AN EVALUATION OF WOMENS' CHALLENGES IN THE UTILISATION OF MAIZE METAL SILO IN ZIMBABWE. A CASE OF MAKONI DISTRICT.

A dissertation submitted in partial fulfilment of the requirements for the Master of Science Degree in Food Security and Sustainable Agriculture (Production)

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DECLARATION

I hereby declare that the research project entitled **"An evaluation of women's challenges in the utilisation of maize metal silo in Zimbabwe. A case of Makoni District."** submitted to Bindura University of Science Education, Department of Agriculture Economics, Education and Extension is a record of an original work done by me under the guidance and supervision of **Dr Renias Chivheya** and this work is submitted in partial fulfilment of the requirements for the award of a Master of Science Degree in Food Security and Sustainable Agriculture. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree or diploma.

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DEDICATION

I dedicate this study to: my ever-loving wife, Faith Jamera who supported and encouraged me during the entire period of my studies, my loving Father (Baba Fari), my motivator who natured me up to this level of education, my daughters Makanaka and Atida who sacrificed their time and relinquished my attention during my studies.

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ABSTRACT

Maize grain postharvest storage losses are a challenge in Makoni District. To mitigate the challenge, NGOs in collaboration with Department of Agritex supplied maize metal silo technology to selected households as a pilot project. Women face several challenges in the utilisation of these new technologies. The study identified women's challenges, determined women's perceptions, evaluated socio-economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo in the district. A purposive sampling method was used to select the 8 wards that benefited to the Centro Internacional de Mejoramiento de Maizy (CIMMYT), Action Contre la Faim (ACF) and Improved Nutrition and Sustainable Production for Increased Resilience and Economic Growth (INSPIRE) metal silo pilot projects. At wards, simple random sampling method was used to identify 185 women metal silo users from wards lists. Pre-tested structured questionnaires were administered on women metal silo utilizers. The data was analysed using descriptive analysis, Eta, KAP analytic framework, Spearman correlations and binary logistic regression analysis. The study results revealed that obtaining subsidy or credit facilities to purchase metal silo, accessing trainings on metal silo, and determining amount of grain consumed and amount of grain remaining in the metal silo are some of the challenges identified faced by women utilising metal silo. Eta revealed a very strong association (eta>0.5) between utilisation and challenges identified. The KAP analytic framework analysis results revealed that women are knowledgeable about the metal silo technology, appreciate the practices done on stored maize in the metal silo technology and have a positive attitude towards metal silo technology. There were strong positive significant correlations between K-P, K-A and A-P. The binary regression analysis revealed that household income level, household size, household labour force availability and level of education of household head and cultural or traditional beliefs have a significant effect in determining women's role in the utilisation of maize metal silo. Women face challenges in the utilisation of maize metal silo in the district, though they have positive perceptions on metal silo technology. Socio-economic and cultural factors also impact on women's roles in the utilisation of a maize metal silo in the district. There is need to address the socio-economic and cultural factors that impact negatively on women's roles.

Keywords: Metal silo, Challenges, Perceptions, Cultural-Socio-economic-factors, Women.

LIST OF ACRONYMS AND ABBREVIATIONS

ACF	Action Contre la Faim
AGRITEX	Agricultural Technical and Extension Services
ANSAF	Agriculture Non State Actor Forum
CIMMYT	Centro Internacional de Mejoramiento de Maizy Trigo (Spanish for International Maize and Wheat Improvement Centre)
EGSP II	Effective Grain Storage Project II
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agricultural Organisation
IFIs	Individual farmer interviews
INSPIRE	Improved Nutrition and Sustainable Production for Increased Resilience and Economic Growth.
I-SAPS	Institute of Social and Policy Sciences
KAP	Knowledge Attitude and Practice
LGB	Larger Grain Borer
MAMID	Ministry of Agriculture, Mechanisation and Irrigation Development
NGOs	Non-Governmental Organisations
SDC	Swiss Agency for Development and Cooperation
SPSS	Statistical Package for Social Scientists
SSA	Sub Saharan Africa
TOC	Theory of Constraints
WB	World Bank
WHO	World Health Organisation

TABLE OF CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix 1

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Meeting the food demand of the rapidly increasing global population is emerging as a challenge to mankind (Lusiba *et al*., 2016; Kumar and Kalita, 2017). The global population is expected to grow to 9.1 billion people by the year 2050, and about 70% extra food production will be required to feed it (Hodges *et al*., 2011). Most of this population rise is expected to be attributed to developing countries, several of which are already facing issues of hunger and food insecurity. Attempts to enhance food demand, food and income security in most countries worldwide, including countries in Sub-Saharan Africa (SSA) region have focused on increasing production and productivity with limited attention to reducing postharvest losses. A post-harvest loss, a critical issue, does not receive the required attention and less than 5% research funding has been allocated for this issue in previous years (Kitinoja *et al*., 2011).

Approximately one-third of food produced globally (about 1.3 billion tonnes), worth about US$ 1trillion, is lost during postharvest operations every year (Kumar and Kalita, 2017). In most of African countries, grains with a value estimated monetary value of over US$2 billion are lost annually after harvest (Zorya *et al*., 2011; SDC, 2011). Maize postharvest losses are estimated to exceed $100 million per annum in the eight major producing Sub-Saharan Africa (SSA) countries (Kitinoja *et al*., 2011).

Postharvest losses of grains are extensive and a major threat to food security in SSA region. Major factors that influence losses are: attacks on grain by insects, rodents, birds and mycotoxin contamination (HELVETAS and ANSAF, 2016). The problem is acute in SSA region because on-farm storage technologies, which are considered to be solutions to the problem are either not widely available or poorly adopted and utilised by users due to different factors, leading to postharvest losses of up to 30% of grains and even up to 40% (Tefera *et al*. 2011). FAO (2008), argued that grain postharvest losses in ASS countries are high due to utilisation of traditional storage structure that are inefficient for the storage and preservation of grain. Lusiba *et al*. (2017) asserts that postharvest losses are known to be a result of technologies and practices used.

Post-harvest losses are a life changing and high cost to pay for smallholder farmers in Zimbabwe. The cost is even greater for these farmers who have no safety net to buffer them from this livelihood risk. FAO (2015) reported that, in Zimbabwe, postharvest losses are estimated at 20-38% in storage alone and can be as high as 40% when including field, transportation, handling and processing losses. The high grain losses during on-farm storage therefore deny the farmers the opportunity to attain food security and increased income (Likhayo *et al*., 2016). In most communal areas of Zimbabwe, grain production is characterized by one year of good production followed by two or three years of deficit (FAO, 2015a). That is why long term post-harvest storage is important as they are a permanent reduction to crop harvest that should be consumed by the farmers.

Makoni District, like most districts in Zimbabwe, maize grain postharvest storage losses (15.23%) is a challenge which leads to food insecurity of many households in the communities (Mvumi *et al*., 2017). On average farmers harvest 0.8 to 2 tonnes of maize grain and store about one tonne for family consumption throughout the season (FAO, 2015a). The most common storage pests leading to storage losses in the district is the destructive larger grain borer (LGB) and maize weevils (Mvumi *et al*., 2017). To mitigate the challenge, NGOs (CIMMYT, ACF and INSPIRE) in collaboration with Department of Agritex supplied metal silo technology. The metal silo is maize grain storage structure which was given to selected households as a pilot project for farmers to reduce storage losses and improve household food and income security. The farmers in the district before intervention of metal silo technology used to store maize grain in traditional storage structures. FAO (2008) and Gitonga *et al*. (2013), argued that traditional storage practices in African countries including Zimbabwe cannot guarantee protection against storage pests of staple food crops like maize. The lack of suitable storage structures for grain storage and absence of storage management technologies often force the smallholder farmers to sell their produce immediately after harvest and only to buy the grain again during lean times of the season (Tefera *et al*., 2011). Safe storage of maize at farm level is crucial as it directly impacts on poverty alleviation, food and income security of the smallholder farmers (Meja *et al*., 2016).

Technology interventions play a critical role in addressing the issue of postharvest losses and several efforts have been made to develop and disseminate these technologies for smallholder farmers but with low uptake and utilisation (Kumar and Kalita, 2017). Famers in the district are still utilising the traditional storage structures in the presence of new effective metal silo

introduced 6 years ago and still experiencing maize grain storage losses up to date. Lusiba *et al*. (2016) argued that farmers' adoption and subsequent utilisation of technology is strongly linked to perceptions.

The poor performance, uptake and utilisation of postharvest storage technologies in Makoni District might not only be driven by the challenges faced by users but also by the users' perceptions (Affognon *et al*., 2015). Women's perceptions on new technology such as maize metal silo is hinged on knowledge, practices and attitudes. According to Uaiene e*t al*. (2009), understanding farmers' perception of a given technology is crucial in the generation and diffusion of new technologies and farm household information dissemination. Therefore by determining women's perceptions towards the metal silo technology and utilisation will inform the designers and fabricators aimed at customising, up scaling the utilisation of metal silo technology and reduce postharvest storage losses.

Some of the constraints faced by women emanate from social, economic and cultural barriers which favour men in accessing and utilisation of productive and effective resources like metal silo storage technology (FAO, 2011). These challenges hinder women's productivity and reduce their contributions to the agricultural sector and to the achievement of broader economic and social development goals (FAO, 2011).

Most recent research on post-harvest management, Omotilewa *et al*. (2016) and Tefera *et al*. (2011), placed emphasis on technical and economic/cost aspects of poverty alleviation and improving post-harvest management technological innovations without much attention on socio economic/cultural aspects. Hardly any literature that systematically provides a deeper understanding of women's challenges in grain postharvest technologies related activities is documented especially in SSA. Most studies point to a mix of many gender-based factors that hinder agricultural technology adoption but none has evaluated women's challenges in technology utilisation of few technologies adopted in the communities. There is dearth of information in SSA countries especially in Zimbabwe concerning women's challenges on utilisation of metal silo as a maize grain storage structure

1.2 Statement of the Problem

High grain post-harvest storage losses due to insect pests, rodents and mould infestation, poor handling storage structures, lack of appropriate grain storage technologies in Zimbabwe have been a challenge in the small scale farmers (Mvumi *et al*., 2017). Various studies by FAO (2015), have estimated postharvest storage losses to be in the range of 20-38%and even up to 40% in most small scale farmers. Challenges in the utilisation of new improved promoted grain storage structures and inefficient utilisation of storage structure by women during on-farm storage deny the farmers the opportunity to attain food security and increased household income (Likhayo *et al*., 2016). Success stories in promoting improved on-farm storage technologies have indeed been rare in SSA (World Bank, 2015). Lack of substantial adoption of improved grain storage technologies in Zimbabwe, Makoni district among them emanate from lack of knowledge on the available storage technologies and the challenges accoutred by users of the metal silo technology (Likhayo *et al*., 2016).

Women make essential contributions to the agricultural sector in all developing countries as they are responsible for food production, food processing and meal preparation (Mukasa and Salami, 2016; Rahman, 2016). However, when new technologies are introduced, target mostly men and sufficient attention is not paid to how this may negatively impact on women's daily activities and specialized knowledge (FAO, 2015a). Since the implementation of the CIMMYT (EGSP Il), ACF and INSPIRE metal silo technology projects in Zimbabwe, Manicaland province, Makoni district, there is a death of information concerning users' challenges on the utilisation of metal silo technology as maize grain storage structure in Zimbabwe and SSA countries especially in communal sector where CIMMYT, ACF and INSPIRE projects were implemented.

1.3 Objectives of the study

1.3.1 The main objective

The broad objective of the study is to evaluate women's challenges in the utilisation of maize metal silo in Zimbabwe.

1.3.2 Specific objectives

The specific objectives study seeks to:

1. Identify women's challenges in the utilisation of maize metal silo in Makoni district.

2. Determine the women's perceptions in the utilisation of maize metal silo technology in Makoni district.

3. Evaluate the socio economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo in Makoni district.

1.4 Research Questions

The above objectives will lead to a set of research questions about women's challenges on utilisation of metal silo as a maize grain storage structure, which this study seeks to tackle in pursuit of its overall objective. These research questions are as follows:-

1. What are the challenges faced by women in the utilisation of maize metal silo in Makoni district?

2. What are the women's perceptions on the utilisation of maize metal silo technology in Makoni district?

3. What are the socio economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo in Makoni district?

1.5 Significance of the study /Justification

This study aims to evaluate the women's challenges in the utilisation of maize metal silo in the district. Challenges in the utilisation of maize metal silo might be one of the factors hindering the uptake of this safe and effective option of reducing storage losses. Identification of challenges in the utilisation of metal silo and addressing those challenges might lead to subsequent high uptake of the storage technology and reduce storage losses due to insect pests, rodents and mould infestation. This reduction of postharvest losses due to up take of metal silo will substantially contribute to provision of safe storage and free of pesticide maize grain leading to maize grain food security and healthy farmers due to reduction of storage pesticide usage in the district and the country.

More importantly is the idea of investing in developing technologies suitable for women and redressing women's perceptions, socio economic, cultural and institutional factors negatively affecting women in effective utilisation of storage structures. This provide an opportunity or avenue for significantly enhancing food security in the region among the smallholder farmers.

In addition to that, this study will serve as reference material to other students who will be researching on the same field in the future. It will act as an eye opener to other scholars and initiate prompts desire for other scholars to conduct further research on women's challenges in the utilisation of a metal silo storage structure in SSA countries. Although there are many studies currently underway worldwide on gender, this study will add a local perspective to the gender analysis of maize grain post-harvest management.

1.6 Delimitation of the Study

Most of the farmers to be targeted in the study were limited to beneficiaries of CIMMYT, ACF and INSPIRE metal silo projects and users of metal silos in the Makoni district. The process of identifying the metal silo household beneficiaries and users within the ward was made easier through use of wards lists record available at the District Agritex Office. The technique of pre-tested questionnaires was used; this method has been tested and succeeded with the past researchers.

1.6.1 Limitation of the study

In any research, there are always certain limitations. The primary limitation of this study was its limited scope of being done in the 8 wards of Makoni District only a single district concerning women's challenges in the utilisation of a metal silo as a maize grain storage structure. Furthermore, use of pre-tested questionnaire is subjected to problem of recall failure by respondents. Another challenge was the willingness of the respondent to give full and true information in regards to their household matters. That is said because; this study is designed to evaluate the challenges faced by women in the utilisation of maize metal silo in Makoni District alone. However, the issue women's challenges on utilisation of metal silo storage structure would have been better understood in the country if women challenges issues were studied through time and at least cover many districts within the country. Hence, owing to the fact that the study was conducted in a few wards in a district, the findings therefore cannot be generalised to the rest of Zimbabwe.

1.7 Outline of Thesis

The remainder of the thesis is as follows:

Chapter two presents a review of the literature on other studies done by other scholars on challenges faced by women in the utilisation of a maize metal silo, women's perception in the utilisation of maize metal silo and factors determining the role of women in the utilisation of maize metal silo storage structure. This chapter is important because it presents the basis for comparison with research findings.

Chapter three provides description of the study area. In addition, the chapter describes the methodology of the study. It focuses on research design, sampling procedure, data collection procedure, data analysis procedure and ethical considerations. Details of the analysis per individual objective are given in the subsequent chapter four, five and six.

Chapter four, identifies women's challenges in the utilisation of a maize metal silo in Makoni district using a 5 point Likert scale ranging from 'not a challenge' to 'a very big challenge'. Additional analysis procedure done was to investigate the strength of association between women's challenges and identified challenges in the utilisation of a metal silo using a nonparametric associational statistics Eta.

Chapter five, determine women's perceptions on the utilisation of maize metal silo technology in Makoni district using KAP analytical framework and later on Spearman rank correlation was used to evaluate possible associations between knowledge-practices (K-P), knowledge-attitudes (K-A), attitudes-practices (A-P) in determining women's perception on the utilisation of metal silo technology as a maize grain storage structure in Makoni district.

Chapter six, present the socio-economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo in Makoni district. Explanation was sought on the effect of the following socio-economic, cultural and institutional independent variables: level of income/financial capabilities, household size, household resources, labour availability, level of education, norms/values, social hierarchy, cultural/traditional beliefs, religion, AGRITEX, NGOs, local leadership, focal farmers, farmer gatherings and media determining the role of women in the utilisation of maize metal silo storage structure.

Finally, chapter seven combines the results, conclusions and policy recommendations of the previous chapters. The chapter enlighten the major challenges faced by women in the utilisation of maize metal silo storage structure, women's perceptions on the utilisation of maize metal silo storage structure and factors determining women's roles in the utilisation of maize metal silo in Makoni district.

1.8 References

Affognon, H., Mutungi, C., Sanginga, P. and Borgemeister, C. (2015). Unpacking postharvest losses in Sub-Saharan Africa: a meta-analysis. *World Development 66:49-68.*

FAO. (2015a).Running out of time. The reduction of women's work burden in agricultural production. Rome, Italy.

FAO. (2015). Technical manual for the construction and use of family-sized metal silos to store cereals and grain legumes. Rome, Italy

FAO (2013). Zimbabwe. Accessed atwww.fao.org on 09 December 2018.

FAO. (2011). The State of Food and Agriculture. Women in Agriculture, closing the gender gap for development. Rome, Italy.

FAO. (2008). Household metal silos; key allies in FAO's fight against hunger. Rome, Italy

Gitonga, Z. M., De Groote, H., Kassie, M. and Tefera, T. (2013). Impact of metal silos on households' maize storage, storage losses and food security: An application of a propensity score matching. *Food Policy, 43, 44–55*.

HELVETAS and ANSAF. (2016). A Study on: Farmers' Access to Postharvest Technologies. Final report (Refined version) Grain Postharvest Loss Prevention (GPLP) Project and Agriculture Non State Actor Forum (ANSAF).

Hodges, R.J., Buzby, J.C. and Bennett, B. (2011). Postharvest losses and waste in developed and less developed countries: Opportunities to improve resource use. *Journal of Agricultural Science 149(1):37-45.*

Kitinoja, L., Saran, S., Roy, S. K., Kader, A. A. (2011). Postharvest technology for developing countries: Challenges and opportunities in research, outreach and advocacy. *J. Sci. Food Agric. 2011, 91, 597–603.*

Kumar, D. and Kalita, P. (2017). Reducing Postharvest Losses during Storage of Grain Crops to Strengthen Food Security in Developing Countries. *Foods, 6, 8.*

Likhayo, P., Bruce, A. Y., Mutambuki, K., Tefera, T. and Mueke. (2016). On-Farm Evaluation of Hermetic Technology against Maize Storage Pests in Kenya. *Journal of Economic Entomology, Vol. 109, No. 4*

Lusiba, S. G., Kibwika, P. and Birungi, K. F. (2016). Farmers' perceptions and their implications on the use of rice postharvest handling technologies and practices in Eastern Uganda. *RUFORUM Working Document Series No. 14 (1): 911-919.*

Meja, K. V., Chris, J. S. and Tegla, S. J. (2016). Impact of metal silo storage technology on household food security. *Global Journal of Agricultural Economics and Econometrics, Vol.4 (4), 230-238.*

Mukasa, A. N. and Salami, A. O. (2016). Gender equality in agriculture: What are really the benefits for sub-Saharan Africa? *Chief Economist Complex | Africa Economic Brief Volume 7, Issue 3.*

Mvumi, B. M., Chigoverah, A. A., Chamboko, T. and Mupindu. S. (2017). Post-production practices, grain losses and perceptions in maize-based smallholder farming systems of Zimbabwe. Presented at the 1stAfrican Postharvest Conference, Nairobi, Kenya, 28 to 31 March 2017.

Omotilewa, O. J., Ricker-Gilbert, J., Ainembabazi, H., Shively, H. (2016). Impacts of Improved Storage Technology among Smallholder Farm Households in Uganda. 5th International Conference of the African Association of Agricultural Economists, September 23-26, 2016, Addis Ababa, Ethiopia

Rahman, S. (2016). Women's involvement in agriculture in northern and southern Kaduna State, Nigeria. *Journal of Gender Studies, 17:1, 17-26.*

SDC. (2011). Effective Grain Storage for Improved livelihoods.

Tefera, T., Kanampiu, F., De Groote H., Hellin J., Mugo S., Kimenju S., Beyene Y., Boddupalli, P. M., Shiferaw B., Banziger M. (2011). The metal silo: An effective grain storage technology for reducing post-harvest insect and pathogen losses in maize while improving smallholder farmers' food security in developing countries. *Crop Prot. 30:240-245.*

Uaiene, R. N., Arndt, C. and Masters, W. A. (2009). Determinants of Agricultural Technology Adoption in Mozambique, Discussion Papers, No. 67E, National Directorate of Studies and Policy Analysis. Ministry of Planning and Development, Republic of Mozambique.

World Bank (2015). World Development Indicators 2015, Washington, DC. USA.

Zorya, S., Morgan, N., Rios, L. D. (2011). Missing food: The Case of Postharvest Grain Losses in Sub-Saharan Africa 60371-AFR. The World Bank, Washington, DC.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter gives a comprehensive outline of theoretical and empirical literature analysis of the women's challenges in the utilisation of maize metal silo, women's perceptions on the utilisation of maize metal silo technology. It furthermore, reviews on the socio-economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo storage structure. The chapter also, presents the theoretical framework used in the thesis and lastly, the summary of literature review of the thesis.

2.1.1 Challenges in the utilisation of a metal silo.

The following section of the chapter gives a literature review analysis of challenges in the utilisation of maize grain metal silo storage structures by different research studies. Some of the challenges identified in literature includes: artisans and distance of users, cost and credit facilities of purchasing metal silo, women's education and skills in the utilisation of metal silo, hermetic sealing of metal silo, maize grain processing before storage in the metal silo, handling of the metal silo during maize grain storage, safe storage moisture determination, size, shape and weight of metal silo, height of larger capacity metal silo, installation of larger size metal silo in doors, security of metal silo on the shade outdoors, lack of compartments to store other grains for women, monitoring maize grain inside metal silo and outlet of the metal silo.

Artisans and distance of utilizers: Hodges and Stathers (2015), states that, there is a shortage of artisans in most farming communities for silo construction. In Malawi SDC (2015c), artisans that fabricate metal silos are located in centres with electricity about 30km from where metal silo users (farmers) are located. This distance issue is a constraint to women as they have limited mobility owing to well documented triple roles (World Bank, 2009). Furthermore, metal silo is a delicate structure in terms of maintaining hermetic seal; so long distance transportation of metal silo might results in substantial damage of the metal silo. However, the location of artisans and users of metal silo in Makoni district is yet to be evaluated to determine any challenges experienced.

