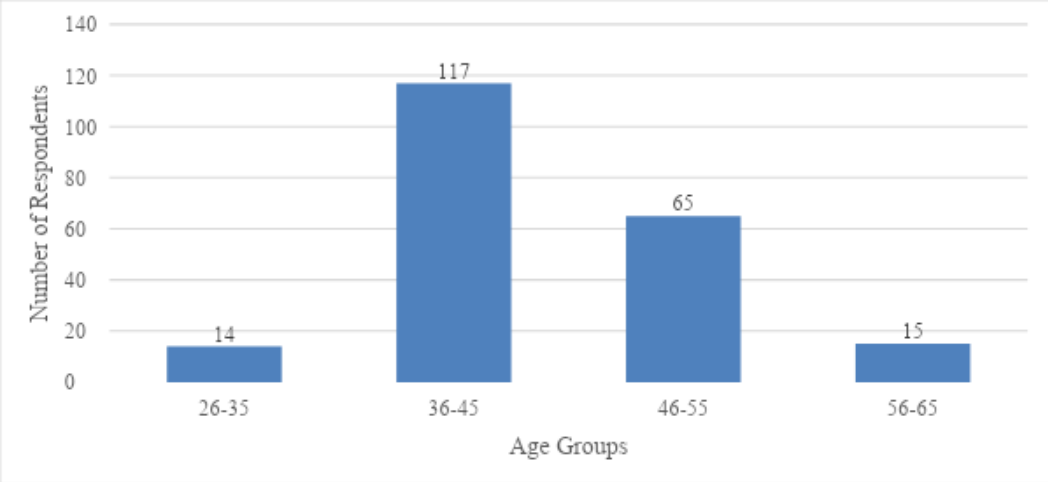



Figure 2: Age Groups of Respondents

Figure 2 shows that the majority of the sample 55.5% were aged between 36 and 45 years, and a significant number were between 46-55 years old. These results seem to indicate that most of the respondents in this research were mature people, meaning a high potential for reliable results.

The respondents were asked to indicate their highest educational qualifications. Table 4, shows the findings on educational attainments.

**Table 4: Highest Educational Level**

| Educational Level | Number of Respondents | Percentage of Respondents |
|---|---|---|
| Diploma | 82 | 38.9 |
| First Degree | 102 | 48.3 |
| Masters | 27 | 12.8 |
| Total | 211 | 100.0 |

According to Table 4, all the respondents were educated with at least a diploma, 48.3% having an undergraduate degree and 12.8% having a master's degree. In terms of occupation status most respondents, 76.3% were non-managerial employees and their supervisors (14.2%), and the remainder very few managers, both middle and top level management. Higher levels of educational attainment of the respondents have can mean the respondents sampled are knowledgeable about the phenomenon being investigated, thus valid responses are possible.

There respondents were required to indicate their work experience in GMB. The question on work experience was asked to determine whether the respondents have been working for GMB for a period long enough to be able to provide reliable answers. Table 5 shows the findings on work experience.

Table 5: Tenure of Employment in GMB

| Number of Years | Number of Respondents | Percentage of Respondents |
|---|---|---|
| 3-5 years | 5 | 2.4 |
| 6-10 years | 107 | 50.7 |
| 11-15 years | 96 | 45.5 |
| 16-20 years | 3 | 1.4 |
| Total | 211 | 100.0 |

According to Table 5, with regards to tenure, just over half the sample, 50.7% had worked for the company for 6 to 10 years, nearly an equal number (45.5%) have tenure of between (11-15) years. The findings show that most of the respondents had adequate working experience to be in a position to comment about the operations in GMB.

## Warehousing Strategies Adopted to Contain Maize Post

-Harvest Losses in Zimbabwe

Descriptive statistics: mean and standard deviation, and the relative importance index were used to identify and examine the warehouse strategies adopted to contain maize post-harvest losses in Zimbabwe. Based on a Likert scale of 5 ranging from 1 (no adoption) to 5 (mostly adopted), and a mean close of 3 or close to 3 implying no decision made with regards to level of adoption. Table 6 illustrates the results of the study.

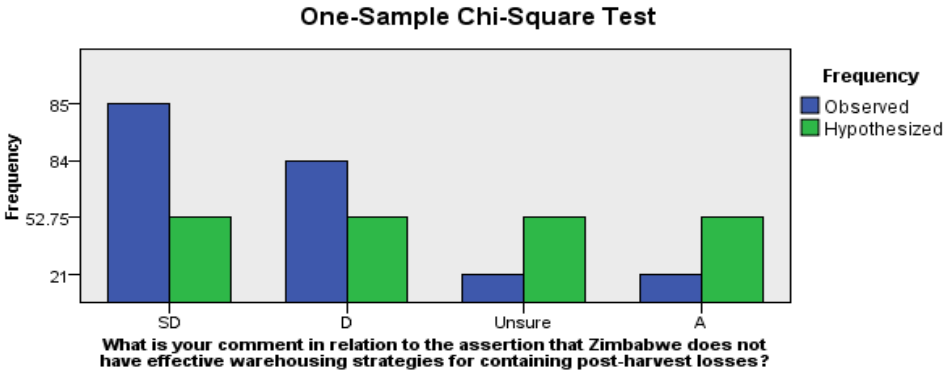
Table 6: Maize Warehousing Strategies Adopted in Zimbabwe

| Strategies | N | Mean | Std. Deviation |
|---|---|---|---|
| Sound management of assets and premises used in maize warehousing | 211 | 4.3033 | 1.18841 |
| Effective organising of the warehouse processes | 211 | 4.2986 | .78130 |
| There is use of appropriate technology in the warehouses | 211 | 4.0047 | 1.34341 |
| There is capacity building and sound leadership in maize warehousing | 211 | 4.0000 | 1.34164 |
| There is sound planning of the warehouse processes | 211 | 4.0000 | 1.34164 |

Table 6 indicates that Zimbabwe has several warehouse strategies in place to contain maize post-harvest storage losses. Mean scores of above 4 indicate the majority of the respondents agreed of the presence of strategies in the organisation. The results indicate that Zimbabwe has a sound management system of assets and premises used in grain warehousing (mean=4.30, Std Dev=1.2), effective organisation of warehouse processes (mean=4.30, Std=0.78) and makes use of appropriate technology in the warehouses (mean=4.01, Std Dev = 1.34). In addition results illustrate that Zimbabwe has capacity building and sound leadership, and sound planning of warehousing processes in place.