Cost and credit facilities of purchasing metal silo: Hodges and Stathers (2015), Gitonga *et al*. (2013) and Ognakossan *et al*. (2010), reported that, the initial cost of purchasing a metal silos of 1 ton (the smallest size considered to be cost effective) and 1.8 ton capacities, respectively, is very high for smallholder rural farmers. This high cost of purchasing metal silo is a challenge for women as most rural women are financially constraint in the SSA. Chigoverah and Mvumi (2016), reported that, metal silos are relatively expensive compared to other storage techniques, smallholder farmers especially women would require credit or a subsidy to purchase these structures. This is a challenge to rural women where credit facilities are difficult to access and in a country where there are no subsidies for farm storage structures. Kumar and Kalita (2017) reported that, metal silo in developing countries have been found to be effective in several other studies but purchasing cost is a challenge to most women in rural areas. Similar sentiments were echoed by Ndegwa *et al*. (2016), although metal silos substantially reduce insect and pest infestation and potentially improve smallholder farmers' food security and income but the challenge is on high acquiring cost of metal silo compared to the other storage structures. HELVETAS and ANSAF (2016) reported that, lack of financial resources to acquire storage structures like metal silos is a major challenge faced by women in rural communities. However, FAO (2008), reported different sentiments that metal silos are inexpensive and can last for more than 15 years, if properly maintained. This different opinions concerning cost of metal silo necessitated the study in Makoni district so as to attain farmers 'views.

Women's education and skills in the utilisation of metal silo: Mwebaze and Mugisha, (2011), reported that, the education of the spouse (women) has a positive effect in utilisation of metal silo, as the decisions to use new postharvest technology may be influenced by household members other than the household head. Manandhar *et al*. (2018) reported that, the challenge faced by women in utilising metal silo is the high skills required for utilising the technology. This opinion was supported by HELVETAS and ANSAF (2016), who reported that, the majority of the farmers lack knowledge on proper handling of new storage structures as most of the farmers never received any training on the utilisation of metal silo in some communities. However, Manandhar *et al*. (2018), reported different views concerning skills and training in the utilisation of metal silo, as he viewed metal silo as easy to use, durable and is simple to design and construct. Gitonga *et al*. (2015), reported that, metal silo is easy to handle and can be produced in different sizes from 100 to 3000 kg grain holding capacity

based on requirements. Training on proper metal silo handling is not yet to be evaluated in Makoni district.

Hermetic sealing of metal silo: Hodges and Stathers (2015) and Cardoso *et al*. (2012), reported that, at household level keeping metal silo airtight is not easy. Failure to maintain a hermetic seal during storage could significantly reduce the effectiveness of metal soli during storage. In a poorly sealed metal silo, losses of the stored grain can be very high (Yusuf and He, 2011). Maintaining a hermetic seal is a challenge for women during utilisation of metal silo as they frequently open the storage to take daily grain consumptions. Yusuf and He (2011), maintain hermetic environment within the silo might be improved by adding rubber stoppers under the covers/lids on inlet and outlet in order to perfectly protect grain stored and maintain hermetic environment inside silo. The basic working principle of hermetic grain storage is elimination of oxygen in conjunction with an increase in carbon dioxide within the storage atmosphere, thus disrupting the respiration of insects, fungi and grain. All insects inside die when the air in the storage is reduced to 30% oxygen or less. Also, fungal development ceases when the oxygen level decreases to 1% (Yusuf and He, 2011). Once this special airtight silo has been closed the grain is in confined and controlled atmosphere.

Maize grain processing before storage in the metal silo: According to Nyanga and Ambali (2017), the introduction of technology increased the time for processing the maize grain for storage as the farmers have to hand shell the maize and take more time to ensure that the grain is completely dry before storage. Again, the loading and sealing of the technology is more involving and time consuming as compared to conventional storage facilities (Nyanga and Ambali, 2017).

Handling of the metal silo during maize grain storage: Poor handling of silo is another challenge faced by women, according to Nyanga and Ambali (2017) women utilising metal silo experiences losses of grain in storage, some in Makoni district have lost buckets ranging from 4 to 15 buckets (of their 1 tonne stock) due to inability to tie the silos properly.

> "I threw away 15 buckets (approximately 300kg) of maize from the silo. This was the remaining grain which was now rotting in the silo after l had used of it. The first time we used the silo, we never lost a single bucket so l suspect that l was not able to tie the opening of the silo tightly especially that l was left alone after my husband had gone to work". Female farmer in Makoni district utilising metal silo.

Safe storage moisture determination: Tefera *et al*. (2011), states that, for cereals to be stored safely in a metal silo, the grain must be dried to a moisture content of less than 14% to limit mould formation and cereals rotting. This precaution before storage is a challenge to most women rural as most of them do not have moisture meters to precisely determine maize moisture before storing grains in metal silo storage structure. Since, most of small holder farmers in Zimbabwe and even in Africa depend on traditional methods of testing grain dryness by touching with hand, breaking some of the grains and observing it by their eyes and some do salt test, in which the hygroscopic properties of salt are used to determine the moisture content of grains (Yusuf and He, 2011; Kimatu *et al.*, 2012). If drying is insufficient, the whole stock could be lost (FAO, 2015a).

Size, shape and weight of metal silo: According to SDC (2015a), women in Kenya are facing challenges on size, shape and weight of metal silo. Some women have suggested that a variety of sizes from 1 bag to 6 bags capacity should be fabricated to store maize and other different metal silo sizes to be used to store other household consumptions like groundnuts. Some suggested that the metal silo should not be one unit but should have different chambers to help determine amount used or remaining. This size issue was in line with suggestions by Bokusheva *et al*. (2012), the favourable capacities of metal silos are 550 kg and 820 kg for most families in developing countries, which corresponds to the annual grain consumption of an average family of 5-6 members.

Height of larger capacity metal silo: SDC (2015a), women in Kenya complained that the 10 bags capacity silo is too tall to load grain. One has to use a stool or call for male assistance to load tall metal silo and this, they thought it is insensitive to women adopters and utilises. They suggest that, the silo should be made shorter and wider rather than thin and tall as is it currently, for easy access and be placed on raised surface for easy access to the opening and removal of grain (SDC, 2015a). In Malawi studies by SDC (2015c), unmasked gender concerns regarding technical design (size and height) of the metal silos. Women farmers find the metal silo too high for comfortable loading of grain and too heavy to be carried. Instead, women in Malawi SDC (2015c) prefer relatively lighter and shorter designs of metal silos than the one firstly introduced in 2012 by government and CIMMYT in most parts. However, FAO/WB (2010), suggested that provision of mobile storage might be a solution to grains postharvest losses problem. FAO/WB (2010), suggest a metal silo design with four wheels, square metal frame-stand with supports of metal-angles, columns, bars and ring beams to replace currently fixed metal silo. However, challenges concerning metal silo size, height,

loading problem and suggestion on mobile metal silo are yet to be reviewed in Zimbabwe to determine any concerns in the utilisation of metal silo.

Installation of larger size metal silo in doors: Hodges and Stathers (2015), reported that, some women raised concern with 3 tonne size, the metal silo size is too enormous to fit in the house, hence, need to be located in the shade either inside the house or in a special shelter outside house, this adds to the costs to the farmer

Security of metal silo on the shade outdoors: Hodges and Stathers (2015), reported that, metal silos on the shade outside house need padlock or fastening facility at both grain-inlet and outlet. This improves the security and prevents the grain from children's reach or stealing. The current utilised metal silo in Zimbabwe does not have padlock or fastening facility, hence a challenge in utilising the metal silo.

Lack of compartments to store other grains: SDC (2015b) reported that women in Shamva district of Zimbabwe complained that they faced challenges with the utilisation of metal silo as it is not compartmentalized. As a result, men have monopolised the use of the metal silo for maize, while women's crops such as groundnuts are stored in the traditional granary.

Storage of enough grain reserves in the metal silo: SDC (2015b) reported that, women in Shamva district reported that the metal silo was too small to accommodate household grain reserves. On average most households, both male and female headed reported that metal silos store an average of between one and two tonnes; hence a silo which accommodates only a tonne cannot benefit them much as they would still need to go back to the traditional granary to store surplus maize.

Monitoring maize grain inside metal silo: SDC (2015a), states that, women in Kenya faces challenges in monitoring what happens inside once maize grain is store, hence suggest need of a window from which one can look through to monitor the maize, check whether it is safe and not rotting or already sold out. Quality control is difficult once grain is store (Hodges and Stathers, 2015).

Outlet of the metal silo: SDC (2015a), states that, women in Kenya faces a challenge on outlet of the silo hence suggested that the opening to have a tap that open and close easily, safely and controllably. They suggest the inside of the bottom part to be slanted so that when grains are about to finish, they can just flow through once the tap is opened instead of one having to insert their hands and scoop them out. Other suggested making the inlet and outlet

of the silos tighter in order to avoid air getting into the silos and causing the grain to rot. The grain near the silo bottom is not easy to withdraw, unless someone gets into the silo (Hodges and Stathers, 2015).

Complete discharge of maize grain in the metal silo: Yusuf and He (2011), suggested that, mobile metal silo design, should have top and bottom concentric hoppers truncated with cones, as metal silos concentric hoppers enhance discharge by pressure due to gravity. Grain in the bottom metal silo cannot be completely discharged without tilting or lifting one end of the silo. This causes the silo to buckle, crack and twist, deflect or bent-in from the bottom (Yusuf and He, 2011). The grain that remains at the bottom after discharging is complete or during cleaning, harbour pathogens and pests that will infest new grain loaded rendering the metal silo ineffective leading to losses.

2.1.2 The women's perceptions in the utilisation of metal silo technology

The following section of the chapter gives a literature review analysis of women's perceptions using KAP framework analysis in the utilisation of metal silo technology by different research studies.

2.1.2.1 KAP framework analysis

The Knowledge, Attitude and Practice (KAP) paradigm provides a good framework for measuring the women's perception in the utilisation of a metal silo. The KAP survey was developed in the 50's and was originally designed to research family planning in the Third World (Ntawuruhunga, 2016). There are three different objectives of KAP studies. The first objective is to assess KAP towards a concept. The second objective is to use it for problem identification and intervention planning. Thirdly KAP studies can be used as an evaluation tool (Vandamme, 2009)

KAP surveys can be used as a tool for problem identification and intervention planning. Furthermore, KAP surveys are most widely used studies for uncovering societal context specific dynamics. I-SAPS (2007), states that, the KAP exercise help identify and analyse the gaps between women's perceptions and metal silo technology in any given community. In this study therefore for a community or women to utilise metal silo for maize grain storage purposes (P), they should be knowledgeable about the benefits of the metal silo storage structure (K) over the traditional storage they commonly use. Knowledge of the metal silo over traditional in turn should instil in the community or the women the right attitude (A)

towards the metal silo, which attitude should enhance the uptake and utilisation of metal silo as maize grain storage structure.

Muleme *et al.*, (2017), states that, knowledge, attitude and practice studies fundamentally assume a linear association between knowledge, attitude and practices. Lusiba *et al.*, (2016), argues that adoption and subsequent utilisation of technologies is strongly linked to perceptions. In the theory of planned behaviour, Ajzen (1991) argued that farmers' behavioural intentions (decision to take up technology and utilize) is dependent on perceptions in form of attitude towards the behaviour, subjective norms and behavioural control beliefs. Moreover, a KAP survey is generally used to identify and describe critical elements, negative attitudes and reasons for non-adoption of a recommended technology (Ntawuruhunga, 2016).

2.1.2.2 Knowledge in the utilisation of metal silo technology

According to SDC (2015a), farmers in Kenya who have adopted and utilise the metal silo technology and have seen the benefits of technology over traditional storage methods. The farmers agree that the stored grains are fully protected from rats, weevils and termite attack and cannot allow water to sip through the grain. Hence metal silos serves as a long term measure for food security, reduces postharvest grain loss and helps avert hunger in the households and also in the community.

SDC (2015b) reported that, communities in Shamva district (Zimbabwe), view metal silo storage technology as a durable and maize stored, is kept clean and in its natural state for a long time. Kumar and Kalita (2017) reported that, in developing countries, communities perceive metal silos to be an economic alternative, as the cost per unit of grains decreases with increases in the size of silos. Kumar and Kalita (2017) reported that, the maintenance cost is very low in the case of silos, which can compensate for the high initial cost to some extent.

According to Nyanag and Ambali (2017), the technology offered security against grain pilferage and also reduced conflict emanating from sourcing and application of chemical protective to the stored grain. Farmers estimated that they are saving $40 to $120 per year (i.e. when multiplied by the maximum number frequency of application per year) by storing maize grain in hermetic technology, which is use for purchasing chemicals protectants (Nyanga and Ambali, 2017).

SDC (2015b) reported that, both men and women in Shamva district, recommended that the metal silo ought to be sold at an affordable price so that everyone can purchase the metal silo. Furthermore, there should be different payment terms including use of crops for payment for the metal silos. Maonga *et al*. (2013) reported that, the metal silo cost issue remains highly contentious and prohibitive to average smallholder farmers in Malawi, as farmers perceive they could not effectively demand and purchase the metal silo as they found it relatively more expensive than traditional storage structures.

The grain stored in the technology was of high quality and would sell at a higher price, for example, in Shamva district, during the 2016 harvesting season, grain from hermetic vessels traded at plus or minus $USD7.00 while that from conventional storage vessels traded at plus or minus $USD4.00 (Nyanga and Ambali, 2017).

Maonga *et al*. (2013), reported that, on cost-effectiveness, farmers perceived metal silo technology as cheaper in the long-run, as it does not require pesticides during future usage as most living organisms inside the silo are suffocated and die. This saves money on pesticides and there is no need for bags, hence another cost-saving measure. Farmers view metal silo technology as long-lasting investment, hence exempt farmers from incurring huge sums of short-run variables costs common with traditional storage methods.

2.1.2.3 Attitudes in the utilisation of metal silo

SDC (2015a) reported that women viewed the silo as a symbol of prestige in the community (for women) due to its shiny and imposing nature.

SDC (2015b) reported that, the technology saves on money because no chemicals are applied and farmers' health status has improved because they no longer use chemicals to dust the maize and neither do they consume food that is contaminated by the use of pesticides. Kumar and Kalita (2017), reported that same communities perceive the technology as labour saving as previously used labour in mid-storage grain retrievals to re-apply chemicals is saved. SDC (2015b) reported that, women in Shamva district (Zimbabwe) perceive the metal silo as promoting health and hygiene benefits. This is because no chemicals are applied on the grains and entry into the silos to retrieve grain is not necessary

Maonga *et al*. (2013) states that, long-term grain storage was perceived to help farmers and the communities at large to avert hunger as metal silos serve as bulk store for maize grain that

helps people in the communities to buy food when stocks run out of food during critical food lean periods.

Maonga *et al*. (2013) reported that, farmers perceive metal silo technology as environmentally friendly, as it help to preserve trees and grass since the technology does not require intensive use of forestry products. Hence, the technology has potential to contribute to environmental conservation efforts.

According to Maonga *et al*. (2013), farmers in Malawi perceived metal silos as a technology that is more effective, more expensive and more secure than other storage methods but having many benefits over the traditional storage methods. The perceived benefits of metal silo include full protection of grain against pests, water moisture, fire and as well as potential theft.

2.1.2.4 Practices in the utilisation of metal silo.

Nyanga and Ambali (2017) reported that, in Zimbabwe Shamva and Makoni districts communities, due to utilisation of hermetic technology, there was a shift of roles which men play in the storage and management of grain, which in a way was reducing women's drudgery. They reported that women might be losing ownership of the dura (maize granary with its contents) due to the introduction of the hermetic technology yet traditionally dura is owned by women. Ownership of the hermetic technology is a contentious issue that could affect adoption and utilisation of the technology in the communities (Nyanga and Ambali, 2017). Hence, the introduction of the hermetic technology heralded positive change in gender relations including spouses in terms of decision making and workload sharing related to the maize value chain.

Nyanag and Ambali (2017) reported that, in Shamva and Makoni districts, the hermetic technology increased the grain processing time as it had to be hand shelled, the perceived benefits by the farmers seemed to outweigh the perceived costs as health effects from consumption of agrochemicals and the winnowing labour are presumed to be eliminated. The technology is viewed as the most ideal to manage and resolve the problems of postharvest losses caused by aflatoxin contamination (Nyanga and Ambali, 2017).

> "We no longer eat contaminated grain, those fumigation pills we used before the hermetic technology are dangerous, but we had no choice as we had no alternative

effective grain storage technology. At times we would use the grain before the effects of the fumigation pill expired." Female hermetic silo beneficiary (Shamva Ward 3).

According to Nyanga and Ambali (2017), although the technology is viewed as labour saving, it is worth determining whose labour is saved and at what point during the crop value chain. During the utilisation of metal silo, an increase of 7.1% in cooperation between spouses in drying the maize was reported and it was men's drudgery that was reduced (Nyanga and Ambali, 2017). Furthermore, a decrease of 2.1%, 5.4%, 25.3% and 4.1% in the number of women carrying out activities such as shelling, winnowing, applying protectants and loading grain respectively (Nyanga and Ambali, 2017). Men's drudgery is mainly reduced in shelling and drying. The reduction in both men and women's drudgery is attributed to sharing of the tasks among men and women in the utilisation of metal silo (Nyanga and Ambali, 2017).

Nyanga and Ambali (2017) reported that, in terms of applying grain protectants, both men and women have workload reduced as the technology does not require protectants application. Winnowing, task mainly done by women, is reduced due to hand shelling which results in less chaff being introduced to the grain. (Nyanga and Ambali, 2017). The technology reduces women and men's drudgery in management of the grain during storage as there is no repeated winnowing and applying of grain protectants as compared to conventional storage facilities. The farmers pointed that grain remain clean throughout storage period and do not have to winnow it for milling (Nyanga and Ambali, 2017).

Mwebaze and Mugisha, (2011) reported that, farmers perceive using the improved postharvest technologies as beneficial, as they are able to store maize for much longer periods and obtain off-season prices, which are significantly higher than at harvest.

SDC (2015a) reported that, in Kenya, male farmers reported that they no longer have to buy pesticides or bags to store the maize and therefore in the long run using metal silos. The technology saves money and increase maize enterprise profits as they are now able to sell maize when prices are good. Maonga *et al*. (2013) also reported that, farmers view metal silo as beneficial in terms offering long-term storage of grain for food security and for better market prices as it enable farmers to sell their grain at high prices during the lean months. This help to increase and spread farm household income over the year. If the technology is well managed storage of grain in the metal silo is perceived to have potential to improve food security and farm income at household level. Metal silo technology help to maintain quality

of the stored grain over a relatively longer period of time, as such the grain attracts competitive prices during the time of sale.

In addition to that, the hermetic technology study in Makoni and Shamva districts by Nyanga and Ambali (2017) farmers perceived technology relevant in reducing postharvest physical and economic grain losses. The postharvest grain losses from traditional and conventional storage practices increased the levels of household food insecurity. The technology hindered the chances of household to bridge the gap between the previous harvest and the next. Farmers revealed that during the lean season, farmers still had enough quality grain in stock which was not the case before acquisition of hermetic storage technology (Nyanga and Ambali, 2017).

According to Nyanga and Ambali (2017), the technology have long term benefits such as reduction in grain weight loss caused by insect feeding thus maintain quality and quantity of the grain. The Nyanga and Ambali (2017) indicates that adult insect mortality can reach up to 98% after just one month of storage in metal silo due to creation of low oxygen environment that reduces development of stored grain insects (Williams *et al*., 2014).

2.1.2.5 Perceived areas of improvement on the metal silo by some communities.

However, communities in Kenya and Malawi perceive that according to SDC (2015a) and SDC (2015c)), metal silo needs improvement to be done on:

1.) Size, shape and weight of silo. Farmers suggested that different sizes of silos should be fabricated from 1 bag capacity to fit inside house, not only 10 to 20 bags capacity. Women prefer a variety of sizes from 1 bag to 6 bags and different capacities should be fabricated for storage of different grains and other products like flour. Women suggested that the metal silo should not be too tall as they face problems in loading grain for storage. The silo should be made shorter and wider rather than thin and tall as it is currently, for easy access without assistance. Same views were echoed by Malawian women, SDC (2015c) who preferred a design flexible in size and its capacity to suit farmer demand.
2.) Metal silos with locking systems and transparent window for monitoring. Most men in Kenya suggested a lockable metal silo for increased control and access to the grain, whilst women in Malawi preferred a provision for locks for security reasons. Women in Malawi and Kenya suggested they faces difficulties in monitoring what happens inside silo once grain is stored, hence metal silo should have windows or transparent

section for monitoring and checking whether grain is safe and not rotting or already sold out.

3.) Improving the strength of the metal silos and other packages. Most men felt that the metal sheet used to make metal silo is very light and easily damaged hence need to use thicker iron sheet.

4.) Metal silo outlet. Both men and women want the opening at the bottom to be a tap so that it can open and close easily, safely and controllably and the inside of the bottom part to be slanted to hence just flow through once the tap is opened instead of inserting hand inside and scoop grain out, whilst in Malawi, women preferred stand/legs or raised outlet on the metal silo for easy retrieval of the grain.

2.1.3 The socio economic, cultural and institutional factors determining women's roles in the utilisation of a metal silo.

The following section of the chapter gives a literature review analysis of socio-economic, cultural and institutional factors determining women's roles in the utilisation of metal silo by different research studies.

2.1.3.1 Socio economic factors determining women's roles of women in utilisation of a metal silo

Division of labour: SDC (2015a) reported that, in Kenya, division of labour is affected by individual farm household characteristic, levels of income, access to technology and appropriateness of the specific technology.

Income/financial capabilities: Higher income leads to high investment in postharvest management and thus reduces technology gap. This was supported by Maonga *et al*. (2013) and Bocquého*et al*. (2011), farmers with larger financial capabilities are considered to be more prone to technology utilisation and who does what role during the usage of technology.HELVETAS and ANSAF (2016) reported that, income is one of the factors that affect utilisation of improved storage structures and even determine the gender roles during the utilisation of storage structure. Bocquého*et al*. (2011) reported that, technology which tends to entail large financial obligations, more risk averse farmers are expected to be more reluctant to adopt and utilisation the technology and even determine who does what during the usage of the technology. The farmers tend to be more sensitive to the uncertainty relative to their total income rather than the uncertainty relative to the income from the new technology.

Household size: Household size as a single entity influences thoughts and actions of the individual members and it has great influence on roles during technology utilisation. Maonga *et al*. (2013) reported that, household size determine gender roles in the utilisation of metal silo on the bases that, larger household size avail enough family labour compared to smaller household size where family labour is in shortage supply hence no gender division of labour. Rugumamu (2009) reported that, in smallholder crop production, women are involved in postharvest activities than men. Further, dryness of grains is assessed and determined by women who crash the grains with teeth. Women also possess the art and science of holding and shaking reed-woven trays of different sizes while capitalizing on wind speed and direction for efficiency of the activity.

Household resources: Mwebaze and Mugisha (2011) state that, availability of household resources has a significant effect to the use and determination of gender roles in the utilisation of the improved postharvest technologies.

Farmer's education: Education is considered as a process of producing the desired changes in the behaviour of the people. Education in a society is a primary condition for its socio-economic development. Formal education of individual's play an important role in shaping attitude towards technology utilisation as it helps in interpreting about an idea. Mwebaze and Mugisha (2011) stipulated that, farmers with more education acquire more knowledge of improved farming methods and are likely to use new technology more rapidly without consideration of gender roles in the utilisation of new technology. Maonga *et al*. (2013) reported that, education has a positively affect in determination of gender roles in the utilisation of metal silo storage structure on the bases that educated farmers understand better the essence of working together and labour sharing within the household. These farmers stand a better chance of exposure to new information and appreciate the importance of gender equality through improved understanding.

Socio-economic changes: According to Manda and Mvumi (2010), gender roles and responsibilities on stored maize grain are influenced by socio-economic and technological changes. The interaction of socio-economic factors determining women's roles and metal silo utilisation in Makoni district has not been explored and this has necessitated this current evaluation.

2.1.3.2 Cultural factors determining women's roles in the utilisation of metal silo

Cultural specific roles: SDC (2015a) reported that, in Kenya, division of labour is culturally-specific, hence, in the absence of male-heads of households, women perform all the other tasks traditionally done by men in the postharvest management of maize grain in communities. Among the Maasai and Kalenjin ethnic groups, women perform all the tasks related to postharvest activities related to utilisation of metal silo, while among the Agikuyu, Luyhia, Luo, Kisii and Kamba ethic groups, the division of labour in utilisation of metal silo postharvest activities are performed by men and women.

Availability of norms and social hierarchy: Mikalitsa (2010) reported that, in Kenya, there are various factors that determine division of labour within the household. These can either be constraints of opportunities for the households in terms of household provisioning mechanisms. Community norms, social hierarchy and social factors are constraints due to the way they discriminate women in various aspects such as ownership of productive resources and their designation of gender roles (Mikalitsa, 2010).

Gender norms: Gender norms about men's control of technology, information and knowledge limit women's opportunity to learn, use and benefit from technologies (FAO, 2015). There is a wide range of social norms that inhibits women from accessing and adopting technology, certain technologies or practices may not be considered suitable for them (FAO, 2015)

Cultural context: SDC (2015b) reported that, technology development like metal silo needs to be embedded and be informed by the cultural context in which it is to be used. As from Shamva district, impacts of introduction of improved postharvest management technology in terms of women's access and control of grain differs across ethnic groups (Korekore and Zezuru).

Cultural beliefs: Manda and Mvumi (2010) reported that, cultural beliefs have a strong influence in crop processing in Zimbabwe. For example in Tonga culture, traditional beer for rituals is only brewed by elderly post-menopausal women and young girls. Dzingai and Bourdillon (1998) also reported similar studies that, in Shona culture the elderly post-menopausal women and young girls are involved in grain withdrawal and in initiating threshing of small grains because it is believed that if done by other people, the grain quantities would mysteriously diminish. Maonga *et al*. (2013) reported that, culturally, women and men within a household, play different roles on the farm and maize grain

postharvest management utilisation of storage structures. In Malawi, field observations revealed that men are concerned with management of cash enterprises on the farm while women take care of household food security issues, hence, this cultural belief determine gender roles in the utilisation of metal silo.

Own and control of technologies: SDC (2015c) reported that, in Malawi, the implication for technology adoption is that, while women are expected to adopt, own and control improved technologies such as metal silos, the cultural changes in that country are skewed in favour of men through the rights and privileges that bestowed by patriarchy. Again, SDC (2015c) a metal silo occupies a precious space in a household asset economy in the Chitengwa communities of Mchinji and Lilongwe districts. Hence, men own and control big household assets like metal silos in the home. In Zimbabwe, culturally, the traditional granary is owed by women, however, because of the value embedded in the hermetic silo, men automatically assumed ownership (Nyanga and Ambali, 2017).

Marital status: Maonga *et al*. (2013) reported that, issues of marital status determine the gender roles in utilisation of new storage structures like metal silo, as it is known culturally that there are certain tasks customarily done by men in a male headed household and all these tasks will be all done by women in a female headed household.

2.1.3.3 Institutional factors determining women's roles in the utilisation of metal silo

Roles of institutions: The role of institutions is to educate and raise awareness on gender roles in the utilisation of metal silo in the communities and rests ultimately with the field extension worker, whether they are government employees or members of (NGOs) (FAO, 2008). Maonga *et al*. (2013) reported that, sometimes government and institutional organisations like NGOs play a beginning role in determining roles of individuals within the household during the utilisation of new storage structure like metal silo in the communities. Government and NGOs support smallholder farmers to improve gender roles, adoption and utilisation of agricultural technologies by making the technical innovations and their complementary inputs more easily accessible and cheaply available to farmers. Mwebaze and Mugisha, (2011) reported that, institutional factors influence utilisation of the improved postharvest technology, hence determine and influence gender roles in the utilisation of metal silo storage structure.

Awareness: The best way to increase gender equality in technology utilisation in the communities is through increase of awareness among the women and men on the roles they

play within the household. Hence, extension agents, NGO agents, local leadership and focal farmers and other trainers determine the gender roles in the utilisation of metal silo storage structure during the trainings and social interactions in the communities. The view is supported by SDC (2015b); institutions involved in raising awareness of metal silo utilisation should extend on storage for future sale rather than just for consumption. This will enhance the involvement of men in grain storage and make grain storage a household and shared responsibility, rather than a responsibility for women.

Trainings: Training is a process to improve skill, attitude, and knowledge and change attitude in desirable direction. It plays an important role in adoption and utilisation of an innovation. Mikalitsa (2010) states that, institutional structure, legal parameters and training are opportunities for both men and women since they empower both genders in recognizing their rights, roles and provide legal framework through which disadvantaged groups found avenues for redress. According to Bukosheva *et al*. (2012), trainings allow farmers to obtain new knowledge and thus become more aware of possibilities for more efficient utilisation of new technology. Again, training courses present an important communication channel for disseminating information about new technological solutions available on the market.

Farmer gatherings information sharing: According to SDC (2015b), information on gender roles in metal silo and postharvest technology is provided by Agricultural Extension Officers as well as neighbours. Both men and women preferred workshops as well as field days as platforms for sharing information regarding gender roles and postharvest technologies and as well as way of marketing new postharvest storage technologies. These platforms provide for dialogue and direct interface with the technology and farmers can seek clarity on areas that they do not understand unlike other strategies.

Artisan trainings: SDC (2015b) reported that, in Shamva district, artisans received training on business development skills and were expected to market the technology and consider the fabrication of metal silos as a business. However, they did not receive any gender training hence; acknowledging the different needs of men and women in utilising metal silo was a missed marketing opportunity.

Lack of information and knowledge: SDC (2015a) reported that, lack of access to information about the technology or lack of required complementary knowledge and skills to use the technology might influence the gender roles in the utilisation of the new technology. The reasons for women getting less information or extension services or less likely to use or

process the information received is that women often lack mobility, access to transport and funds for participation in meetings, training or demonstration of these technologies.

Access to extension agents: Maonga *et al*. (2013) states that, access to agricultural extension messages have positive influence on technology adoption and utilisation of new storage structure in terms of gender roles during the postharvest season by farmers. The agricultural extension services play a positive role in utilisation and improve farmers' awareness of the available new technologies and the individual roles should play during the utilisation of new storage structure within the household. HELVETAS and ANSAF (2016) reported that, access to extension services beyond production period affect utilisation of improved storage structures and even determine the gender roles in the usage of the improved storage structures. However, FAO (2015) reported that, even if women have equal access to extension services, a lack of complementary knowledge or necessary inputs will restrict their ability to take full advantage of introduced technology.

Access to education and information: SDC (2015b) reported that, women compared to men have less access to education opportunities and mass media and this factors determination of gender roles in the utilisation of new technologies between women and men. Women have less education and less access to extension services, which reduces their chances to gain access to information and the use agricultural technologies and gender roles in the utilisation of new technology (FAO, 2011). Inadequate information about improved agricultural technologies and gender roles is one of the constraints in agriculture. Women do not have adequate access to agricultural information and innovation. These factors also prevent women from adopting and utilising new technologies as readily as men in the performance of their agricultural activities (FAO, 2011). Doss (2003), reported that, farmers should have access to information about improved technologies before they can adopt and utilise them.

Gender sensitivity: SDC (2015b) states that, development and promotion of the metal silo utilisation requires gender sensitivity in the part of the artisans, as it is important that gender training be mainstreamed in the artisans training programme. Gender training may enable artisans to understand different roles played by men and women farmers, design preferences for both men and women and potential strategies for targeting the technologies.

Extension trainings and visits: Mwebaze and Mugisha, (2011) states that, institutional training courses and extension visits positively influence technology use, hence, more intense extension approach increase technology adoption, utilisation and gender roles determination

in the use of new storage technologies. Extension trainings on postharvest helps the women not only to acquire detail knowledge about agricultural technology, but also help them to solve their problems by offering alternative solutions.

Farmer's neighbours: Mwebaze and Mugisha, (2011) reported that, farmers with neighbours who adopt and utilisation the new technology, and those with higher levels of social capital accumulate more information and utilise technology much faster without determining the gender roles during the utilisation.

Media: Leewis (2004) categories conventional media according to four dominant channels: mainly textual e.g. newspapers, farm journals and flyers; auditory e.g. radio and cassettes; mainly visual e.g. posters; and combinations e.g. audio visual and television. These can reach large audiences rapidly, create knowledge and spread information and lead to changes in weakly held attitudes leading to determination of women's roles in the utilisation of new technologies. The mass media exposure helps women to gain general awareness as well as provides scientific and technical information. It plays an important role to develop their performance in the utilisation of new technology and economic activities in which they get involved in postharvest management. In general, it appears that the interaction of institutional factors determining women's roles and metal silo utilisation in Makoni District is not well documented.

2.2 Conceptual framework

In this study, the Theory of Constraints (TOC) provided by Goldratt (1992) was used as a framework to guide the conceptual statement. Goldratt's Theory of Constraints focuses on efficiency of all the processes as a whole rather than the efficiency of any one single process. The attainment of food security and increased income status of smallholder farmers in Zimbabwe, Makoni district should not only focus on increased production and productivity, and ignore postharvest management practices that reduce postharvest losses estimated at 20-38%, valued at 4 billion dollars annually in SSA. The food system (field to fork) as a whole system should function efficiently to enhance food security and reduce postharvest losses rather than focusing on the efficiency of production only, the single process.

In the TOC, a given group of processes will have a weakest link and the weakest link controls the entire systems production rate. In SSA, including Zimbabwe, storage structures being

utilised by smallholder farmers have failed to guarantee complete grain protection against storage pests and moulds infestation during storage, leading to a very high order of postharvest losses due to storage pests losses. The storage structure in Makoni district is the weakest link and the (storage structure) weakest link controls the entire system to attainment of food security and increased income level of the farmers.

According to TOC, in order to maximise the system production, the weakest link must be improved and all other links in the processes regulated to the speed of the weakest link. The weakest link is the constraint and all steps must be examined together to determine the constraint, the core problem for termination. As a measure to reduce postharvest losses due to storage pests and moulds infestation, and enhance food security and increased income level in the Makoni district, CIMMYT, ACF and INSPIRE, the NGOs, introduced metal silo technology as pilot projects for grain storage. The rate of metal silo adoption by smallholder farmers in the district is very low. This low rate of adoption of a metal silo might emanate from challenges in the utilisation of the new technology.

Women are more involved in postharvest management activities compared to men (Mvumi *et al*., 2017). At household level, women play a predominant role in household food security, and they account for between 60 to 80% of household food production in SSA (FAO, 1997). Challenges in the utilisation of any postharvest storage technology affect women most, hence, this study aim evaluate the women's challenges in the utilisation of a metal silo as a maize grain storage structure in Makoni district. Following TOC, this conceptual framework consist of three models that are interrelated: women's challenges, women's perceptions and factors determining role of women in the utilisation of a metal silo as a maize grain storage structure. The three models are the steps to be examined together to determine why smallholder farmers still experience high order of postharvest losses whilst prove effective storage structure like metal silo have been fabricated and availed to farmers to adopt and utilise to reduce postharvest losses for the attainment of food security at household level in the district. These three models are the constraints assumed to influence the low rate of uptake of effective metal silo technology storage among the smallholder farmers to reduce postharvest losses leading to improved food security, increased income level and reduced poverty in Makoni district.

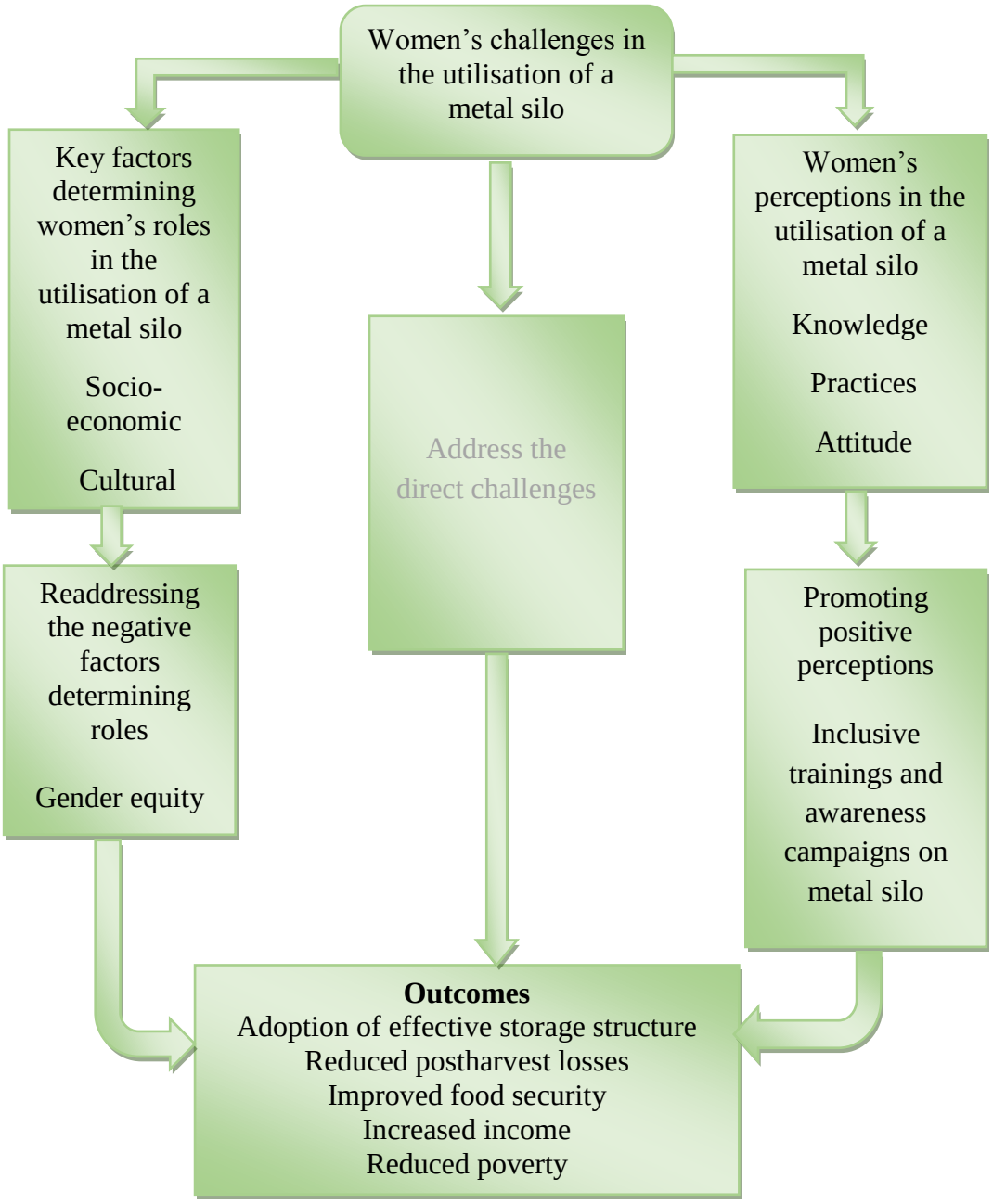


Figure 2.1: Conceptual Framework explaining women's challenges, factors determining women's roles and women's perceptions in the utilisation of a metal silo.

2.3 Summary of literature Review

The chapter commenced with theoretical and empirical literature review on research studies regarding women's challenges in the utilisation of maize metal silo storage structure. The scholars revealed that there are different challenges associated with women during the adoption and utilisation of a metal silo. The challenges range from technical, social, economic and institutional aspects. These challenges are experienced by women in all

communities where metal silo is utilised as a maize grain storage structure. Experienced challenges in the utilisation of a new technology designed to solve farmers' problems deter them from adoption and utilisation of such technology. Limited studies have been done to identify these challenges in the context of Makoni District.

The studies by scholars reveal that user's perceptions on the new technology such as a metal silo is hinged on knowledge, practices and attitudes. Adoption and subsequent utilisation of a technology is strongly linked to perceptions of the user. Therefore, understanding user's perceptions regarding a given technology is crucial in the generation and diffusion of new technology dissemination intended to solve user's problems.

Finally, the chapter reviewed literature on research studies done regarding socio-economic, cultural and institutional factors determining women's roles in the utilisation of a metal silo as a maize grain storage structure. Literature reveal that there are socio-economic, cultural and institutional factors in every society or community that determine what should be done by women and men with regard to postharvest unitisation of structures based on gender roles. These socially constructed roles in utilisation of postharvest storage structures are usually unequal in terms of power and decision making as well as control over assets and events. The studies review that the socially disadvantaged groups in the society suffer most in terms of gender roles equity and equality due to cultural factors. The institutional factors are the crucial plays in enhancing gender roles equality and equity in the communities. However, precise information on socio-economic, cultural and institutional factors determining women's roles in the utilisation of a metal silo as a maize grain storage structure in Makoni District is scanty. The conceptual framework is presented along with areas to be addressed in the society to reduces postharvest storage losses and enhance food security for households. The next chapter gives a description of the study methodology.

2.4 References

Ajzen, I. (1991). The theory of planned behaviour. Organizational Behaviour and Human Decision Processes 50:179-211.

Bocquého, G., Jacquet, F. and Reynaud, A. (2011). Determinants of miscanthus adoption: an empirical investigation among French Farmers. *Paper submitted to the 5émes Journées de recherché en sciences socials, INRA/SFER/CIRAD, December 8-9, 2011, Dijon, France, 1-42.*

Bokusheva, R., Finger, R., Fischler, M., Berlin, R., Marín, Y., Pérez, F. and Paiz, F. (2012). Factors determining the adoption and impact of a postharvest storage technology. *Food Security, 4, 279–293.*

Cardoso, L., Bartosik, R., Campabadal, C. and De La Torre, D. (2012). Air-Tightness Level in Hermetic Plastic Bags (Silo-Bags) for Different Storage Conditions; Navarro, S., Banks, H. J., Jayas, D. S., Bell, C. H., Eds.; Instituto Nacional de Tecnología Agropecuaria: Balcarce, Spain, 583–589.

Chigoverah, A. A. and Mvumi, B. M. (2016). Efficacy of metal silos and hermetic bags against stored-maize insect pests under simulated smallholder farmer conditions. *Journal StoredProducts Reserves, 69, 179–189.*

Doss, C. R. (2003). Understanding farm level technology adoption: Lessons from CIMMYT's micro surveys in Eastern Africa. CIMMYT Economic Working paper. Mexico, D.F.

Dzingai, V. and Bourdillon, M. F. C. (1998). Religious, ritual, and environmental control in the Zambezi Valley: The case of Binga. Working Paper, Centre for Applied Social Sciences, University of Zimbabwe, Harare, Zimbabwe.

FAO. (2015a).Running out of time. The reduction of women's work burden in agricultural production. Rome, Italy.

FAO. (2015). Technical manual for the construction and use of family-sized metal silos to store cereals and grain legumes. Rome, Italy

FAO. (2011). The State of Food and Agriculture. Women in Agriculture, closing the gender gap for development. Rome, Italy.

FAO. (2008). Household metal silos; key allies in FAO's fight against hunger. Rome, Italy.

FAO. (1997). FAO focus: women and food security. Food and Agriculture organization of the United Nations. Rome, Italy.

FAO/WB. (2010). FAO/World Bank workshop on reducing post-harvest losses in grain supply chains in Africa, FAO Headquarters Rome, Italy 18-19 March 2010.Accessed at http://www.fao.org/fileadmin/user_upload/ags/publications/FAO_WB_ on 10 July 2018

Gitonga, Z., De Groote, H. and Tefera, T. (2015). Metal silo grain storage technology and household food security in Kenya. Journal of Development and Agricultural *Economics Volume. 7(6), 222-230.*

Gitonga, Z. M., De Groote, H., Kassie, M. and Tefera, T. (2013). Impact of metal silos on households' maize storage, storage losses and food security: An application of a propensity score matching. *Food Policy, 43, 44–55.*

Goldratt, E. M. (1992). An Introduction to Theory of Constraints: The Production Approach. Avraham Y. Goldratt Institute.

HELVETAS and ANSAF. (2016). A Study on: Farmers' Access to Postharvest Technologies. Final report (Refined version) Grain Postharvest Loss Prevention (GPLP) Project and Agriculture Non State Actor Forum (ANSAF).

Hodges, R. and Stathers, T. (2015). Summary report on a survey of grain storage options. Natural Resources Institute, University of Greenwich. UK.

I-SAPS, (2007). Gender in Education: Knowledge, Attitude and Practice (KAP) Assessment. Pakistan.

Kimatu, J. N., McConchie, R., Xie, X. and Nguluu, S. N. (2012). The Significant Role of Post-Harvest Management in Farm Management, Aflatoxin Mitigation and Food Security in Sub-Saharan Africa. *Greener Journal of Agricultural Sciences Volume 2, 279 288.*

Kumar, D. and Kalita, P. (2017). Reducing Postharvest Losses during Storage of Grain Crops to Strengthen Food Security in Developing Countries. *Foods, 6, 8.*

Leewis, C. (2004). Communication for rural innovation: rethinking agricultural extension. 3rd ed. Oxford: Blackwell Science in association with CTA.

Lusiba, S. G., Kibwika, P. and Birungi, K. F. (2016). Farmers' perceptions and their implications on the use of rice postharvest handling technologies and practices in Eastern Uganda. *RUFORUM Working Document Series No. 14 (1): 911-919*.

Manandhar, A., Milindi, P. and Shah, A. (2018). An Overview of the Post-Harvest Grain Storage Practices of Smallholder Farmers in Developing Countries. *Agriculture, 8, 57*.

Manda, J. and Mvumi, B. M. (2010). Gender relations in household grain storage management and marketing: the case of Binga District, Zimbabwe. *Agricultural Human Values, 27: 28-103*.