With regards to the assertion that Zimbabwe does not have effective warehousing strategies for containing maize post-harvest storage losses, One Sample Chi-square test, a non-parametric, was the test statistic employed to test the hypothesis.

The non-parametric test was used in favour of the more powerful One Sample t-Test which violated the sample size assumption. T-test requires samples less than 30. The One-Sample Chi-Square results in Figure 2 show the findings.




| | |
|---|---|
| **Total N** | 211 |
| **Test Statistic** | 76.450 |
| **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 3: One-Sample Chi-Square: Effectiveness of Warehousing Strategies in Zimbabwe

The results in Figure 3 indicate significant differences in the hypothesised frequencies (N=52) and the expected frequencies ($X^2(3) = 76.45$, $p<0.01$). Higher frequencies were observed in people disagreeing with the assertion that Zimbabwe does not have effective warehousing strategies for containing post-harvest losses (N=169), while lower frequencies were observed in the number of people agreeing (N=21) and not use (N=21) than the hypothesised (N=52).

The results from the study suggest that Zimbabwe has effective warehousing strategies for containing maize post-harvest storage losses. However, while there were effective warehousing strategies in the GMB, interviews conducted suggests that losses due to the absence of sound post-harvest storage practices remained a concern in Zimbabwe. This is similar to what was experienced in Nigeria. In order to ensure that the quantity and quality of food produced was preserved, there was the formulation of the national storage policy of the Federal Government of Nigeria (FGN). The FGN stipulated that 5% of food production be stored by the federal government for strategic reserve purposes, 10% by the state government as

buffer stock, and 85% stored at the farm by individual farmers or by traders in food warehouses (Kalita, 2015). However, Jeremiah (2015) argues that, despite having up to 1.3 million tons of grain storage capacity and more than 48 warehouse facilities for its grains reserves program (SGR), weak management of warehoused grain by staff at these facilities resulted in huge post-harvest losses (up to 50% in some cases). The grain losses suffered were mainly due to the lack of knowledge and ineffective stored grain management practices.

Maize is the most critical grain crop in Zimbabwe because it is a major feed grain and a staple food for all the population. Thus, the containment of post-harvest food losses is an important step in ensuring future world food security in a sustainable way. Table 6 also showed that most of the respondents were in agreement with the view that Zimbabwe makes use of appropriate technology in grain warehouses. New and efficient technology is necessary in warehousing. Technology strategy involves the duty of building, maintaining and making use of a company's technological resources. However, planning, organising, and relevant technology are all dependent on leadership. Sound leadership is important for efficient and effective warehousing operations.

This study pointed out that Zimbabwe ensures capacity building and sound leadership in warehousing, with a mean score of 4.0. This is very important because warehousing and its management cannot be appreciated differently from the general functions of management. According to Sayeed (2013), the four functions of warehouse management are planning, organising, leading, and controlling. More so, from a warehousing perspective, the key functions are (i) receiving, quality control, and put-away/storage and (ii) picking, sorting, packing, and shipping (Sainathuli et al., 2014).

The study results in Table 6 also show that Zimbabwe is able to ensure sound management of assets and premises in warehousing. Maize storage assets are very critical in the containment of post-harvest storage losses. However, Jurevicius (2013) points out that the resources or assets, themselves, do not provide any benefit for an institution if they are not managed to capture their value. Moreover, almost all of the interview participants pointed out that the grain storage assets require sound management, including proper maintenance. If the assets are well maintained, the maize will not be damaged by moisture and pests. Asset management must be given high priority and viewed as a financial concept, managed alongside core business functions such as Finance, Human Resources, and Information Technology (Abdullahi, 2015). According to Bourne Humphrey and Mark Jenkins (2013), the assets need to be managed, not just maintained. This will help to reduce maize post-harvest storage losses and ensure food security in Zimbabwe.

## Conclusion and Recommendations

The study concluded that GMB has effective warehouse strategies for containment of maize post-harvest losses. However, while there are effective warehousing strategies, the losses due to the absence of sound post-harvest storage practices remain a concern in GMB. The implementation of every strategy needs to be monitored in order to be effective. The maize storage assets, that is; the maize storage silos, storage sheds, storage bags need to be managed well. This task is done by the human element involved in maize storage hence it is recommended that GMB should constantly monitor the implementation of their warehouse strategy. The human element is important in most strategies as it implements the strategy. Consequently, they should be involved in the strategy development process in order to comprehend it and be able to put it into action. The Government of Zimbabwe should prioritise the training of grain handlers in the Grain Marketing Board on grain handling in order to improve the grain storage practices. A change of organisational operational culture is needed to sensitise all human resources involved in grain storage of the criticality of reducing maize post-harvest storage losses. This is because, while there were effective warehousing strategies, the losses due to the absence of sound post-harvest storage practices remain a concern in GMB.

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