Maonga, B. B., Assa, M. M. and Haraman, E. M. K. (2013). Adoption of small metallic grain silos in Malawi: A farm level cross-sectional study. *International Journal of Development and Sustainability, Volume 2 No. 2, 1534-1548.*

Muleme, J., Kankya, C., Ssempebwa, J., Mazeri, S. and Muwonge, A. (2017). A Framework for Integrating Qualitative and Quantitative Data in Knowledge, Attitude and Practices Studies: A case study of Pesticide Usage in Eastern Uganda. *Frontiers in Public Health 5:318*

Mikalista, S. (2010). Gender -specific constraints affecting technology use and household food security in western province of Kenya. *AJFAND online, Vol. 10, No.4.*

Mwebaze, P. and Mugisha, J. (2011). Adoption, utilisation and economic impacts of improved post-harvest technologies in maize production in Kapchorwa District, Uganda. *International Journal of Postharvest Technology and Innovation, Volume 2, No. 3, 301–327.*

Ndegwa, M. K., De Groote, H., Gitonga, Z. M., Bruce, A.Y. (2016). Effectiveness and economics of hermetic bags for maize storage: Results of a randomized controlled trial in Kenya. *Crop Protection, 90, 17–26.*

Nyanga, L. K. and Ambali, C. P. (2017). Postharvest management technologies for reducing aflatoxin contamination in maize grain and exposure to humans in Zimbabwe. Final Technical Report. Harare, Zimbabwe.

Ntawuruhunga, D. (2016). Farmers' Knowledge, Attitude and Practice towards African Indigenous Vegetables in Kenya. MSc Thesis in Research Methods. Jomo Kenyatta University, Department of Horticulture in the Faculty of Agriculture, Nairobi, Kenya.

Ognakossan, K. E., Tounou, A. K., Lamboni, Y., Hell, K. (2010). Economic analysis of alternative maize storage technologies in Kenya. In Proceedings of the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, 19–23 September 2010; pp. 19–23.

SDC. (2015a). Gender Analysis of Maize Post-Harvest Management in Kenya: A Case Study of Nakuru, Naivasha and Embu Districts.

SDC. (2015b). Gender Analysis of Maize Post-Harvest Management in Zimbabwe: A Case Study of Shamva District

SDC. (2015c). Gender Analysis of Maize Post-Harvest Management in Malawi: A Case Study of Lilongwe and Mchinji districts.

Tefera T., Kanampiu F., De Groote H., Hellin J., Mugo S., Kimenju S., Beyene Y., Boddupalli P. M., Shiferaw B., Banziger M. (2011). The metal silo: An effective grain storage technology for reducing post-harvest insect and pathogen losses in maize while improving smallholder farmers' food security in developing countries. *Crop Protection 30:240-245.*

Vandamme, E. (2009). Concepts and challenges in the use of Knowledge-Attitude-Practice surveys: Literature review. Department of Animal Health, Institute of Tropical Medicine, Antwerpen, Belgium, Unpublished.

Williams, S.B., Baributsa, D. and Woloshuk, C. (2014). Assessing Purdue improved crop storage (PICS) bags to mitigate fungal growth and aflatoxin contamination. *Journal of Stored Products Reserves, 59, 190-196*

World Bank (2009). Gender in Agriculture Sourcebook, Agriculture and Rural Development. Washington, DC– USA.

Yusuf, B. L. and He, Y. (2011). Design, development and techniques for controlling grains post-harvest losses with metal silo for small and medium scale farmers. *African Journal of Biotechnology Volume 10, 14552-14561.*

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter gives an overview of the research methods, which delineates whether the research is quantitative or qualitative. The chapter furthermore explicitly defines the study area, present the research design, as well as the target population and the study unit. It is also made up of sampling methods in terms of the sampling technique, sampling procedures and sample size. Data analysis methods and its framework. The chapter is capped off by presenting the ethical considerations and finally, research methodology summary

3.2 Description of study area/sites

3.2.1 Study site

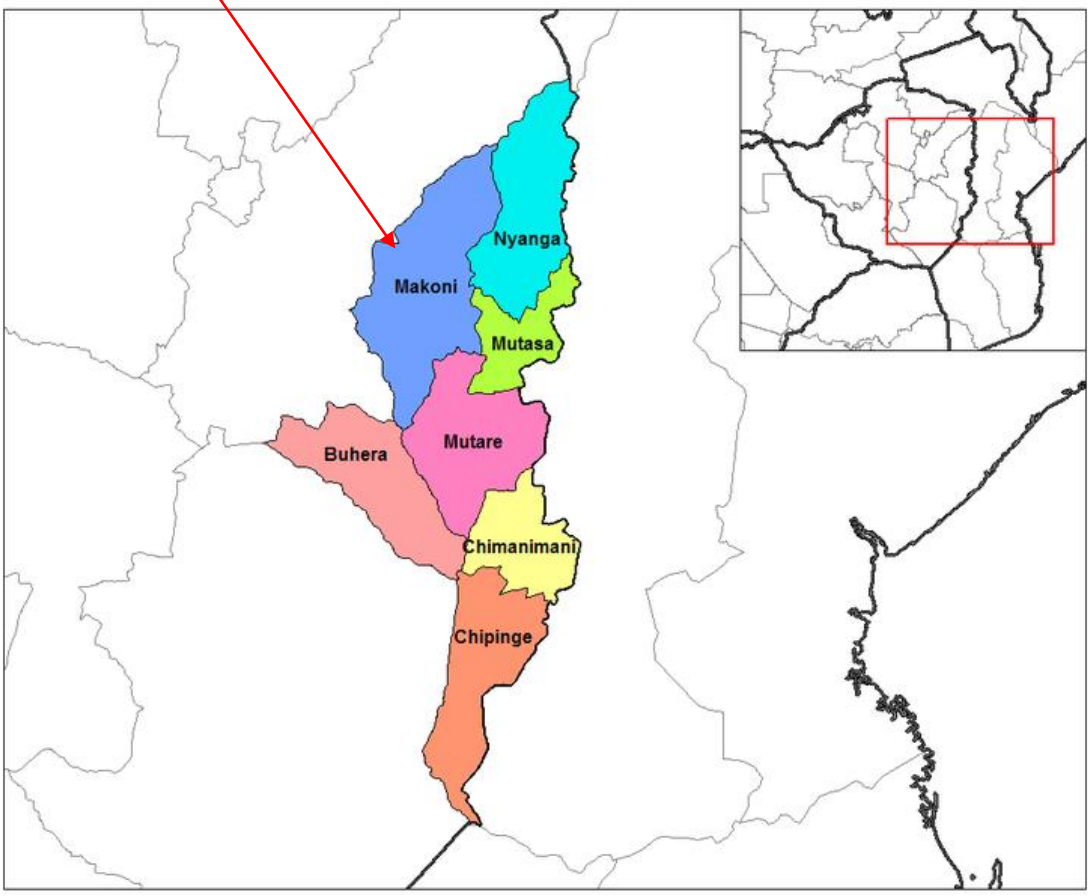
This study was conducted in Makoni district the largest district in Zimbabwe and also largest district in Manicaland province covering a total of 787 050 ha, of which a total of 107 032 Ha is arable land. Makoni district has geographic coordinates of 18º 12´30´´S and 32º48´00´´E located in North-eastern part of Zimbabwe and located in the North-western part of Manicaland Province. The district is located 170 kilometres southeast of Harare, the capital of Zimbabwe. Manicaland is subdivided into seven rural districts which Buhera, Chimanimani, Chipinge, Makoni, Mutare, Mutasa, and Nyanga.

Makoni district's main town is Rusape and has estimated total population of over 300 000 with 52.3% of this being females. In the district, resettlement schemes constitute 42% of the total area, whilst 28-30% is under communal holding. The remainder constitute large scale commercial farms, towns and service centres.

The district has a 70% of the total land lies in high agricultural potential natural farming region II a and II b, 20% lies in natural farming region III and 10% is under natural farming region IV. The district area is defined by its grasslands and a hilly landscape with a tropical climate that is mitigated in high altitude areas. The primary source of income in the district differs as the poor and middle class mainly depend on cash from crop production as a source of income. Major food crops include maize and groundnuts with sorghum and millets mostly

grown in the drier parts of the district and major cash crops include tobacco, potato, cotton, beans, paprika, butter and sunflower. The district receives annual rainfall ranging between 650 mm and 1500mm. The soils are generally granite-derived sands with inherently poor soil fertility. Makoni District on the map below is highlighted in sky blue colour within the Manicaland Province Map.

Makoni District Map.



Source: www.en.wikipedia.org/wiki/Makoni-district

Figure 3.1: Map of Manicaland Province and the districts.

3.3 Research Design

The study employed cross-sectional survey research design to solicit women's challenges, determine women's perceptions and factors determining women's roles in the utilisation of maize metal silo storage structure in Makoni District. A quantitative approach was used. This design involved collection and gathering of data from a specified population (women metal silo beneficiaries) on a specific subject with the intent of generalizing from a sample to a population.

3.4 Target population

The target population of the current study was the small holder farmers who benefited from NGOs metal silo projects and utilizers of metal silo in Makoni district, Manicaland Province. The target population for the current study was 372 metal silo beneficiaries and utilizers of metal silo in Makoni district. This population purposively drawn from the eight wards in the district that benefited from CIMMYT, ACF and INSPIRE projects in the Makoni district.

3.5 Sampling Procedures and Sample Size

Makoni District was purposefully selected based on closeness to the researcher, so as to enhance movement during data collection process. At district level, a purposive sampling method was used to select the wards that benefited from the CIMMYT, ACF and INSPIRE metal silo pilot projects. The working population was the total number of metal silo utilizers in the district wards. At ward level, simple random sampling was used to identify study respondents from the ward lists obtained from district training officer and ward extension officers of farmers utilising metal silos. The formula below was utilised to account for the sample where a probability sampling method is used (Abebe, 2016)

$$n = \frac{N}{1+N^{(e)2}}$$

Where n = sample size; N = population size, 372 in this case and e = degree of precision (95%).

$$n = \frac{372}{1+372(0.05)^2}$$

$$n = 185$$

Table 3.1: Sample Distribution within the 8 wards of Makoni District.

District	Ward	Number of metal silo utilizers	Percentage (%)	Sample size
Makoni	7	42	50.0	21
	9	39	51.3	20
	14	49	49.0	24
	18	45	48.9	22
	19	42	50.0	21
	24	41	48.8	20
	34	59	50.8	30
	35	55	49.1	27
Total		**372**	**49.7**	**185**

Source: District training officer and Ward extension officers, 2018 and author's calculations

3.6 Data collection methods

All data for the three specific objectives were collected and collated using questionnaire. The questionnaire contained questions relating to identification women's of challenges, women's perceptions, and factors determining women's roles in the utilisation of metal silo. It was administered to women only within the households that were utilising metal silo as a storage structure. During administering process, the questionnaire was translated into the local ChiShona language for ease understanding by the household. The questionnaire for data collection was pre-tested before it was used to collect actual data as explained in the subsequent subtitle.

3.6.1 Validity and reliability of survey instrument (questionnaire)

The validity of the questionnaire was tested through expert opinion from the supervisors' guidance and ACF, INSPIRE and Agritex personnel in the district. Furthermore, the researcher, however, referred to literature (journals, books, theses and dissertations) to ascertain how the research instrument meets standards.

3.6.2 Pre-testing

Thirty respondents (metal silo utilizers) were randomly selected from another ward outside the targeted population wards and 30 questionnaires were pretested to identify questionnaire problems. Pre-testing was used in the study to identify flaws in the questionnaire and

determine the time required by a respondent to complete the questionnaire. During pre-testing it was discovered that the questionnaire was too long that it took 30 minutes on one person by 185 respondents to get 93 hours of data collection. Then it was adjusted by removing and rephrasing some questions to take 20 minutes per person by 185 respondents to get 62 hours to complete all the questionnaires for data collection. Some questions on background information were removed like "How frequently to you take grain from your maize metal silo?" and "Who has the responsibility of taking grain from the metal silo?" Some of the questions removed on challenges identification were those questions concerning construction of metal silo shed outdoors and construction of base platform of the metal silo. On determination of women's roles, some of the questions rephrased and jargon improved for women interviewed was "Do Agritex officers trainings determine gender roles in the utilisation of maize metal silo?" to "Do the trainings you receive from Agritex offices state women's roles in metal silo utilisation?" Some of the questions that were found not totally with the objectives and were removed like "Do you receive trainings from NGOs or Government agents on postharvest management of cereal grains?" and "How the metal silo works during maize grain storage. Data analysis using SPSS during pretesting, no information was found missing or found to be irrelevant and removed. After pre-testing the instrument, the researcher and two assistances collected the data.

3.6.3 Identification of women's challenges in the utilisation of metal silo.

A personally administered pre-tested structured questionnaire was used as the main primary tool for data collection. The questionnaire was structured such that it included all the challenges assumed by scholars to be faced by women in the utilisation of metal silo. Personally administered questionnaires were used mainly to take advantage of; high response rate which is associated with the technique as the interviewer will ensure that all questions are answered, high reliability of the data as the interviewer can query to solicit for more data where the information given is vague or need more explanation and finally questionnaire is a cheaper and fast to administer to a rather large population.

The women's challenges in the utilisation of maize metal silo were measured using a 5-point Likert scale ranging from "not a challenge" to "very big challenge". Furthermore, Eta was used to investigate the strength of the association between women's challenges in the utilisation and the identified challenges. The challenge and assigned points are shown in the Table 3.2 below.

Table 3.2: Women's challenges and the 5-point Likert scale ranges

Women's challenges	5-point Likert scale range					Mode	Total
	Not a challenge	A challenge	A minor challenge	A big challenge	A very big challenge		
Availability of artisans for metal silo fabrication within the ward							
Location (place where the artisans stay) of the artisans within the ward.							
Transportation (carrying metal silo) of a metal silo (1-3 tonne) from artisans' location to your homestead.							
Increased postharvest management processing done to grain before storage/loading.							
Determining oxygen and carbon dioxide level within the metal silo.							
Determining the amount of grain used and amount still remaining in the metal silo.							
Experience of grain losses due to grain moisture accumulation, pest infestation and grain rotting in the metal silo due to poor handling of the storage structure							
Determining Grain Moisture Content (MC) before grain loading in the metal silo.							
Installation/fitting a metal silo (1-3 tonne) in the room.							
Thorough cleaning of metal silo before loading new season grain							
Cost of purchasing or acquiring a metal silo.							
Raw materials (e.g. galvanised iron sheets etc.) needed to manufacture/fabricate metal silo at ward level.							
Obtaining subsidy or credit facilities to purchase metal silo at ward level.							
Accessing trainings on how to utilise a metal silo at ward level.							
Compatibility of metal silo size, shape and weight during utilisation with women's activities.							
Lack of compartments within the metal silo structure to store other grains specifically for women.							

3.6.4 Determination of women's perceptions on the utilisation of maize metal silo.

A personally administered pre-tested questionnaire was used to solicit information on the women's perceptions on the utilisation of maize metal silo technology in Makoni district using KAP analysis frame work and Spearman rank correlation was used to evaluate possible associations between knowledge-practices (K-P), knowledge-attitudes (K-A), attitudes-practices (A-P) in determining women's perception on the utilisation of maize metal silo technology in Makoni district.

A total of 17 questions were included in the questionnaire categorized as follows; 6 questions on knowledge determination, 5 questions to characterize attitudes and 6 questions for profiling practices towards metal silo utilisation. The respondent had to answer YES or NO for each variable. YES indicating their acknowledgement of positive perception aspect about metal silo technology and NO indicating the opposite. The following variables in Table 3.3 below were extracted and the number of respondents who said YES for positive perception or NO for negative perception for each variable was recorded as shown in Table 3.3 below. Individuals with a score above 50% for YES were considered as having positive perception about the metal silo technology and individuals with a score less than 50% for NO were considered as having negative perception about the metal silo technology.

Table 3.3: Women's perceptions on the utilisation of the maize metal silo technology

	Women's perception on the technology	
	YES %	NO %
# Knowledge variables		
Know the cost of metal silo?		
Know how metal silo works?		
Know the benefit of metal silo over traditional storage structures?		
Know about grain quality of maize grain stored in a metal silo?		
Know that storing grain in a metal silo has health benefits?		
Know that metal silo is a durable structure?		
AVERAGE		
# Practice variables		
Reduced storage losses?		
Increase in grain sold?		
Reduced storage costs?		
Promotion of health and hygiene?		
Reduced repeated cleaning of grain before use?		
AVERAGE		
# Attitude variables		
Is an effective grain protection technology?		
Is metal silo a labour saving technology?		
It is money saving technology (buying pesticides and packaging bags periodically) in the long term?		
Are there any health benefits in utilising metal silo?		
Technology conserves trees (environmentally friendly)?		
Technology increase wellbeing of household in terms of food security		
AVERAGE		

3.6.5 Socio-economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo.

A personally administered questionnaire was used to solicit information on socio-economic, cultural and institutional factors determining the role of women in the utilisation of maize metal silo in Makoni district. The questionnaire was administered to capture key socio-

economic, cultural and institutional factors determining the role of women in the utilisation of a metal silo as a maize grain storage structure. The socio-economic factors captured were linked to household characteristics; level of income/financial capabilities, household size, household resources, labour availability and level of education. The cultural factors captured included; availability of norms/values, social hierarchy, cultural/traditional believes customs and religion. The institutional factors captured included; effect of government extension service (AGRITEX), NGOs, local leadership, focal farmers, neighbour farmers, trainings, farmers gatherings (field days, workshops and demonstrations) and media (radio and newspapers)

3.7 Organization and implementation of the fieldwork

The study team for data collection comprised of researcher himself and two research assistance degree graduate, Agritex Extension officers working within the study district. The selection of assistance was based on willingness to participate in the research and fluency Shona the local language. Due to financial constrain, no enumerators included in data collection exercise. The research assistances were hypothesised to have broader knowledge of the study district. Consent was first sought from the District Administrator, which is a political office responsible for governing the district. At community level, consent was sought from traditional leaders as well as elected leaders (councillors). Before signing of the consent form, participants were informed about the purpose of the research and were made to understand the nature and purpose of the research for them to consent to participate without coercion.

In this study, participation was voluntary, based on participants' knowledge of research processes and the consequences of such processes on their well-being as well as the freedom to withdraw from the research process.

3.8 Data analysis methods

This section describes the analytic tools to be used in the research project on each objective. As for objective one, firstly, a 5-point Likert scale ranging from "not a challenge" to "very big challenge", followed by descriptive statistics and inferential analysis and lastly, Eta was used to investigate the association of women and identified in the utilisation of maize metal silo storage structure in Makoni district.

On objective two, the KAP framework analysis for women's perception on metal silo technology. Furthermore, Spearman rank correlation was used to evaluate possible associations between knowledge-practices (K-P), knowledge-attitudes (K-A), attitudes-practices (A-P) in determining women's perception on the utilisation of maize metal silo technology storage structure in Makoni district.

Again, as such on objective three, binary regression analysis used to evaluate the socio economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo in Makoni district.

3.8.1 Women's challenges in the utilisation of maize metal silo.

The data that was collected using questionnaire was coded, entered, cleaned and run in Statistical Package for Social Sciences (SPSS Version 20) software and Microsoft Excel 2013 program for analysis. The following specific objective was set in pursuit of the overall objective:

- To identify women's challenges in the utilisation of maize metal silo in Makoni district.

3.8.1.1 Analytic presentation

A 5-point Likert scale analysis, followed by descriptive statistics and Eta test was applied to identify women's challenges in the utilisation of a maize metal silo in Makoni district. A 5-point Likert scale ranging from "not a challenge" to "very big challenge "was used to identify women's major challenges in the utilisation of a metal silo. Again, the descriptive statistics such as mean, followed by use of nonparametric associational statistics Eta used to investigate the strength of the association between women and identified challenges in the utilisation of maize metal silo.

3.8.2 Women's perceptions on the utilisation of a metal silo technology.

The data that was collected using questionnaire was coded, entered, cleaned and run in Statistical Package for Social Sciences (SPSS Version 20) software and Microsoft Excel 2013 program for analysis. The data was used to complete Table on women's perceptions on the utilisation of maize metal silo technology in Makoni district. The process was done in order to accomplish the following specific objective:

- To determine women's perceptions on the utilisation of maize metal silo technology storage structure in Makoni district using the KAP framework.

3.8.2.1 Analytic presentation

A data analysis using counts and frequencies will be carried out on a number of factors to produce a Knowledge, Attitude and Practice (KAP) framework representing the women's perceptions on the utilisation of maize metal silo technology as highlighted in the Table 3.4. Cell count frequencies was used to indicate the percentages of households that answered YES or NO to different perception parameters that included individual's knowledge of a maize metal silo storage structure, the attitude towards the maize metal silo storage structure and the practices carried out during the utilisation of maize metal silo technology storage structure. Furthermore, Spearman rank correlation was used to evaluate possible associations between knowledge-practices (K-P), knowledge-attitudes (K-A), attitudes-practices (A-P) in determining women's perception on the utilisation of maize metal silo technology in Makoni district.

3.7.3 Socio-economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo.

The data that was collected using questionnaire was coded, entered, cleaned and run in Statistical Package for Social Sciences (SPSS Version 20) software and Microsoft Excel 2013 program for analysis. The process was done in order to accomplish the following specific objective:

- To evaluate the socio economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo in Makoni district.

Table 3.4 below is the description and measurement of key variables.

Table 3.4: Description of variables

Item	Description and measurement Type	Expected outcome (+/_)
Factor determining women's role	Binary dependent variable of whether or not factor determine women's role in utilisation, 1=Yes; 0=No	Dependant
Socio-economic factors		
Income	Whether income level/financial capabilities determine the role or not; 1 = Yes, 0 = No	+
Household size	Whether household size determine the role or not; 1= Yes, 0 = No	+
Household resources	Whether household resources determine the role or not; 1 = Yes, 0 = No	+
Labour availability	Whether labour availability determine the role or not; 1 = Yes, 2 = No	+
Education	Whether education level determine the role or not; 1 = Yes, 0 = No	+
Cultural factors		
Norms or values	Whether norms/values determine the role or not; 1 = Yes, 0 = No	-
Social hierarchy	Whether social hierarchy determine the role or not; 1= Yes, 0 = No	-
Culture or traditional beliefs	Whether cultural/traditional believes determine the role or not; 1 = Yes, 0 = No	-
Customs	Whether customs determine the role or not, 1 =Yes, 0 = Not	-
Religion	Whether religion determine the role or not, 1 = Yes, 0 = No	-
Institutional factors		
(Government Extension service, AGRITEX)	Whether AGRITEX trainings determine the role or not; 1 = Yes, 0 = No	+
NGOs	Whether NGOs trainings determine the role or not; 1 = Yes, 0 = No	+
Trainings on postharvest	Whether trainings on postharvest determine the role or not; 1 = Yes, 0 = No	+
Local leadership	Whether local leadership advice determine the role or not; 1 = Yes, 0 = No	-
Focal farmers	Whether focal farmers advice determine the role or not; 1 = Yes, 0 = No	-
Farmer gatherings	Whether farmer gatherings (Field days, workshops and demonstrations) determine the role or not; 1 = Yes, 0 = No	+
Media	Whether media (radio and newspaper) determine the role or not; 1 = Yes, 0 = No	+

3.7.3.1 Mathematical representation of the Binary Logistic Regression model

The parameter of the logistic regression model was estimated with the Maximum Likelihood Estimation (MLE) technique. A binary response function (factors determining women's roles and no factors determining women's roles in the utilisation of metal silo) was specified and estimated by the procedure. The binary logistic regression specification is suited to models where the endogenous variable is dichotomous, which in this case are the socio economic, cultural and institutional factors determining women's roles in the utilisation of metal silo. These factors determining role of women in the utilisation of metal silo were measure using a bid value of one and zero, where one represents factors determining the role of women and zero not determining the role of women. The logistic regression model then provides a model of observing the probability of factor determining the role or not determining the role of women. The binary logistic model adopted from Bigsten and Shimeless (2003), is econometrically specified explicitly as:

$$P_i = F(Z_i) = \frac{1}{1+e^{-(\alpha+\Sigma\beta iXi)}} \quad (1)$$

Where Pi is the probability no factor determining role of women in the utilisation of a metal silo

Xi stands for the 1thexplanatory variable.

α and β are regression parameters to be estimated and e is the base of the natural logarithm.

Furthermore, for simplicity and ease of interpretation of the coefficients, a logistic model could be written in the form of the odds and log of odd. The odds ratio is the ratio of the probability of the no factors determine role of women in the utilisation (1-Pi). Thereby yielding:

$$\left(\frac{Pi}{1-Pi}\right) = e^{Zi_i} \quad (2)$$

Taking the natural logarithm of equation (2) yields

$$In\left(\frac{Pi}{1-Pi}\right) = Z_i = \alpha + \beta_i X_i + \ldots\ldots + \beta_n X_n + E \quad (3)$$

If the disturbance term Ui is taken into account, the logit model becomes:

(4)

Where α and β are parameters of the model and can be estimated using the Maximum Likelihood (ML) method.

Where Z_i = socio economic/cultural/institutional factor determining women's in the utilisation of a metal silo (1 = factor determining the role of women, 0 = no factor determining the role of women) and β_i is the slope of the equation in the model.

3.8 Ethical Considerations

Blanche *et al*. (2009) assert that the purpose of research ethics is to protect the welfare of the research participants. They further argue that research ethics also involve not only the welfare of the informants but extend to areas as scientific misconduct and plagiarism. The nature and purpose of the study and methods of data collection was addressed in detail to all the respondents. The study will follow an informed consent protocol. All the participants will verbally agree to the terms of the study before data collection is undertaken. The respondents will be given the choice to discontinue the process if they feel uncomfortable during the interview. Permission will be obtained for all the photographs to be taken and to electronically record all the interviews. All the interviews will be conducted in a place and time suitable and convenient to the respondents. The moral, ethical and cultural norms of the respondents will be respected. Furthermore, all information to be collected will be handled with confidentiality. No name will appear in the final report and measures will be taken to avoid information to be referred back to any of the respondents.

3.9 Chapter Summary

The chapter has examined the research methodology by first describing the Makoni District study area. Research design, sampling procedures, data collection and data analysis for each of the three objectives were part of the chapter. Additionally, the chapter comprehensively examined the data analysis methods and analytic presentation for each objective in the study. The chapter also focused on the coding, entering, cleaning and processing of data and the statistical packages used to analyse data. Furthermore, the chapter presented the logistic regression analysis used to analyse socio-economic, cultural and institutional factors determining the role of women in the utilisation of maize metal silo in Makoni district. Finally, the chapter examined the reliability of the results.

The next chapter will present and discuss the results of the findings of objective one. The chapter concentrates on the responses of the respondents to the questions in the questionnaires. Descriptive statistics, tables and charts were used to aid the analysis of the data.

3.11 References

Abebe, L. (2016). Determinants of Intra-Household Gender Difference in Access to Agricultural Extension Service on Improved Maize Variety: The Case of Toke Kutaye District, Oromia Regional State, Ethiopia. MSc Thesis. Haramaya University.

Bigsten, A. and Shimeless, A. (2003). Prospects for Pro-poor Growth in Africa, A Paper presented at the WIDER Conference on Inequality, Poverty and Human Wellbeing', Helsinki, Finland, 30-31 May 2003.

Blanche, M. T., Durreheim K., and Painter D. (2009). Research in practise. Republic of South Africa: University of Cape Town Press.

CHAPTER 4

WOMEN'S CHALLENGES IN THE UTILISATION OF MAIZE METAL SILO IN MAKONI DISTRICT

ABSTRACT

Maize grain postharvest storage loss is a challenge in Makoni District. To mitigate the challenge, NGOs in collaboration with Department of Agritex supplied metal silo to women in district. Women face challenges in the utilisation of these new technologies. The objective of the study was to identify women's challenges in the utilisation of maize metal silo storage structure in Makoni District. A purposive sampling was done to select wards that benefited to the CIMMYT, ACF and INSPIRE metal silo projects at district level. At the 8 wards, simple random sampling was done to identify 185 metal silo utilizers from the wards lists. Pre-tested questionnaires were administered to women utilising metal silo from February to March 2019. The data was analysed using descriptive statistics, 5-point Likert Scale ranging from "not a challenge" to "a very big challenge" to identify women's challenges in the utilisation of maize metal silo in Makoni District. The results revealed that, determining of amount of grain consumed and amount of grain remaining in the silo, obtaining subsidy or credit facilities to purchase a metal silo and accessing trainings on metal silo utilisation were identified as challenges for women utilising metal silo in Makoni district. Furthermore, Eta revealed a very strong positive association (eta = 0.892) between challenges and utilizers in Makoni District. Women face challenges in the utilisation of maize metal silo in Makoni District. To boost the utilisation of metal silo and reduce postharvest storage losses, the government and NGOs might train more artisans, design a silo with transparent window, and facilitate loans to purchase the silo, increase trainings of women on metal silo utilisation.

Keywords: Metal silo, Challenges, Likert scale, Utilisation, Storage losses

4.1 Introduction

The food grain production is constrained by failure to recognise women's challenges in postharvest management activities (SOFA Team and Doss, 2011). Agricultural sector worldwide, especially in developing countries is underperforming because women, who are often a crucial resource in agriculture, face constraints that reduce their productivity (SOFA Team and Doss, 2011). Women play key roles in postharvest storage activities through the efficient utilisation of new storage technology structures designed to reduce storage losses in their households leading to achieving food and nutrition security (FANRPAN, 2017; FAO, 2015a and World Bank, 2009).

Postharvest grain losses in developing countries are high due to utilisation of traditional storage structures that are inefficient for the storage and preservation of grain (FAO, 2008). In SSA countries including Zimbabwe, postharvest losses have been estimated to range between 20- 40%, which is highly significant considering the low agricultural productivity in the region. (FAO, 2013). Postharvest losses accounts for direct physical losses and quality losses of grain that reduce the economic value of grain crop and making it unsuitable for human consumption (Kumar and Kalita, 2017).

Makoni District, like most districts in Zimbabwe, maize grain postharvest storage losses is a challenge which leads to food insecurity of many households in the communities (Mvumi *et al*., 2017). To mitigate the challenge, NGOs in collaboration with Department of Agritex supplied metal silo technology a maize grain storage structure to selected households as a pilot project.

At household level, women overseers the grain in storage, keep an eye on the remaining food grain levels and ensure that grain in storage does not have pests (FAO and Mvumi *et al*., 2015). The poor uptake and utilisation of metal silo technology as storage structure might be hinged on women's challenges in the utilisation of the technology. The designers do not take into considerations the needs of socially disadvantaged women (users) of the technology (Affognon *et al*., 2015). Lusiba *et al*., (2016) argued that tailoring the storage technologies in the context of user is paramount for optimal uptake and utilisation of the technology leading to reduction of maize grain postharvest storage losses and subsequent improvement of household food security.

Research efforts in the world over and indeed in Zimbabwe have been expended in the search for effectiveness of the metal silo storage structure compared to traditional storage structures against storage pests with limited studies on users' challenges in the utilisation of the technology. There is, however, scanty knowledge on the women's challenges in the utilisation of a metal silo as a storage structure. The objective of this study is to identify women's challenges in the utilisation of a metal silo technology as a maize grain storage structure in Makoni District.

4.2 Material and Methods

Details regarding the study area and the methodology which encompasses sampling procedures, questionnaire design, methods of data collection and data analysis are described in chapter three. For the purpose of this chapter, only a summary is provided.

4.2.1 Description of study area

The study was conducted in Makoni District in Manicaland Province of Zimbabwe. Details on the description of the study area are given in Chapter three.

4.2.2 Research Design

The study employed mainly survey research design comprising use of individual farmer (beneficiaries and utilizers of metal silo) interviews (IFIs) through use of personally administered questionnaire in the collection of data. Details regarding the research design are given in Section 3.3 of Chapter 3.

4.2.3 Sampling procedure

Randomly selected metal silo beneficiaries and utilizers farmers from eight wards of Makoni District were interviewed by the researcher from February to March 2019. Details regarding the sampling procedure are given in Section 3.5 of Chapter 3.

4.2.4 Data collection procedure

The study employed a personally administered pre-tested questionnaire and observation techniques for data collection through personal interviews from February to March 2019. More details concerning data collection procedure are given in Section 3.6 of Chapter 3.

4.2.5 Data analysis procedure and methods

Descriptive statistics was applied to analyse the background of the sampled households. Furthermore, a 5-point Likert scale ranging from “not a challenge” to “a very big challenge” was applied to identify women’s challenges in the utilisation of a metal silo as maize grain storage structure. Furthermore, nonparametric associational statistics Eta was used to investigate the strength of association between women’s challenges in the utilisation of a silo and identified very big challenges. The structure and details of the 17 assumed challenges on metal silo utilisation are shown on 5-point Likert scale questionnaire given in Section 3.7.1 of Chapter three. More details regarding data analysis method and analytic presentation is given Section 3.9.1

4.2.6 Challenges encountered during data collection

The study encountered challenges during data collection in terms of the spatial distribution of respondents in the Makoni District. Most of the metal silo utilizers and beneficiaries were situated very far apart, some from one corner of the District relative to the other. In that essence, the logistics were particularly limiting. The financial constrain was a challenge again, the spatial distribution added further transport and communication cost which were compounded by time devotion to such endeavours. Hence, the researcher had to use motor bikes to travel long distance.

Some women respondents were not free to interviewed in the absent of their male household heads, hence male households were preferred to be present but were not allowed to respond to the questions. Respondents suspected the researchers were government agents and were afraid that the metal silo would be taken away from them and be allocated to other household as for NGOs metal silo beneficiaries if they divulge many challenges. As such some of the respondents were reluctant to reveal all the challenges they encounter in the utilisations of metal silo. This had negative implications on accuracy of the data collected.

4.3 Results and discussion

4.3.1 Farmers' background information

Table 4.1: Results of respondents background information.

Variables	Sample size (n) = 185			
Respondents	100 % women			
Age range (yrs)	**18 - 30**	**31 – 40**	**41 - 50**	**Above 51**
	17.1 %	17.1 %	28.6 %	37.1 %
Level of Education	**None**	**Primary**	**Secondary**	**Tertiary**
	8.6 %	28.6 %	62.8 %	0 %
Period of metal silo utilisation (yrs)	**> 2**	**2 – 4**	**4 – 6**	**< 6**
	8.6 %	28.6 %	62.8%	0 %
Size of metal silo (kg)	**>500**	**500 – 1000**	**1000 – 3000**	**< 3000**
	0 %	88.6 %	11.4 %	0 %
Amount of maize grain stored after harvest (kg)	**>500**	**500-1000**	**1000-3000**	**<3000**
	26.6%	62.8%	8.6%	2%
NGOs that supplied metal silo	**INSPIRE**	**CIMMYT**	**ACF**	
	17.1 %	42.9 %	40 %	

Source: Field Survey, 2019

The following is the representation of the results of background information of the respondents.

Questionnaire respondents: The Table 4.1 show study results background information of the metal silo beneficiaries in Makoni District. The study targeted 185women farmers utilising metal silo eight wards of the district as the respondents in order to produce valid and

reliable information on the evaluation of women's challenges in the utilisation of a metal silo as a maize grain storage structure in Makoni District. This was in line with FAO and Mvumi *et al*. (2015) and Likhayo *et al*. (2016) who assert that, at household level, women oversee grain in storage and is the main utilizers of on-farm storage structures. However, AfDB (2014) argues that women face many challenges in the utilisation of equipment and structures designed to ease and solve farm problems of postharvest storage losses.

Age range of respondents: the study results on Table 4.1 show that majority of women respondents, metal silo utilizers in Makoni District are age above 51 (37.1%), followed by the age ranged of 41-50 (28.6%). Age range of 18-30 and 31-40 had similar women respondents (17.1%) respectively. The findings mean that majority of the respondents were mature enough to provide reliable information about the challenges in the utilisation of a metal silo. This increased the validity and reliability of the study results. This age range also knows the importance of well storing grain harvested as their have limited means of sourcing grain during food insecurity periods. Elderly and mature women farmers prioritise effective grain storage and reduction of storage losses in order to be food secure throughout the season. This is supported by Gitonga *et al*. (2013), that grain is storage is essential to food security by bridging the period between two harvests.

Level of education: the study results also show that secondary level of education (62.8%) was attained by most of the women respondents. Primary level of education had 28.6% and 8.6% of the respondents had none formal education. This indicates that women in the district have attained formal education hence literate. Mwebaze and Mugisha (2011) support the education of women as it have positive effect in adoption and utilisation of a metal silo technology. Formal education of individual play an important role in shaping attitude towards technology utilisation as it helps in interpreting about an idea. Metal silo technology utilisation requires high skill. This was supported by Manandhar *et al.* (2018), women's challenges in utilisation of metal silo is the high skills required for utilising the technology.

Period of metal silo utilisation: the study results indicate that 62.8% of the respondents have 4-6 years' experience in the utilisation of a metal silo, followed by 2-4 years (28.6%), and lastly less than 2 years (8.6%). No respondents had more than 6 years' experience in the utilisation of a metal silo as maize grain storage structure. The majority of respondents have quiet sufficient experience in utilising metal silo as a storage structure, hence, provided valid

challenges in the utilisation of the storage structure. More years in utilisation could imply more experience and exposure to challenges in the utilisation of the new technology. This increased the validity and reliability of the study results in identifying women's challenges in the utilisation of a metal silo as a maize grain storage structure in the district.

Size/capacity of metal silo: the study results in Table 4.1 show that 88.6% of the respondents indicated that they are commonly utilising 500-1000kg metal silo size and 11.4%, are utilising 1000-3000kg metal silo size. No respondents (0%) have indicated to be utilising less than 500kg size and above 3000kg size metal silo in Makoni District. Failure to obtain respondents utilising metal silo above 3000kg size could limit challenges encountered as Yusuf and He (2011) reported that more challenges are experienced when utilising bigger (above 3000kg). During the utilisation of big size metal silo, grain near the silo bottom is not easy to withdraw unless someone gets into the silo to scoop grain out (Hodges and Stathers, 2015). The commonly utilised metal silo size in Makoni District is in line with findings by Bokusheva *et al*. (2012), who stated that the most favourable capacities of metal silos are 550kg and 820 kg for most families in developing countries which corresponds to the annual grain consumption of an average family of 5-6 members.

Amount of maize grain stored after harvest: the study results indicate that 62.8% of the respondents store maize grain in the amount of 550-1000kg after harvest, followed by 26.6% respondents who store less than 500kg of maize grain, followed by 8.6% respondents who store 8.6% and lastly 2% respondents indicated to store above 3000kg of maize grain after harvest. Amount of maize grain stored after harvest might indicate the yield level per hectare within the district and as well is in line with the metal silo size being commonly utilised by most women in the Makoni District. This also increases the validity and reliability of the study results. The amount of grain stored after harvest might also indicate that most respondents utilise metal silo for storing grain for annual consumption only without extra maize grain for sale during the lean period of the season. This could indicate that women in Makoni District are not taking advantage of the other purpose of utilising metal silo of increasing maize enterprise profits as they are able to sell maize when prices are good and when maize grain will be attracting competitive prices during such time of sale (Maonga *et al*., 2013; Nyanga and Ambali, 2017).

NGOs that supplied metal silo: the study results show that 42.9% of the metal silos in Makoni District were distributed by CIMMYT, followed by 40% distributed by ACF and lastly INSPIRE distributed 17.1%. This indicate that three NGOs were the main distributors of metal silo in the district among the farmers in order to utilise this effective new technology to reduce postharvest storage losses experienced in the district.

4.3.2 Identification of women's challenges in the utilisation of maize metal silo storage structure.

Table 4.2: Results of women's challenges on 5-point Likert scale

Women's challenges in the utilisation of a metal silo as a maize storage	5-point Likert Scale Range										Mode	Totals
	Not a challenge		A challenge		A minor challenge		A big challenge		A very big challenge			n (%)
	n=185	%	n=185	%	n=185	%	N=185	%	n=185	%		
Availability of artisans for metal silo fabrication within the ward.	0	0	16	8.6	26	14.3	69	37.1	74	40	Very big challenge**	185 (100%)
Location (place where the artisans stay) of the artisans within the ward.	0	0	5	2.9	37	20	85	45.7	58	31.4	Big challenge	185 (100%)
Transportation (carrying metal silo) of a metal silo (1-3 tonne) from artisans' location to your homestead.	5	2.9	10	5.7	37	20	74	40	58	31.4	big challenge	185 (100%)
Increased postharvest management processing done to grain before storage/loading.	53	28.5	42	22.9	48	25.7	26	14.3	16	8.6	Not a challenge	185 (100%)
Determining oxygen and carbon dioxide level within the metal silo.	16	8.6	16	8.6	32	17.1	63	34.3	58	31.4	Big challenge	185 (100%)
Determining amount of grain consumed and amount of grain remaining in the metal silo.	0	0	26	14.3	16	8.6	53	28.5	90	48.6	Very big challenge**	185 (100%)
Experience of grain losses due to grain moisture accumulation, pest infestation and grain rotting in the metal silo due to poor handling of the storage structure	43	22.9	5	2.9	53	28.5	26	14.3	58	31.4	Very big challenge	185 (100%)
Determining Grain Moisture Content (MC) before grain loading in the metal silo.	11	5.7	11	5.7	31	17.1	90	48.6	42	22.9	Big challenge	185 (100%)
Installation/fitting a metal silo (1-3 tonne) in the room.	53	28.6	21	11.4	48	25.7	53	28.6	10	5.7	Not a challenge	185 (100%)
Constructing a proper platform (base stand for metal silo) at ward level.	11	5.7	11	5.7	58	31.4	63	34.3	42	22.9	Big challenge	185 (100%)
Thorough cleaning of metal silo before loading new grain	5	2.9	5	2.9	32	17.1	69	37.1	74	40	Very big challenge**	185 (100%)
Cost of purchasing or acquiring a metal silo.	0	0	31	17.1	22	11.5	58	31.4	74	40	Very big challenge**	185 (100%)
Raw materials (e.g. galvanised iron sheets etc.) needed to manufacture/fabricate metal silo at ward level.	0	0	16	8.6	22	11.5	100	54.3	47	25.6	Big challenge	185 (100%)
Obtaining subsidy or credit facilities to purchase metal silo at ward level.	0	0	16	8.6	26	14.3	53	28.6	90	48.5	Very big challenge**	185 (100%)
Accessing trainings on how to utilise a metal silo at ward level.	0	0	0	0	32	17.1	33	17.8	120	65.6	Very big challenge**	185 (100%)
Compatibility of metal silo size, shape and weight during utilisation with women's activities.	10	5.7	16	8.5	32	17.1	85	45.7	42	22.9	Big challenge	185 (100%)
Lack of compartments within the metal silo to store other grains specifically for women.	5	2.9	21	11.4	32	17.1	42	22.9	85	45.7	Very big challenge**	185 (100%)

Source: Field Survey, 2019. Above 40%**frequency was identified as challenges.

Availability of artisans: the study results revealed that 40 % of the respondents agreed to the notion that availability of metal silo artisans for fabrication within the ward is a challenges faced by women in the utilisation of a maize metal silo in Makoni District. The findings are in line with Hodges and Stathers (2015) and SDC (2015c), who reported that there is a shortage of metal silo artisans in most farming communities as given in section 2.1.1 of Chapter two. This could suggest that maize metal silo artisans in Makoni District are not easily found by farmers who wish to adopt and utilise metal silo as a maize grain storage structure. This could mean that government and NGOs recruited and trained very few artisans in the district to spear ahead the utilisation of a metal silo technology

Determining amount of grain consumed and amount of grain remaining in the metal silo: the study results revealed that 48.6% of the respondents agreed that determining amount of grain consumed and amount of grain remaining in the metal silo in a challenge for women in the district. This finding is in line with the findings by SDC (2015a), who reported women in Kenya faces challenges in monitoring what happens inside once maize grain is stored hence need of a window for monitoring and checking whether inside is safe and free from rotting or already complete. Hodges and Stathers (2015), echo similar sentiments that, quality control is difficult once grain is stored as given in section 2.1.1 of Chapter two. The structure is not transparent to monitor and control quality once grain is loaded. Hence, this could suggest the need to keep proper record of amount of grain loaded and balance it with the amount grain off loaded in order to determine amount still remaining for future planning to be grain secure and loading quality grain only.

Thorough cleaning of metal silo before loading new grain: the study results show that 40% of the interviewed women have indicated that the process of thorough cleaning of maize metal silo before loading new grain is a challenge in Makoni District. Yusuf and He (2011) support these findings. The grain that remain at the bottom after discharging is completed or during cleaning, harbour pathogens and pest that will infest new grain loaded rendering the metal silo ineffective leading to losses. Hodges and Stathers (2015), points out that grain near the silo bottom is not easy to withdraw unless someone gets into the silo. Yusuf and He (2011), suggest the new design of metal silo that have bottom that have concentric hoppers truncated with cones to enhance discharge by pressure due to gravity as given in section 2.1.1 of Chapter two. This could suggest the need to prefabricate the design of metal silo to

enhance thorough and complete cleaning of grain left overs in the metal silo in order to render the structure effective storage structure.

Cost of purchasing metal silo: the results reveal that 40% of the interviewed women indicated that, cost of purchasing a metal silo is a challenge in Makoni District. Ndegwa *et al.* (2016), concur with the same sentiments that, although metal silo substantially reduce insects and pest infestation and potentially improve smallholder farmers' food security and income, however the challenge is on high acquiring cost of the metal silo compared to other storage structures. Gitonga *et al*. (2013), Hodges and Stathers (2015), Chigoverah and Mvumi (2016) and Kumar and Kalita (2017) support this finding that initial cost of purchasing a metal silo is very high and a challenge for rural smallholder women farmer as given in section 2.1.1 of Chapter two.

Subsidy or credit facilities to purchase metal silo: all the interviewed women (48.5%) agreed that obtaining subsidy or credit facilities to purchase metal silo at ward level is a real challenge for most women in the district. HELVETAS and ANSAF (2016), postulate similar sentiments that lack of financial resources to acquire storage structure like metal silo is a major challenge faced by women in rural communities. Chigoverah and Mvumi (2016) supported the findings that rural women require credit or a subsidy to purchase the metal silo, however, this is a challenge to rural women where credit facilities are difficult to access and no subsidies for farm storage structures as given in section 2.1.1 of Chapter two. This could suggest that subsidy and credit facilities are very difficult to obtain in rural areas of the district in order for women to purchase metal silo storage structure.

Accessing trainings on metal silo utilisation: the results reveal that all interviewed women (65.6%) agree that accessing trainings on how to utilise a metal silo at ward level is a challenges in Makoni District. This finding is supported by HELVETAS and ANSAF (2016) who reported that, the majority of the farmers lack knowledge on proper handling of metal silo in some communities. Manandhar *et al*. (2018) asserts that the challenge faced by most women in utilising metal silo is the high skills required for utilising the technology as given in section 2.1.1 of Chapter two. This could suggest that women in Makoni District might have a challenge in accessing comprehensive trainings on the utilisation of metal silo storage structure. This might be due to the fact that new agricultural storage technologies are not adequately covered in conventional curricula in agricultural colleges where extension staff

are trained. Furthermore, this could suggest that refresher courses or follow up trainings sessions are required on new postharvest storage structures. However, Manandhar *et al*. (2018) and Gitonga *et al*. (2015), reported different views concerning skills and training in the utilisation of metal silo, as he viewed metal silo as easy to use and handle technology as given in section 2.1.1 of Chapter two.

Lack of compartments within the metal silo to store other grains specifically for women: the results show that 45.7% of the women indicated that lack of compartments within the metal silo to store other grains specifically for women is a challenge in Makoni District. SDC (2015c) support the finding that women in Shamva District complained that they faced challenges with the utilisation of metal silo as it not compartmentalized, hence, as a result, men have monopolised the use of the metal for maize while women's crops such as groundnuts are stored in the traditional granary as given in section 2.1.1 of Chapter two. This could indicate that, women in Makoni prefer metal silo to have other compartments to store other essential grains the same structure used to store maize grain.

4.3.3 Investigation of association between women's challenges in the utilisation of maize metal silo and identified challenges.

Nonparametric associational statistics Eta was used to investigate the strength of the association between women's challenges in the utilisation of a maize metal silo and identified challenges by the 5-point Likert scale above.

Challenges: Eta was used to investigate the strength of association between women's challenges in the utilisation of a maize metal silo and identified challenges for women, (eta = 0.892). This implies a very strong association, hence, women utilising metal silo in Makoni District are likely to face challenges in finding metal silo artisans within the ward, determining amount of grain consumed and amount of grain remaining in the silo, failure to thoroughly clean the silo before loading new grain, obtaining subsidy or credit facilities to purchase metal silo and lack of other compartments within the silo to store other grains specifically for women.

4.4 Conclusion

The chapter has identified women's challenges in the utilisation of maize metal silo storage structure. Furthermore, Eta nonparametric associational statistics was used to investigate the strength of association between women utilizers and identified challenges in Makoni District. The limited utilisation of a metal silo as a maize grain storage structure in Makoni District could be explained by the identified women's challenges in the utilisation of a metal silo. Utilizers and challenges had a strong association (eta>0.5). Challenges identified were; limited availability of artisans for metal silo fabrication within the district, women farmers have a problem in determining grain consumed and amount of grain remaining in the silo, thorough cleaning of the silo before loading new grain, cost of purchasing a metal silo is too high, no subsidy or credit facilities to purchase metal silo, accessing trainings on metal silo utilisation and finally lack of compartments within the metal silo structure to store other grains specifically for women. Furthermore, there was a very a strong association between women utilizers and challenges. Women utilising metal silo are more likely to experience these challenges identified.

Low and slow uptake of metal silo utilisation among farmers might be hinged on the identified challenges encountered in the utilisation of the maize metal silo. The government and NGOs into agriculture should therefore try and recruit more artisans, fabricate a metal silo with a transparent window for monitoring grain stored, add compartments to store other grains and bottom of silo to have concentric hoppers truncated with cones to enhance discharge by pressure of gravity leading to complete discharge of grain at the bottom of the metal silo, increase in-services of extension workers on new storage technologies for them to cascade the information to women farmers in order to increase metal silo uptake and utilisation and reduce postharvest storage losses.

4.5 Recommendations

Government through the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement under the department of Agritex and NGOs in agriculture should promote the uptake or adoption and utilisation of maize metal silo among smallholder farmers especially the women by:-

- Intensively recruiting and training more metal silo male and female artisans in all districts of the country in order to increase the availability of metal silo artisans in all

wards of the district. This will spearhead wide spread of adoption and utilisation of a metal silo as maize grain storage structure and reduce postharvest storage losses.

- Tailoring postharvest technologies in the context of women and address women's challenges for optimal uptake and utilisation to reduce maize grain postharvest storage losses.
- Redesigning metal silo on the following areas: - metal silo to have a monitoring window from which one can look through to monitor the maize, check whether it is safe; metal silo to have top and bottom concentric hoppers truncated with cones to enhance discharge by pressure to gravity leading to complete discharge of grain at the bottom of the metal silo; metal silo to have compartments in order to store other grain products specifically for women.
- Providing discount rate, loans, subsidies and financial facilities to women farmers to acquire new grain storage structure in order to reduce postharvest storage losses.
- To increase extension trainings mainly on rural women, awareness and technological demonstrations to enhance technical knowhow in women farmers in the metal silo technology.
- Increase in service trainings courses for Agricultural extension officers especially on postharvest storage structures like metal silo and agricultural curricula in agricultural colleges to cover new postharvest storage technologies. This will enable extension officers to cascade current information regarding new improved technologies meant to reduce postharvest storage losses in the communities.
- Organise rural women farmers into groups of 10-15 members for training on the metal silo and formulate income generating projects like ISAL group saving and horticultural projects to in order to raise capital to buy the metal silo for each member in the group.

4.6 References

AfDB. (2014). Transforming Africa's Agriculture to Improve Competitiveness: Agriculture Sector Strategy 2010–2014. Transforming Africa's Agriculture to Improve Competitiveness. Tunis: African Development Bank.

Affognon, H., Mutungi, C., Sanginga, P. and Borgemeister, C. (2015). Unpacking postharvest losses in Sub-Saharan Africa: a meta-analysis. *World Development 66:49-68.*

Bokusheva, R., Finger, R., Fischler, M., Berlin, R., Marín, Y., Pérez, F. and Paiz, F. (2012). Factors determining the adoption and impact of a postharvest storage technology. *Food Security 4, 279–293.*

Chigoverah, A. A. and Mvumi, B. M. (2016). Efficacy of metal silos and hermetic bags against stored-maize insect pests under simulated smallholder farmer conditions. *Journal of Stored Products Reserves, 69, 179–189.*

FANRPAN). (2017). An Evaluation of Gender Roles, Relationships, and Social Equity in Postharvest Management in Benin and Mozambique. The 1st All Africa Post Harvest Congress &Exhibition 28th-31th March 2017, Safari Park Hotel, Nairobi Kenya. Available at www.fanrpan.orgaccesses on 20 February 2019.

FAO. (2015a). Running out of time. The reduction of women's work burden in agricultural production. Rome, Italy.

FAO (2013). Zimbabwe, http: www.fao.org. (Accessed 09 December 2018).

FAO. (2008). Household metal silos; key allies in FAO's fight against hunger. Rome, Italy.

FAO and Mvumi, B., Chamboko, T., Mupindu, S. and Chigovera, A. (2015). Maize food analysis cause and solutions. Harare, Zimbabwe.

Gitonga, Z., De Groote, H. and Tefera, T. (2015). Metal silo grain storage technology and household food security in Kenya. *Journal of Development and Agricultural Economics Volume 7(6), 222-230.*

Gitonga, Z. M., De Groote, H., Kassie, M. and Tefera, T. (2013). Impact of metal silos on households' maize storage, storage losses and food security: An application of a propensity score matching. *Food Policy, 43, 44–55.*

HELVETAS and ANSAF. (2016). A Study on: Farmers' Access to Postharvest Technologies. Final report (Refined version) Grain Postharvest Loss Prevention (GPLP) Project and Agriculture Non State Actor Forum (ANSAF).

Hodges, R. and Stathers, T. (2015). Summary report on a survey of grain storage options. Natural Resources Institute, University of Greenwich. UK.

Kumar, D. and Kalita, P. (2017). Reducing Postharvest Losses during Storage of Grain Crops to Strengthen Food Security in Developing Countries. *Foods, 6, 8.*

Likhayo, P., Bruce, A. Y., Mutambuki, K., Tefera, T. and Mueke, K. (2016). On-Farm Evaluation of Hermetic Technology against Maize Storage Pests in Kenya. *Journal of Economic Entomology, Volume, 19, No. 4*

Lusiba, S. G., Kibwika, P. and Birungi, K. F. (2016). Farmers' perceptions and their implications on the use of rice postharvest handling technologies and practices in Eastern Uganda. *RUFORUM Working Document Series No. 14 (1): 911-919.*

Manandhar, A., Milindi, P. and Shah, A. (2018). An Overview of the Post-Harvest Grain Storage Practices of Smallholder Farmers in Developing Countries. *Agriculture, 8, 57.*

Maonga, B.B., Assa, M.M. and Haraman, E.M. K. (2013). Adoption of small metallic grain silos in Malawi: A farm level cross-sectional study. *International Journal of Development and Sustainability, Volume 2 No. 2, 1534-1548.*

Mvumi, B. M., Chigoverah, A. A., Chamboko, T. and Mupindu. S. (2017). Post-production practices, grain losses and perceptions in maize-based smallholder farming systems of Zimbabwe. Presented at the 1stAfrican Postharvest Conference, Nairobi, Kenya, 28 31 March 2017.

Mwebaze, P. and Mugisha, J. (2011). Adoption, utilisation and economic impacts of improved post-harvest technologies in maize production in Kapchorwa District, Uganda. *International Journal of Postharvest Technology and Innovation, Vol. 2, No. 3, 301-327.*

Ndegwa, M. K., De Groote, H., Gitonga, Z. M., Bruce, A.Y. (2016). Effectiveness and economics of hermetic bags for maize storage: Results of a randomized controlled trial in Kenya. *Crop Protection, 90, 17–26.*

Nyanga, L. K. and Ambali, C. P. (2017). Postharvest management technologies for reducing aflatoxin contamination in maize grain and exposure to humans in Zimbabwe. Final Technical Report. Harare, Zimbabwe.

SDC. (2015a). Gender Analysis of Maize Post-Harvest Management in Kenya: A Case Study of Nakuru, Naivasha and Embu Districts.

SDC. (2015b). Gender Analysis of Maize Post-Harvest Management in Malawi: A Case Study of Lilongwe and Mchinji districts.

SOFA Team and Doss, C. (2011). The role of women in agriculture. ESA Working Paper No. 11-02. Accessed atwww.fao.org/economic/esa on 15 January 2019

Tefera, T., Kanampiu, F., De Groote H., Hellin, J., Mugo, S., Kimenju, S., Beyene Y., Boddupalli, P. M., Shiferaw B., Banziger M. (2011). The metal silo: An effective grain storage technology for reducing post-harvest insect and pathogen losses in maize while improving smallholder farmers' food security in developing countries. *Crop Protection 30:240-245.*

World Bank (2009). Gender in Agriculture Sourcebook, Agriculture and Rural Development. Washington, DC– USA.

Yusuf, B. L. and He, Y. (2011). Design, development and techniques for controlling grains post-harvest losses with metal silo for small and medium scale farmers. *African Journal of Biotechnology Volume 10, 14552–14561.*

CHAPTER 5

WOMEN'S PERCEPTIONS IN THE UTILISATION OF MAIE METAL SILO TECHNOLOGY IN MAKONI DISTRICT

ABSTRACT

Maize grain postharvest storage losses are a challenge in Makoni District. To mitigate the challenges, NGOs in collaboration with Department of Agritex supplied metal silo to farmers in the district. Women are the main utilizers of maize metal silo. The poor utilisation of maize metal silo technology is not only as a result of technical challenges but also of user's perceptions. The objective of the study was to determine the women's perceptions in the utilisation of maize grain metal silo technology in Makoni District. A purposive sampling method was used to select the wards that benefited to the CIMMYT, ACF and INSPIRE metal silo projects. At the 8 wards, simple random sampling method was used to identify 185metal silo utilizers from the wards lists. Pre-tested questionnaires were administered on women utilising metal silo from February to March 2019. The data was analysed using KAP analytic framework andSpearman correlation was used to evaluate association between knowledge-practices (K-P), knowledge-attitudes (K-A), and attitudes-practices (A-P) on women's perceptions in the utilisation of a maize metal silo technology.The results revealed that on average, women (62.9%) interviewed had positive knowledge on metal silo technology. The knowledge variables with highest and lowest positive perceptions were: benefits of metal silo over traditional storage structures and cost of the metal silo, respectively. On average, women (53.5%) interviewed had positive appreciations of actions and direct practices in the utilisation of maize metal silo technology. The practice variables with highest and lowest positive perceptions were reduction in storage cost accounted for and increase in grain sold during high demand, respectively. On average, women (52.1%) interviewed had positive attitudes towards maize metal silo technology. The attitudes variables with highest and lowest positive perceptions were labour/money saving, and effective maize grain protection technology, respectively. Spearman correlation revealed a strong positive significant correlation between knowledge-practices, knowledge-attitudes, and attitudes-practices respectively. Women have positive perceptions on knowledge of the metal silo, attitudes and practices towards metal silo technology in the utilisation. The government and NGOs should increase technology demonstrations, awareness campaigns and extension trainings targeting women on the metal silo technology and postharvest innovations meant to reduce storage losses.

Keywords: Perception, Metal silo, Knowledge, Attitude, Practice.

5.1 Introduction

Agricultural sector worldwide, especially in developing countries is underperforming because women, who are often a crucial resource in agriculture and the rural economy, face constraints that reduce their productivity (SOFA Team and Doss, 2011). The researchers, designers, and fabricators do not take into considerations the needs of socially disadvantaged groups like women and their perceptions when availing new technologies meant to address postharvest storage losses in the communities (Affognon *et al*., 2015 and FAO, 2015a). Lusiba *et al*. (2016) argued that tailoring the technologies and practices to context of users is paramount for optimal uptake and utilisation.

Women play an essential role in food and nutrition security through their responsibilities in provision and preparation of food consumed at household level (FANRPAN, 2017). The poor performance of postharvest storage technologies is not only driven by the technical challenges in the delivery system but also the users' perceptions (Affognon *et al*., 2015). Lusiba *et al*. (2016) argued that farmers' adoption and subsequent utilisation of technology is strongly linked to perceptions. According to Uaiene e*t al*. (2009), understanding farmers' perception of a given technology is crucial in the generation and diffusion of new technologies and farm household information dissemination. However, determining women's perceptions towards the metal silo technology and utilisation will give designers and fabricators areas improvement for customising and up scaling the utilisation of metal silo technology.

However, the influence of perceptions on use of technologies and utilisation/practices has been less studied worldwide (Martins *et al*., 2014). Limited studies have been done in Makoni District to determination of women's perception in the utilisation of a metal silo maize grain storage structure in Makoni District, hence necessitated this current study in the context of Makoni District..

5.2 Material and Methods

Details regarding the study area and the methodology which encompasses sampling procedures, questionnaire design, methods of data collection and data analysis are described in chapter three. For the purpose of this chapter, only a summary is provided.

5.2.1 Description of study area

The study was conducted in Makoni District in Manicaland Province of Zimbabwe. Details on the description of the study area are given in Chapter three.

5.2.2 Research Design

The study employed mainly survey research design comprising use of individual farmer (beneficiaries and utilizers of metal silo) interviews (IFIs) through use of personally administered pre-tested questionnaire in the collection of data. Details regarding the research design are given in Section 3.3 of Chapter 3.

5.2.3 Sampling procedure

Randomly selected metal silo beneficiaries and utilizers farmers from eight wards of Makoni District were interviewed by the researcher from February to March 2019. Details regarding the sampling procedure are given in Section 3.5 of Chapter 3.

5.2.4 Data collection procedure

The study employed a personally administered pre-tested questionnaire and observation techniques for data collection through personal interviews from February to March 2019. More details concerning data collection procedure are given in Section 3.6 of Chapter 3.

5.2.5 Data analysis procedure and methods

The data that was collected using questionnaire, which was coded, entered, cleaned and run in Statistical Package for Social Sciences (SPSS Version 20) software and Microsoft Excel 2013 program for analysis. Descriptive statistics was applied to analyse the background of the sampled households. The data was used to complete Table 5.2 and KAP analytic framework was used to analyse women's perceptions on the utilisation of maize metal silo technology in Makoni district. Furthermore, Spearman rank correlation was used to evaluate possible associations between knowledge-practices (K-P), knowledge-attitudes (K-A), attitudes-practices (A-P) in determining women's perception on the utilisation of maize metal silo technology in Makoni district. More details on the data analysis method and analytic presentation regarding women's perceptions is given in Section 3.7.2 and 3.9.1.2 of Chapter 3

5.2.6 Challenges encountered during data collection

The study encountered challenges during data collection in terms of the spatial distribution of respondents in the Makoni District. Most of the metal silo utilizers and beneficiaries were situated very far apart, some from one corner of the District relative to the other. In that essence, the logistics were particularly limiting. Hence, the researcher had to use motor bike to travel long distance. The financial constrain was a challenge again, the spatial distribution added further transport and communication cost which were compounded by time devotion to such endeavours.

Some women respondents were not free to be interviewed in the absence of their male household heads, hence male households were preferred to be present but were not allowed to respond to the questions. The metal silo beneficiary respondents suspected the researchers were government agents and were afraid that the metal silo would be taken away from them and be allocated to other household as beneficiaries if they divulge many challenges. As such some of the respondents were reluctant to reveal all the challenges they encounter in the utilisations of metal silo. This had negative implications on accuracy of the data collected.

5.3 Results and Discussion

5.3.1 KAP analysis results for the women's perception on metal silo technology

Table 5.1 shows the study results of the KAP analysis for the women's perceptions on maize metal silo technology in Makoni District. The Table 5.1 indicates those variables that reflect knowledge and those that representing attitude and finally those that have a direct indication on practice of the technology. The frequencies of the respondents and the percentage of the respondents who indicated yes or no to variables under consideration are shown in the table 5.1.

Knowledge assesses the extent to which farmers know about the metal silo technology as maize grain storage structure. Attitude attribute characterizes farmers' feelings and inclination regarding the utilisation of maize metal silo technology storage structure. Practice attribute reveals farmers' actions and direct knowledge on practices in the utilisation of maize metal silo technology storage structure.

Table 5.1: Results of women's perception in the utilisation of metal silo technology: KAP analysis results.

Variables	Women's perception on metal silo technology			
	YES		NO	
	n=185	%	n=185	%
# Knowledge				
Know the cost of metal silo?	90	48.6	95	51.4
Know how metal silo works?	148	80	37	20
Know the benefit of metal silo over traditional storage structures?	122	65.7	63	34.3
Know about grain quality of maize grain stored in a metal silo?	116	62.9	69	37.1
Know the health benefits of storing maize grain in a metal silo?	122	65.9	63	34.1
Know about the durability of the metal silo?	100	54.1	85	45.9
AVERAGE	**116**	**62.9**	**69**	**37.1**
# Practice				
Reduction maize grain storage losses?	148	80	37	20
Increase in grain sold during high grain demand times?	26	14.1	159	85.9
Metal silo has reduced storage costs accounted for?	132	71.4	53	28.6
Promotion of health and hygiene?	116	62.9	69	37.1
Reduction in repeated cleaning of grain before use?	74	40	111	60
AVERAGE	**99**	**53.5**	**86**	**46.5**
# Attitude				
Effective maize grain protection technology?	37	20	148	80
Labour saving technology?	143	77.3	42	22.7
Money saving technology in the long term?	143	77.3	42	22.7
Technology conserves trees (environmentally friendly)?	106	57.3	79	42.7
Technology increase wellbeing of household in terms of food security?	53	28.6	132	71.4
AVERAGE	**96**	**52.1**	**89**	**47.9**

Source: Field Survey, 2019.

Knowledge variables: on average, the knowledge variables analysed revealed that 62.9% of the interviewed women had knowledge on the metal silo technology. The variable with the highest positive perception was the benefits of metal silo over traditional storage structures. The variable with the lowest positive perception was on the cost of metal silo. The interviewed women (80%) reveal that they know the benefits of metal silo over traditional storage structures. SDC (2015a), Hodges and Stathers (2015), and Cardoso *et al.* (2012 supported these findings when they reported that those farmers who have adopted and utilise the metal silo technology realise the benefits of technology over traditional storage methods, given in literature review section 2.1.2.2 of Chapter two. The reason might be that, women utilising metal silo are experiencing less storage losses compared to other women utilising traditional grain storage structure in the district. However, 48.6% of the interviewed women do not know the cost of metal silo. The reason for negative perceptions on metal silo cost might be due to that, the metal silos were donated by CIMMYT, ACF and INSPIRE as stated in chapter one and three.

Practice variables: on average, the practice variables analysed revealed that 53.5% of the women interviewed had positive appreciations of actions and direct practices in the utilisation of maize metal silo technology storage structure. The variable with highest positive perception was reduction in storage costs accounted for during storage. The variable with the lowest positive perception was increase in grain sold during high grain demand periods of the season. The interviewed women (80%) revealed that metal silo technology have reduced storage costs accounted for. These findings are in line with Kumar and Kalita, (2017) and SDC (2015a), who reported that metal silo is economic alternative as the cost per unit of grains decreases with increases in the size of silos. These findings were furthermore supported by Nyanga and Ambali (2017); Kumar and Kalita (2017); SDC (2015b) and Maonga *et al*. (2013), who reported that metal silo technology is cost-effective, and is cheaper in the long-run as it does not require pesticides or packaging bags in future usage, as given in literature review section 2.1.2.4 of Chapter two The reason might be that, the technology exempt farmers from incurring huge sums of money for short run variables costs common with traditional storage methods. However, 14.3% of the interviewed women do not agree that metal silo technology increase grain sold during high grain demands periods of the season. The reason for negative perception on increased grain sold during high grain demands periods might be due to that, most farmers in the district store 500-1000kgs of grains, enough for family's annual consumption only as reported on background information in chapter 4.

Attitude variables: on average, the attitude variables analysed revealed that 52.1% of the interviewed women had positive attitudes towards metal silo technology. The variable with the highest positive perceptions were labour saving and money saving technology in the long term. The variable with the lowest positive perception was effective maize grain protection technology. The interviewed women (77.1%) revealed that metal silo technology saves on labour and money in the long term respectively. These findings are in collaboration with findings by Kumar and Kalita (2017) and Nyanga and Ambali (2017), who reported that labour is saved in terms of applying grain protectant as the technology does not require protectant application, reduced winnowing done by women as less chaff is introduced to the grain during hand shelling, as given in literature review section 2.1.2.3 of Chapter two. Kumar and Kalita (2017) asserts that the technology saves on labour as previously used labour in mid-storage grain retrievals to re-apply chemicals is saved. The findings of being money saving are in line with findings by SDC (2015a) and Maonga *et al*. (2013), who reported similar sentiments that the technology saves money on pesticides and bagging material periodically bought in traditional system, hence cost-saving measure as given in literature review section 2.1.2.3 of Chapter two. This could suggest that women utilising metal silo technology saves on labour and money in the district, hence labour and money saved might be channelled to other activities for the improvement of household in terms of food security. However, 20% of the interviewed women have negative perceptions towards metal silo technology on being effective maize grain protection technology. The reason for negative perception on being effective maize grain protection technology might be due to that, some farmers fail to precisely determine 12% maize grain moisture content before loading grain and some farmers fail to properly seal the metal silo after loading graining leading to storage losses as state in chapter three.

5.3.2 Correlations between Knowledge, Attitudes, and Practices on maize metal silo technology results and discussion.

Table 5.2: Results of correlations between Knowledge-Practices, Knowledge-Attitudes, and Practice-Attitude for women's perception in the utilisation of maize metal silo technology.

Variables		Knowledge	Practices	Attitudes
Knowledge	Coefficient	---	0.705**	0.791**
	Significant	---	0.000	0.000
Practices	Coefficient	---	---	0.892**
	Significant	---	---	0.000
Attitudes	Coefficient	---	---	---
	Significant	---	---	---

Source: Field Survey, 2019.

**. Correlation is significant at the p<0.01 level (2-tailed).

5.3.2.1 Analysis of correlations between Knowledge-Practices, Knowledge-Attitudes, and Attitudes-Practices.

Spearman rank correlation was used to evaluate the possible association between knowledge-practices (K-P), knowledge-attitudes (K-A), and attitudes-practices (A-P) on women's perceptions in the utilisation of a maize metal silo technology in the district. There were strong positive correlations between K-P, K-A, A-P (Spearman rank correlation coefficients were 0.705, 0.791, and 0.892 respectively, p<0.01) as shown in Table 5.2 above.

Study results reveal that, an increase in knowledge in metal silo might imply an increase in practices for women utilising metal silo as maize grain storage structure. Again, an increase in knowledge in metal silo might imply an increase attitude towards metal silo technology for women the district leading to adoption and utilisation of the technology. An increase in attitudes towards metal silo technology might imply an increase in practices for women utilising metal silo technology as a maize grain storage structure. This finding is in line with Muleme *et al*. (2017) and WHO (2008), reported that, knowledge, attitude and practice assume a linear association, as given in section 2.1.2.1 of Chapter two. This finding is supported by I-SAPS (2007), who reported that for community/women to utilise metal silo for grain storage purposes, they should have knowledge about the benefits of metal silo storage technology over the traditional storage structure as knowledge instil the right attitude towards the metal silo technology leading to uptake and utilisation of the technology. The

reason for this fact might be that, knowledge drives attitude and attitudes drives practices leading to positive perception of women on metal silo technology in order for increased uptake and utilisation of the technology in the district. However, Wang *et al*. (2015) and Gumucio *et al*. (2011) contrarily reported that attitudes are not directly observable as practices and numerous studies have shown low or no connection between attitudes and practices. Hence positive attitudes towards metal silo might not imply positive practices in the utilisation of metal silo technology by women in the district.

5.4 Conclusion

The chapter focused on determining women's perception in the utilisation of maize metal silo technology in Makoni District through use of KAP analysis and furthermore, Spearman rank correlation was used to evaluate the possible associations between knowledge-practices (K-P), knowledge-attitudes (K-A) and attitudes-practices (A-P).

Knowledge variables assessed the extent to which women know about the metal silo technology. On average, the knowledge variables analysed revealed that women interviewed had positive knowledge on the maize metal silo technology in the district. The variable with the highest positive perception was the benefits of metal silo over traditional storage structures. The variable with the lowest positive perception was on cost of the metal silo. Women have positive knowledge on metal silo technology as a maize grain storage structure in the district.

Practice variables revealed women's actions and direct practices in the utilisation of maize metal silo technology storage structure. On average, the practice variables analysed revealed that women interviewed had positive appreciations of actions and direct practices in the utilisation of a maize metal silo technology in the district. The variable with the highest positive perception was reduction in storage costs accounted for during storage. The variable with lowest positive perception was increase in grain sold during high grain demand periods of the season. Women have positive appreciations of practices done on metal silo technology during utilisation as maize grain storage structure.

Attitude variables characterised farmers' feelings and inclination towards the utilisation of maize metal silo technology storage structure. On average, the attitude variables analysed revealed that women interviewed had positive attitudes towards metal silo technology. The variable with the highest positive perceptions were labour saving and money saving

technology in the long term respectively. The variable with the lowest positive perception was effective maize grain protection technology. Women have positive attitudes towards metal silo technology.

Furthermore, Spearman rank correlation was used to evaluate the possible association between knowledge-practices (K-P), knowledge-attitudes (K-A), and attitudes-practices (A-P) on women's perceptions in the utilisation of maize metal silo technology as a maize grain storage structure in the district. There were strong positive correlations between K-P, K-A, and A-P respectively in the variables. Knowledge drives attitude, and attitude drivers practice.

The government and NGOs through the department of Agritex should increase technology demonstrations, awareness campaigns and extension trainings targeting women on new storage technologies and postharvest innovations meant to reduce postharvest losses in the district.

5.5 Recommendations

Women's perception on maize metal silo technology utilisation in Makoni District is hinged on knowledge, attitude and practices. Knowledge is assumed to drive attitude which in turn rives practice. Hence, based on the results of the study, the study recommends that, the government through the department of Agritex and NGOs into agricultural farmer extension:-

On Knowledge.

- Focus on women who are responsible for food crop storage during extension service delivery by Extension officers and NGOs in order to boost they knowledge on new postharvest technologies.
- When designing and fabricating maize grain storage structures, the needs of socially disadvantaged groups like women the users of technology should be considered in order to improve uptake and utilisation of the new technologies.
- To fully empower women by extending comprehensive knowledge on new postharvest storage technologies like metal silo technology in the communities

On Attitudes.

- To do excessive awareness campaigns and demonstrations on metal silo technology.
- To practice inclusive participatory extension trainings on metal silo technology on women in Makoni District. This will increase adoption and utilisation of the new

storage technology by women and smallholder farmers in order to reduce storage losses.

On Practices.

- Postharvest management trainings especially on the utilisation of new technology like metal silo should be gender sensitive and priorities women issues.
- Extension officers should plan and organise women in to small groups of 10 to 15 members and cascade new technologies information aimed at addressing women challenges in the utilisation of such technologies.
- To implement monthly trainings, discussions on postharvest storage structures and technology demonstrations schedules in collaboration NGOs in all communities
- Agritex department in collaboration with NGOs operating in Makoni District should encourage extension officers to produce and print literature material like leaflets and facts sheets on metal silo utilisation written in local language (Chishona). These literature materials written in local language should be distributed in all farmer gatherings.
- Women field visits, exchange visits and farmer gathering should be promoted to share metal silo technology experiences among women farmers utilising the technology.

5.6 References

Affognon, H., Mutungi, C., Sanginga, P. and Borgemeister, C. (2015). Unpacking postharvest losses in Sub-Saharan Africa: a meta-analysis. *World Development 66:49-68*.

Cardoso, L., Bartosik, R., Campabadal, C. and De La Torre, D. (2012).Air-Tightness Level in Hermetic Plastic Bags (Silo-Bags) for Different Storage Conditions; Navarro, S., Banks, H.J., Jayas, D.S., Bell, C.H., Eds.; Instituto Nacional de Tecnología Agropecuaria: Balcarce, Spain, 2012; pp. 583–589.

FANRPAN. (2017). An evaluation of Gender Roles, Relationships, and Social Equity in Postharvest Management in Benin and Mozambique. The 1st All Africa Post Harvest Congress &Exhibition 28th-31th March 2017, Safari Park Hotel, Nairobi Kenya. Accessed at www.fanrpan.org on 20 February 2019.

FAO. (2015a). Running out of time. The reduction of women's work burden in agricultural production. Rome, Italy.

Gumucio, S., Merica, M., Luhmann, N., Fauvel, G., Zompi, S., Ronsse, A., Courcaud, A., Bouchon, M., Trehin, C., Schapman, S. (2011). Data Collection Quantitative Methods, the KAP Survey Model (Knowledge, Attitude and Practices); IGC communigraphie: Saint Etienne, France, 5.

Hodges, R. and Stathers, T. (2015). Summary report on a survey of grain storage options. Natural Resources Institute, University of Greenwich. UK.

I-SAPS, (2007). Gender in Education: Knowledge, Attitude and Practice (KAP) Assessment. Pakistan.

Kumar, D. and Kalita, P. (2017). Reducing Postharvest Losses during Storage of Grain Crops to Strengthen Food Security in Developing Countries. *Foods, 6, 8.*

Lusiba, S. G., Kibwika, P. and Birungi, K. F. (2016). Farmers' perceptions and their implications on the use of rice postharvest handling technologies and practices in Eastern Uganda. *RUFORUM Working Document Series No. 14 (1): 911-919.*

Maonga, B. B., Assa, M. M. and Haraman, E. M. K. (2013). Adoption of small metallic grain silos in Malawi: A farm level cross-sectional study. *International Journal of Development and Sustainability, Volume 2 No. 2, 1534-1548.*

Martins, A.G., Goldsmith, P. and Moura. A. (2014). Managerial factors affecting postharvest loss: The case of Mato Grosso Brazil. *International Journal of Agricultural Management 3(4):200-209.*

Muleme, J., Kankya, C., Ssempebwa, J., Mazeri, S. and Muwonge, A. (2017). A Framework for Integrating Qualitative and Quantitative Data in Knowledge, Attitude and Practices Studies: A case study of Pesticide Usage in Eastern Uganda. *Frontiers in Public Health 5:318.*

Nyanga, L. K. and Ambali, C. P. (2017). Postharvest management technologies for reducing aflatoxin contamination in maize grain and exposure to humans in Zimbabwe. Final Technical Report. Harare, Zimbabwe.

SDC. (2015a). Gender Analysis of Maize Post-Harvest Management in Kenya: A Case Study of Nakuru, Naivasha and Embu Districts.

SDC. (2015b). Gender Analysis of Maize Post-Harvest Management in Zimbabwe: A Case Study of Shamva District.

SOFA Team and Doss, C.(2011). The role of women in agriculture. ESA Working Paper No. 11-02. Accessed atwww.fao.org/economic/esa on 20 September 2018

Uaiene, R.N., Arndt, C. and Masters, W.A. (2009). "Determinants of Agricultural Technology Adoption in Mozambique", Discussion Papers, No. 67E, National Directorate of Studies and Policy Analysis. Ministry of Planning and Development, Republic of Mozambique.

Wang, R., Yang, Y., Chen, R., Kan, H., Wu, J., Wang, K., Maddock, J. E. and Lu, Y. (2015). Knowledge, Attitudes, and Practices (KAP) of the Relationship between Air Pollution and Children's Respiratory Health in Shanghai, China. *International Journal of Environmental Reserves and Public Health, 12, 1834-1848.*

WHO. (2008). Advocacy, communication and social mobilization for TB control: a guide to developing knowledge, attitude and practice surveys. Geneva, Switzerland.

CHAPTER 6

THE SOCIO ECONOMIC, CULTURAL AND INSTITUTIONAL FACTORS DETERMINING WOMEN' S ROLES IN THE UTILISATION OF MAZE METAL SILO IN MAKONI DISTRICT

ABSTRACT

Women play pivotal and crucial roles in agricultural activities especially in postharvest management activities. However, women in their execution of crucial postharvest roles emanate gender roles inequality and inequity due to socio economic, cultural and institutional factors determine women's roles in the utilisation of new technologies. The objective of the study was to evaluate the factors determining women's roles in the utilisation of maize metal silo in Makoni District. A purposive sampling was done to select 8 wards that benefited to the CIMMYT, ACF and INSPIRE metal silo projects at district level. At the wards, simple random sampling was done to identify 185 metal silo utilizers from the wards lists. A total of 185 copies of pre-tested questionnaires were administered on women utilising metal silo from February to March 2019. The data was analysed using binary regression model. The results revealed that household income level, household size, household labour force availability and level of education of household head, cultural or traditional beliefs have a significant effect in determining women's role in the utilisation of a metal silo. Socio-economic and cultural factors in the district determine women's roles in the utilisation of metal silo as a maize grain storage structure. To enhance gender equality and equity in the utilisation of a metal silo storage structure in Makoni District the study recommend that household in the communities should venture in to different entrepreneur projects enterprises to boost household income, increase household availability by hiring labour force, improve level of education of household head through extension trainings, and cultural or traditional beliefs to enhance sharing of activities during postharvest management.

Keywords: Women's roles, Socio-economic factors, Cultural factors, Institutional factors, Metal silo.

6.1 Introduction

Women play vital roles in agriculture. Postharvest activities are pre-dominantly the domain of women (FANRPAN, 2017). Women are heavily engage in postharvest activities and utilisation of new storage technologies designed and fabricated to reduce storage losses. In SSA countries, about 50% of the agricultural workers are women and these women face several challenges in the utilisation storage structures designed to ease and solve farm problems of postharvest storage losses (AfDB 2014; SOFA Team and Doss, 2011). At most, women play crucial roles in growing food crops, harvesting, postharvest storage and generating income for their families (FANRPAN, 2017).

In Zimbabwe, women overseers the grain in storage, keep an eye on the remaining food levels and ensure that grain in storage does not have pests (FAO and Mvumi *et al*., 2015). Grain postharvest losses in Zimbabwe are estimated to be at 20-38% due to insect pests, mould infestation during storage, poor handling practices and ineffective storage structures (Affognon *et al*., 2015). Promotion of gender equity and fair distribution of roles in postharvest management and utilisation of new technologies will improve food security through reduction of postharvest storage losses (SOFA Team and Doss, 2011).

There are significant women's challenges in the utilisation of new technologies structures as designers and fabricators do not take into consideration needs of socially, culturally and institutionally disadvantaged groups like women (FANRPAN, 2017). Some of the women's challenges in the utilisation of new storage technologies emanate from socio economic, cultural and institutional factors determining women's roles within the societies. Society at times determines division of roles, responsibilities and power between men and women. These socially constructed roles are usually unequal in terms of power and decision making, as well as control over assets and events (Manda and Mvumi, 2010). The best way to increase gender roles equality and equity in technology design and utilisation in the communities is through increase of awareness among the women and men on the roles they play within the household (SDC, 2015a). In Zimbabwe, especially in Makoni District, limited studies have been done on the evaluation of socio economic, cultural and institutional factors determining women's roles in the utilisation of a metal silo as a storage structure. This chapter seeks to evaluate socio economic, cultural and institutional factors determining women's roles in the utilisation of metal silo storage technology as a maize grain storage structure in Makoni District.

6.2 Material and Methods

Details regarding the study area and the methodology which encompasses sampling procedures, questionnaire design, methods of data collection and data analysis are described in chapter three. For the purpose of this chapter, only a summary is provided.

6.2.1 Description of study area

The study was conducted in Makoni District in Manicaland Province of Zimbabwe. Details on the description of the study area are given in Chapter three.

6.2.2 Research Design

The study employed mainly survey research design comprising use of individual farmer (beneficiaries and utilizers of metal silo) interviews (IFIs) through use of personally administered pre-tested questionnaire in the collection of data. Details regarding the research design are given in Section 3.3 of Chapter 3

6.2.3 Sampling procedure

Randomly selected metal silo utilizers and beneficiaries farmers from eight wards of Makoni District were interviewed by the researcher from February to March 2019. Details regarding the sampling procedure are given in Section 3.5 of Chapter 3.

6.2.4 Data collection procedure

The study employed a personally administered pre-tested questionnaire and observation techniques for data collection through personal interviews from February to March 2019. More details concerning data collection procedure are given in Section 3.6 of Chapter 3.

6.2.5 Data analysis procedure and description of variables used in the analysis

The data that was collected using questionnaire was coded, entered, cleaned and run in Statistical Package for Social Sciences (SPSS Version 20) software and Microsoft Excel 2013 program for analysis. Descriptive statistics was applied, followed by binary regression analysis. Twenty explanatory variables were collected to evaluate the socio economic, cultural and institutional factors determining women's role in the utilisation of maize metal silo storage structure. More details on the data analysis method and analytic presentation are given in Section 3.7.3 and Section 3.9.2 of Chapter 3.

6.2.6 Challenges encountered during data collection

The study encountered challenges during data collection in terms of the spatial distribution of respondents in the Makoni District. Most of the metal silo utilizers and beneficiaries were situated very far apart, some from one corner of the District relative to the other. In that essence, the logistics were particularly limiting. Hence, the researcher had to use motor bike to travel long distance. The financial constrain was a challenge again, the spatial distribution added further transport and communication cost which were compounded by time devotion to such endeavours.

Some women respondents were not free to be interviewed in the absence of their male household heads, hence male households were preferred to be present but were not allowed to respond to the questions. The NGOs beneficiary respondents suspected the researchers were government agents and were afraid that the metal silo would be taken away from them and be allocated to other household as for beneficiaries if they divulge many challenges. As such some of the respondents were reluctant to reveal all the challenges they encounter in the utilisations of metal silo. This had negative implications on accuracy of the data collected.

6.3 Results

Table 6.1 Results of Logistic Regression Model

Variables	Coefficients (SE)	Significance P values
Constant.	-4.496 (0.042)	0.011
Household income level	1.122 (0.124)	0.045**
Household size	1.358 (0.015)	0.061*
Household resources	0.326 (0.021)	0.568
Household labour force availability	4.617 (0.032)	0.075*
Level of education of household head	1.785 (0.027)	0.086*
Norms or values	2.390 (0.038)	0.340
Social hierarchy	0.636 (0.028)	0.419
Cultural or traditional believes	1.956 0.018)	0.021**
Religious practices	2.390 (0.037)	0.230
AGRITEX visits.	0.327 (0.224)	0.981
AGRITEX trainings before benefiting the silo	0.656 (0.082)	0.573
AGRITEX trainings on metal silo utilisation	1.333 (0.134)	0.180
AGRITEX trainings on maize grain postharvest management.	0.436 (0.051)	0.825
NGOs trainings on maize grain postharvest management.	0.082 (1.609)	0.467
NGOs trainings on metal silo utilisation.	0.443 (1.512)	0.769
General trainings on postharvest management practices.	-3.518 (2.922)	0.229
Local leadership advice.	0.029 (2.123)	0.989
Focal/lead farmer trainings.	4.195 (4.681)	0.370
Farmer gatherings on postharvest management.	2.219 (2.059)	0.281
Media.	0.474 (1.819)	0.794

Source: Field Survey, 2019

Cox & Snell R^2 = 0.742, Model Chi square = 46.070, Sig = 0.001

The table gives the regression coefficient with its standard error in parentheses, then the level of significance (probability value).

Significance p<0.1* p<0.05** p<0.01***

6.4 Discussion

The explanatory variables were categorised into different sets of factors for easy of conceptualisation. These categories or groups are socio-economic factors such as household income level, household size, household resources, household labour force availability and level of education for household head; cultural factors such as norms or values, social hierarchy, cultural or traditional believes and religious practices; institutional factors such as Agritex visits, Agritex trainings before benefiting metal silo, Agritex trainings on metal silo utilisation, Agritex trainings on maize grain postharvest management, NGOs trainings on maize grain postharvest management, NGOs trainings on metal silo utilisation, general trainings on postharvest management, local leadership advice, focal or lead farmer trainings, farmer gatherings and media.

The discussion of explanatory variables were centred mainly on factors with 10% and above level of significance only.

6.4.1 Socio-economic factors determining women's roles in the utilisation of maize metal silo.

Household income: the results of the study revealed that household income had a statistical significance (p = 0.045) in determining women's role in the utilisation of maize metal silo storage structure. Studies by Maonga *et al*. (2013) in Malawi and SDC (2015a) in Kenya confirm this finding, as given in literature review section 2.1.3.1 of Chapter two. This could be attributed to the fact that households with higher level of income do have household roles specialisation hence gender roles are clearly stated. Again household with higher income quickly adopt and utilizes postharvest technologies leading to reduction of women's burden on maize grain postharvest management roles.

Household size: the results of the study show that household size have significance (p=0.061) in the determination of women's roles in the utilisation of maize metal silo in Makoni District. This finding was in line with Maonga *et al*. (2013) in Malawi that household

size determine gender roles in the utilisation of a metal silo on the base that larger household size avail enough family labour compared to smaller household size where family labour is in short supply hence no gender division of labour, as given in literature review section 2.1.3.1 of Chapter two. The reason could be that in a larger size household gender roles or women's roles are clearly stated and followed like loading, cleaning winnowing, emptying of maize grain in the metal silo. As reported by Rugumamu (2009), women possess the art and science of holding and shaking reed-woven trays while capitalizing on wind speed and direction for efficiency of the activity hence this activity is mainly done by women, as given in literature review section 2.1.3.1 of Chapter two.

Household labour force availability: it was observed that availability of labour force within the household have a significance (p=0.075) in determining women's roles in the utilisation of a maize metal silo in Makoni District. The reason for this might be that, women's roles in postharvest management activities are specialised roles like winnowing. Hence, increase in household labour force means increase in women's area of specialist in the utilisation of metal silo. However Mvumi *et al*. (2017) reported that there is gender equity among young couples in the distribution of postharvest activities in the utilisation of a metal silo in some communities, as given in literature review section 2.1.3.1 of Chapter two.

Level of education of household head: the study results revealed the level of education of household head have a significance (p=0.086) in determining women's roles in the utilisation of maize metal silo in Makoni District. This finding was supported by Maonga *et al*. (20130, who reported that education has a positively determine gender roles in the utilisation of a metal silo storage structure on the bases that educated farmers understand better the essence of working together and labour sharing within the household, as given in Chapter two. The reason for this fact might be that formal education on household plays an important role in determining gender roles in postharvest technology utilisation like metal silo.

6.4.2 Cultural factors determining women's roles in the utilisation of maize metal silo.

Cultural or traditional beliefs: community cultural or traditional beliefs play a pivotal role in determining women's roles in the utilisation of maize metal silo storage structure. These cultural or traditional beliefs were significantly (p = 0.021) in determining women's roles in the utilisation of maize metal silo storage structure. This finding is supported by Manda and

Mvumi (2010), cultural beliefs have a strong influence in the crop processing in Zimbabwe. This is also in line with the findings of Maonga *et al*. (2013), that culturally there are certain tasks customarily done by men or women in the maize grain postharvest management. Again, studies by FAO and Mvumi *et al*. (2015) confirm this finding, as given in section 2.1.3.2 of Chapter two. Rugumamu (2009) reported that women possess the art and science of holding and shaking reed-woven trays while capitalizing on wind speed and direction for efficiency of the activity hence this activity is mainly done by women, as given in section 2.1.3.2 of Chapter two. The reason could be that, in the district, it is a taboo for man to be seen hold winnowing basket tray and do the cleaning process of maize grain whilst women are around at any given household. Winnowing is a role reserved for women in Makoni District.

6.5 Conclusion

The chapter has looked at different factors that determine women's roles in the utilisation of maize metal silo in Makoni District. The results of the binary regression model indicate that household income level, household size, household labour force availability and level of education of household head, and cultural or traditional beliefs have a significant effect in determining women's roles in the utilisation of a maize metal silo in the district. Socio-economic and cultural factors determines women's roles in the utilisation of maize metal silo in the district. The promotion of equitable division of roles in the utilisation of metal silo during postharvest management might be done through increasing household income, increasing household size, availing enough household labour force, improving level of education of household head and finally through cultural or traditional beliefs.

6.6 Recommendations

Based on the study results, the study recommends that the government through the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, under the department of Agritex, the extension delivery should:-

On Socio-economic factors.

- Promote diversity of household agricultural income generating enterprises in order to boost household income leading to gender roles equality and equity in the postharvest technologies utilisation.
- Encourage households with smaller household size to practice/share postharvest activities by working in family groups or in syndicates. Even to hire part-time

workers during peak period of postharvest activities in order to promote gender equality and equity in postharvest management activities.

- Promote group formation of farmers in the communities in order to boost household labour forces availability.
- Farmer field schools must be introduced to teach men and women postharvest handling technologies. Male and female farmers should be trained on the advantages of collaboration and sharing postharvest tasks to enhance equality and equity.

On Cultural factors.

- Societal cultural or traditional beliefs need to be orientated in such a way that it promotes equitable household division of labour during postharvest management activities.

6.7. References

AfDB. (2014). Transforming Africa's Agriculture to Improve Competitiveness: Agriculture Sector Strategy 2010–2014. Transforming Africa's Agriculture to Improve Competitiveness. Tunis: African Development Bank.

Affognon, H., Mutungi, C., Sanginga, P. and Borgemeister, C. (2015). Unpacking postharvest losses in Sub-Saharan Africa: a meta-analysis. *World Development 66:49-68.*

FANRPAN. (2017). an evaluation of Gender Roles, Relationships, and Social Equity in Postharvest Management in Benin and Mozambique. The 1st All Africa Post Harvest Congress &Exhibition 28th-31th March 2017, Safari Park Hotel, Nairobi Kenya. Accessed at www.fanrpan.org on 20 February 2019.

FAO and Mvumi, B., Chamboko, T., Mupindu, S. and Chigovera, A. (2015). Maize food analysis cause and solutions. Harare, Zimbabwe.

Manda, J. and Mvumi, B. M. (2010). Gender relations in household grain storage management and marketing: the case of Binga District, *Zimbabwe. Agriculture and Human Values, 27: 28-103.*

Maonga, B. B., Assa, M. M. and Haraman, E. M. K. (2013). Adoption of small metallic grain silos in Malawi: A farm level cross-sectional study. *International Journal of Development and Sustainability, Volume 2 No. 2, 1534-1548.*

Mvumi, B. M., Chigoverah, A. A., Chamboko, T. and Mupindu. S. (2017). Post-production practices, grain losses and perceptions in maize-based smallholder farming systems of Zimbabwe. Presented at the 1stAfrican Postharvest Conference, Nairobi, Kenya, 28 31 March 2017.

Rugumamu, C. P. (2009). Assessment of post-harvest technologies and gender relations in maize loss reduction in Pangawe village Eastern Tanzania. *Tanzania Journal of Science Vol 35*

SDC. (2015a). Gender Analysis of Maize Post-Harvest Management in Kenya: A Case Study

SOFA Team and Doss, C. (2011). The role of women in agriculture. ESA Working Paper No. 11-02. Accessed at www.fao.org/economic/esa on 13 January 2019.

CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This Chapter summaries the research proceedings and findings collated from Makoni District in Manicaland Province, Zimbabwe. The broad objective of the study was to evaluate women's challenges in the utilisation of maize metal silo in Zimbabwe as enunciated in the introductory chapter of the study. Descriptive statistics, 5-point Likert scale, nonparametric associational statistics Eta, KAP analytic framework, Spearman correlation and binary regression analysis were approaches used to analyses the specific objectives of the study. The results from a sample of 185 women farmers who were interviewed using a pre-tested structured questionnaire are explained as stated in Chapter 4, 5 and 6. The same results chapter also gives a discussion of the results and conclusions of the study. Finally, this chapter summarises, concludes, makes policy recommendations and looks at areas for further research.

7.2 Research summary

The first chapter of the study was introduction, problem statement, objectives, research questions, justification and outline of the thesis. Second chapter of the study was on literature review synthesis. Third chapter of the study was on methodology which covered study site, research design, sampling procedure, data collection procedure, data analysis produce, ethical considerations and finally the summary of the methodology chapter.

Chapter four, five and six were results chapters for each objective respectively. Chapter four was to identify women's challenges in the utilisation of a maize metal silo in Makoni District. This was achieved through use of 5-point Likert scale ranging from "not a challenge" to "a very big challenge", followed by use of nonparametric associational statistics Eta to investigate the strength of association between women's challenges and identified challenges in the utilisation of a metal silo. Data was analysed using SPSS software version 20. The results show that availability of artisans for metal silo fabrication, determining amount of grain consumed and amount of grain remaining, and thorough cleaning of the metal silo before loading new grain are identified women's challenges in the utilisation of a metal silo. In addition to that, cost of purchasing or acquiring a metal silo, obtaining subsidy or credit

facilities to purchase metal silo, accessing trainings on metal silo utilisation and lack of compartments within the metal silo to store other grains specifically for women are some of the identified women's challenges in the utilisation of a maize metal silo in Makoni District. Furthermore, nonparametric associational statistics Eta was used to investigate the strength of association between women's challenges and identified challenges, it revealed a very strong association (eta = 0.892), hence women utilising metal silo as maize grain storage structure are likely to encounter these challenges identified. There are challenges faced by women in the utilisation of a metal silo as a maize grain storage structure. Women in the district are likely to encounter identified challenges in the utilisation of a maize metal silo in the district. To increase uptake and utilisation of maize metal silo and reduce storage losses leading to improved household food security in the Makoni District, there is need to address these identified.

After have identified the women's challenges in the utilisation of a maize metal silo, the study proceed in Chapter five to determine women's perceptions in the utilisation of maize metal silo technology in Makoni District. One hundred and eight five women utilising metal silo were randomly selected from the wards lists for cross-sectional household survey. Data was analysed using KAP analysis framework, followed by Spearmen rank correlation was used to evaluate the possible association between knowledge-practices (K-P), knowledge-attitudes (K-A), and attitudes-practices (A-P).

Knowledge variables assessed the extent to which women know about the maize metal silo technology. On average, the knowledge variables analysed revealed that women interviewed had positive knowledge on the maize metal silo technology in the district. The variable with the highest positive perception was the benefits of metal silo over traditional storage structures. The variable with the lowest positive perception was on cost of the metal silo. Women have positive knowledge on metal silo technology as a maize grain storage structure in the district.

Practice variables revealed women's actions and direct practices in the utilisation of maize metal silo technology storage structure. On average, the practice variables analysed revealed that women interviewed had positive appreciations of actions and direct practices in the utilisation of maize metal silo technology in the district. The variable with the highest positive perception was reduction in storage costs accounted for during storage. The variable with lowest positive perception was increase in grain sold during high grain demand periods

of the season. Women have positive appreciations of practices done on metal silo technology during utilisation as maize grain storage structure.

Attitude variables characterised farmers' feelings and inclination towards the utilisation of maize metal silo technology storage structure. On average, the attitude variables analysed revealed that women interviewed had positive attitudes towards maize metal silo technology. The variable with the highest positive perceptions were labour saving and money saving technology in the long term respectively. The variable with the lowest positive perception was effective maize grain protection technology. Women have positive attitudes towards maize metal silo technology.

Furthermore, Spearman rank correlation was used to evaluate the possible association between knowledge-practices (K-P), knowledge-attitudes (K-A), and attitudes-practices (A-P) on women's perceptions in the utilisation of maize metal silo technology in the district. There were strong positive correlations between K-P, K-A, and A-P respectively in the variables. Knowledge drives attitude, and attitude drivers practice.

Chapter six presents results of socio-economic, cultural and institutional factors determining women's roles in the utilisation of a maize metal silo in Makoni District. One hundred and eighty five women utilising metal silo were randomly selected from the wards lists for cross-sectional household survey. Data was analysed using binary logistic regression analysis to evaluate socio-economic, cultural and institutional factors determining women's roles in the utilisation of maize metal silo. Statistical significance was measured at 90%, 95% and 99%. The results revealed that household income level ($p=0.045$), household size ($p=0.016$), household labour force availability ($p=0.075$), level of education of household head ($p=0.086$) and cultural or traditional beliefs ($p=0.021$) have a significant effect in determining women's role in the utilisation of a metal silo. There are socio-economic and cultural factors that determine women's roles in the utilisation of a maize metal silo in Makoni District. It is therefore paramount important to improve household income, household labour force availability, encourage group work during postharvest management and cultural or traditional beliefs to promote equitable division of labour during utilisation of metal silo.

Chapter seven was on summary of the study findings, conclusions and recommendations of the study based on the study findings.

7.3 Conclusions

Makoni District is experiencing high maize grain postharvest storage losses leading to food insecurity due to the use of traditional storage structures that are inefficient for the storage and preservation of grain in the presence of effective metal silo technology introduced 6 years ago in the district. The reason for poor uptake and utilisation of a metal silo technology as a maize grain storage structure might be hinged on the challenges faced by women in the utilisation of a metal silo. The study revealed the obtaining subsidy or credit facilities to purchase metal silo and accessories, accessing trainings on metal silo utilisation, and determining amount of grain consumed and amount of grain remaining in the silo are some of the identified women's challenges in the utilisation of a metal silo. There is a very strong association (eta = 0.892) between women and identified challenges, hence women utilising maize metal silo in Makoni District are likely to face these identified challenges.

Again, women's perceptions on metal silo technology revealed that, women had positive knowledge, attitudes and practices towards maize metal silo technology in the district. Spearman correlation revealed a strong positive significant correlation between knowledge-practices, knowledge-attitudes and attitudes-practices. Knowledge drives attitudes and attitudes drives practices in the utilisation of metal silo storage structure for women.

Socio-economic and cultural factors determining women's roles in the utilisation of a maize metal silo in the district revealed statistically significant factors such as household income level (p=0.045), household size (p=0.016), household labour force availability (p=0.075), level of education of household head (p=0.086), and cultural or traditional beliefs (p=0.021) in determine women's roles in the utilisation of a maize metal silo.

7.4 Policy implication and recommendations

Government should promote increased uptake and utilisation of maize metal silo technology as grain storage structure in order to reduce maize grain postharvest storage losses leading to improved household food security by

On challenges.

- Intensively recruiting and training more metal silo male and female artisans in all districts of the country in order to increase the availability of metal silo artisans in all

wards of the district. This will spearhead wide spread of adoption and utilisation of a metal silo as a maize grain storage structure and reduce postharvest storage losses.

- Tailoring postharvest technologies in the context of women and address women's challenges for optimal uptake and utilisation to reduce maize grain postharvest storage losses.
- Redesigning metal silo on the following areas: - metal silo to have a monitoring window from which one can look through to monitor the maize, check whether it is safe; metal silo to have top and bottom concentric hoppers truncated with cones to enhance discharge by pressure to gravity leading to complete discharge of grain at the bottom of the metal silo; metal silo to have compartments in order to store other grain products specifically for women.
- Providing discount rate, subsidies and financial facilities to women farmers to acquire new grain storage structure in order to reduce postharvest storage losses.

On perceptions.

- To increase extension trainings mainly on rural women, awareness and technological demonstrations to enhance technical knowhow in women farmers in the metal silo technology.
- Focus on women who are responsible for food crop storage during extension service delivery by Extension officers and NGOs in order to boost they knowledge on new postharvest technologies.
- Agritex department in collaboration with NGOs operating in Makoni District should encourage extension officers to produce and print literature material like leaflets and facts sheets on metal silo utilisation written in local language (Chishona). These literature material written in local language should be distributed in all farmer gatherings.
- To fully empower women by extending comprehensive knowledge on new postharvest storage technologies like metal silo technology in the communities
- Postharvest management trainings especially on the utilisation of new technology like metal silo should be gender sensitive and priorities women issues.
- Women field visits, exchange visits and farmer gathering should be promoted to share metal silo technology experiences among women farmers utilising the technology.

On socio-economic, cultural and institutional factors.

- Societal cultural or traditional beliefs to be orientated in such a way that it promotes equitable household division of labour during postharvest management activities.
- Promote diversity of household agricultural income generating enterprises in order to boost household income leading to gender roles equality and equity in the postharvest technologies utilisation.
- Encourage households with smaller household size to practice/share postharvest activities by working in family groups or in syndicates. Even to hire part-time workers during peak period of postharvest activities in order to promote gender equality and equity in postharvest management activities.
- Promote group formation of farmers in the communities in order to boost household labour forces availability
- Farmer field schools should be introduced to teach men and women postharvest handling technologies. Male and female farmers should be trained on the advantages of collaboration and sharing postharvest tasks to enhance equality and equity.

7.5 Areas for further research

- A study to evaluate women's challenges in the utilisation of a maize metal silo in others districts where maize metal silo technology was introduce as pilot project for farmers to adopt and utilize to reduce postharvest storage losses could produce different challenges.
- A study to determine factors affecting adoption and utilisation of a maize metal silo in the context of Zimbabwean smallholder farmers could produce clear factors might contribution to poor uptake and utilisation.

APPENDIX 1

QUESTIONNAIRE

EVALUATION OF WOMEN'S CHALLENGES IN THE UTILISATION OF METAL SILO STORAGE STRUCTURE IN ZIMBABWE. A CASE OF MAKONI DISTRICT.

All information provided by you (interviewee) will be treated as STRICTLY CONFIDENTIAL for mutual benefit of both the researcher and the respondents.

Questionnaire Number…… Ward Number……

Enumerator name…….. Makoni District, Manicaland Province

Name of respondent (WOMAN FARMER ONLY)……

Date …… Name of Farm/Village…….....

Background Information: Kindly tick [√]

i. Gender Female only [ ]

ii. Age 18-30 years [ ] 31-40 years [ ]
41-50 years [ ] 51 years and above [ ]

iii. Highest level of your education
None [ ]
Primary [ ]
Secondary [ ]
Tertiary [ ]

iv. For how long have you been using metal silo as a maize grain storage structure?
Less than 2 years [ ]
Between 2-4 years [ ]
Between 4-6 years [ ]

v. Size/capacity of metal silo been used as maize grain storage structure
Less than 500 kg [ ]
Between 501 – 1000 kg [ ]
Between 1001 – 3000 kg [ ]

vi. Name of the NGO that gave you the metal silo……..

Please complete the following questionnaire by placing a tick [√] or filling in the appropriate box/space provided.

SECTION A, OBJECTIVE 1: CHALLENGES IN THE UTILISATION OF A METAL SILO STORAGE STRUCTURE

Technical challenges in the utilisation

A1. The availability of artisans for metal silo fabrication within the ward?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A2. The location (place where the artisans stay) of the artisans within the ward?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A3. Transportation (carrying metal silo) of a metal silo (1-3 tonne) from artisans' location to your homestead?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A4. Is the process of attaining hermetic sealing (proper closer of metal silo) after grain loading?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A5. In the utilisation of a metal silo as a maize grain storage, is there an increased postharvest management processing done to grain before storage/loading?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A6. During the utilisation of a metal silo, loading grain in a metal silo (tall and big 1-3 tonne silo)?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A7. The process of determining oxygen and carbon dioxide level within the metal silo?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A8. Determine the amount of grain used and amount still remaining in the metal silo?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A9. During the utilisation of metal silo, do you experience challenges like grain losses due to grain moisture accumulation, pest infestation and grain rotting in the metal silo due to poor handling of the storage structure?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A10. The process of determining Grain Moisture Content (MC) before grain loading in the metal silo?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A11. The process of installation/fitting a metal silo (1-3 tonne) in the room?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A12. To construct a proper platform (base for putting the silo for metal silo) at ward level?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A13. The process of thoroughly cleaning a metal silo before loading new season grain?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

Economic challenges in the utilisation

A14. The cost of purchasing or acquiring a metal silo?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A15. Finding materials (e.g. galvanised iron sheets etc.) needed to manufacture/fabricate metal silo at ward level?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A16. The process of obtaining subsidy or credit facilities to purchase metal silo at ward level?

Is not a challenge [ ]
Is a challenge [ ]

Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A17. To obtain/organiser financial resources to purchase/acquire metal silo at ward level?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

Institutional challenges in the utilisation

A18. Accessing trainings on metal silo utilisation at ward level?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A19. To obtain quality trainings on how metal silo work at ward level?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

Socio cultural challenges in the utilisation

A20. Size, shape and weight of a metal silo during utilisation compactable with your (women's) activities/duties?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A21. The metal silo you were given by the NGOs (e.g. CIMMYT, ACF and INSPIRE) store inadequate amount of grain for the family throughout the storage season?

Is not a challenge [ ]
Is a challenge [ ]

Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

A22. Lack of compartments within the metal silo to store other grains has led to over control of metal silo by men in the household?

Is not a challenge [ ]
Is a challenge [ ]
Is a minor challenge [ ]
Is a big challenge [ ]
Is a very big challenge [ ]

SECTION B, OBJECTIVE 2: WOMEN'S PERCEPTIONS ON THE UTILISATION OF METAL SILO TECHNOLOGY AS MAIZE GRAIN STORAGE STRUCTURE

	Women's perception on the technology	
	YES %	**NO %**
# KNOWLEDGE VARIABLES		
B1. Cost of metal silo?		
B2. How metal silo works?		
B3. Benefits of a metal silo over traditional storage structures?		
B4. Grain stored in metal silo is of high quality compared to other storage structures?		
B5. Storing maize grain in a metal silo has health benefits?		
B6. Metal silo is more durable structure?		
# PRACTICE VARIABLES		
B7. The metal silo has reduced maize grain storage losses?		
B8. The metal silo increases the quality and quantity of grain you sell during high grain demand times?		
B9. Metal silo has reduced storage costs accounted for?		
B10. Storing maize grain in metal silo promote health and hygiene in the grain stored?		
B11. Metal silo has reduced repeated cleaning of grain before use?		

B12. Metal silo has reduced maintenance and repairing cost?		
# ATTITUDES VARIABLES		
B13. Effective grain protection technology?		
B14. Labour saving technology?		
B15. Money saving technology (buying pesticides and packaging bags periodically) in the long term?		
B16. The metal silo technology conserves trees (environmentally friendly)?		
B17. Technology increase wellbeing of household in terms of food security?		

SECTION C, OBJECTIVE 3: SOCIO-ECONOMIC, CULTURAL AND INSTITUTIONAL FACTORS DETERMINING THE ROLE OF WOMEN IN THE UTILISATION OF METAL SILO AS A MAIZE GRAIN STORAGE STRUCTURE IN MAKONI DISTRICT.

SOCIO ECONOMIC FACTORS DETERMINING THE ROLE OF WOMEN IN THE UTILISATION OF A METAL SILO

C1. Socio economic factors determine women's role in the utilisation of metal silo?	Yes	No
C2. Income level or financial capabilities of a household determine what women do during the utilisation of a metal silo?	Yes	No
C3. Household size determines what women do during the utilisation of a metal silo?	Yes	No
C4. Availability of household resources determines what women do during in the utilisation of a metal silo?	Yes	No
C5. Labour force availability within a household determines what women do during the utilisation of a metal silo?	Yes	No
C6. Level of education of the household head determine what women do during the utilisation of metal silo	Yes	No

CULTURAL FACTORS DETERMINING THE ROLE OF WOMEN IN THE UTILISATION OF A METAL SILO.

C7. Cultural factors determine women's role in the utilisation of a metal silo?	**Yes**	**No**

C8. Norms or values within the household or in the community/village determine what women do during the utilisation of a metal silo	**Yes**	**No**
C9. Social hierarchy determine what women do during the utilisation of a metal silo?	**Yes**	**No**
C10. Cultural or traditional believes determine what women do or not to do during the utilisation of metal silo as a maize grain storage structure?	**Yes**	**No**
C11. Religious practices determine what women do or not to do during the utilisation of a metal silo as a maize grain storage structure?	**Yes**	**No**

INSTITUTIONAL FACTORS DETERMINING THE ROLE OF WOMEN IN THE UTILISATION OF A METAL SILO.

C12. Institutional factors determine women's role in the utilisation of a metal silo?	Yes	No
C13. How often do Agritex extension officers visit your homestead/village in a month?	1-Often	2-Rarely
C14. Before you were given the metal silo, did you receive enough training from Agritex officers? **i.** Did you regularly receive training on metal silo utilisation from Agritex Officers?	Yes Yes	No No
C15. Do Agritex extension officers' trainings on postharvest management determine what women should do during the utilisation of a metal silo as a maize grain storage structure?	Yes	No
C16. Do you receive trainings from NGOs extension officers on postharvest management of maize grain?	Yes	No
C17 Before you were given the metal silo, did you receive enough training from NGOs officers? i. Did you receive training on metal silo utilisation form NGOs	Yes Yes	No No
C18. Do the trainings you received from NGOs on how to use metal silo, determine what women should do in the process of storing maize grain?	Yes	No
C19. Do all the general trainings on postharvest management of maize grain; determine what women should do during the utilisation of a metal silo?	Yes	No
C20. Does the advice you receive from your local leadership determine what women should do during the utilisation of metal silo as a maize grain storage structure?	Yes	No
C21. Do the trainings you receive from Focal/lead farmers determine what women should do during the utilisation of a metal	Yes	No

silo as a maize grain storage structure?		
C22. Do the trainings you receive from farmer gatherings on postharvest management (Field days, workshops and demonstrations); determine what women should do during the utilisation of a metal silo as a maize storage structure?	Yes	No
C23. Do the farmer trainings you receive from media (radio, newspaper and cellular networks) determine what women should do during the utilisation of a metal silo as a maize grain storage structure)?	Yes	No

Thank you