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FACTORS AFFECTING THE UPTAKE OF POSTHARVEST TECHNOLOGY BY TOMATO FARMERS IN UMGUZA, TSHOLOTSHO AND LUPANE DISTRICTS IN MATABELELAND NORTH REGION

BY

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Abstract

Tomato production plays a pivotal role in generation of household food security and nutrition hence improving livelihoods in Zimbabwe's communal areas. Despite this, tomato farmers incur huge postharvest loses leading to huge amount in reductions of profits, food quality and market penetration strategies. There is also minimal evidence on the factors affecting adoption of postharvest practices in Matabeleland region. This study therefore examined factors affecting the embracement of postharvest technology like socio-economic, institutional and cultural. The study used analytic cross sectional survey data with a sample size of eighty-six participants from three districts of Matabeleland North province which are Umguza, Lupane and Tsholotsho. The institutional factors that were affecting the adoption of postharvest technologies and practices included access to credit, training program and group membership. After analysis using the double hurdle regression model the results revealed that some variables were significant in factors affecting the uptake of postharvest technology and these were age of the farmer, group membership, number of income sources, access to radio, participation of farmers and gender of the household. There was minimal access to credit and participation in training programs among tomato farmers in the study area hence the hardship to adopt postharvest technology. The major cause of tomato loses when they are still in the field were pests and diseases that was due to high costs of chemicals that are out of reach for many tomato farmers. The study recommends training and sensitisation programs on the importance of postharvest technology to be carried out amongst farmers. The extension officers should be trained and taught about postharvest technology so as to share information with the farmers. The training should not be left to associations and non-governmental organisations only but the government has to also take a lead in implementing these programs. Also, to address this challenge agribusiness companies should assist in designing postharvest technologies that mirror adoption patterns of smallholder farmers as they constitute the bulk of rural farmers.

Key words: Post harvest technology, double hurdle regression

Declaration

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted to another university nor will it ever be submitted to another university for the award of a degree.

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Dedication

The dissertation is dedicated to my beloved mother Kwanele Ndlovu and my late father Bernard Dima Ndlovu.

List of Acronyms and Abbreviations

RUM	Random Utility Model
SDG	Sustainable Development Goal
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
WHO	World Health Organisation
ZECC	Zero Energy Cool Chambers

Abstract ii
Declaration iii
Acknowledgement v
Dedication vi
List of Tables xi
List of Figures xii
List of Appendices xiii
CHAPTER 1 INTRODUCTION 1
1.1 Introduction 1
1.2 Background of the study 1
1.3 Statement of the problem 3
1.4 Research objectives 3
1.5 Research questions 4
1.6 Assumptions 4
1.7 Significance of the study 4
1.8 Delimitation of the study 5
1.9 Limitation of the study 5
CHAPTER 2 REVIEW OF RELATED LITERATURE 7
2.1 Introduction 7
2.2 Theoretical framework 7
2.2.1 Theory of Reasoned Action (T.R.A) 7
2.2.2 Theory of Planned Behaviour (TPB) 8
2.3 Relevance of the theoretical framework to the study 8
2.3.1 Theory of random utility model (RUM) 8
2.4 Empirical evidence on the main causes of postharvest loses in tomatoes 11
2.5 Review of empirical evidence on studies on postharvest technologies and practices employed in tomato production and other fruits. 12
2.6 Empirical evidence on the factors affecting embracement of postharvest technology in agriculture 15
2.7 Conceptual framework 17
2.7.1 Age of the farmer 19
2.7.2 Household (HH) size 20
2.7.3 Number of income sources 20

2.7.4 Household head 20
2.7.5 Education 21
2.7.6 Membership to market associations 21
2.7.7 Access to media 21
2.7.8 Perception of the farmers 22
2.8 Summary 22
CHAPTER 3 METHODOLOGY 24
3.1 Introduction 24
3.2 Research Design 24
3.3 Population and sampling 24
3.4 Data collection instruments 25
3.5 Data collection procedure 26
3.6 Data analysis and organisation of the data 26
3.7 Research ethics considerations 27
3.8 Summary 27
CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION 28
4.1 Introduction 28
4.2 Data presentation and analysis 29
4.2.1 Socio – economic and demographic characteristics of tomato farmers 29
4.2.2 Main causes of tomato postharvest losses 30
4.2.3 Institutional factors and support services characterizing tomato farmers in Umguza, Lupane and Tsholotsho 31
4.2.4 Source of market information among tomato farmers 31
4.2.5 Major constraints faced by tomato farmers 32
4.2.6 Factors affecting the adoption of the postharvest technology for the tomato farmers 33
4.2.7 Marginal effect of the factors affecting adoption of postharvest technology 34
4.3 Discussion and interpretation 37
4.3.1 Marginal effect of the factors affecting embracement of postharvest technology 38
4.4 Summary 41
CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS .. 42
5.1 Introduction 42

5.2 Discussions 43
5.2.1 Socio economic and socio demographic characteristics of the study area 43
5.2.2 Education level of farmers 43
5.2.3 Causes of postharvest loses 43
5.2.4 Factors affecting the embracement of postharvest technology 44
5.3 Conclusion 45
5.4 Implications 45
5.5 Recommendations 46
5.6 Suggestions for further research 46
References 48

List of Tables

Table 1: Variables to be included in the double hurdle model and expected signs…… 19

Table 2: Socio – economic and demographic characteristics of tomato farmers…...29

Table 3: Institutional factors and support services characterizing tomato farmers in Umguza, Lupane and Tsholotsho……31

Table 4: Constraints faced by tomato farmers……...33

Table 5: Diagnostic Test of the double hurdle model……34

Table 6: Marginal effect of the factors affecting adoption of postharvest technology……..……35

List of Figures

Fig 1: Theoretical framework……. 10

Fig 2: Conceptual framework…….19

Fig 3: Main causes of tomato postharvest losses……...…….30

Fig 4: Major sources of information…….…….32

List of Appendices

Appendix 1: Questionnaire…….57

Appendix 2: Key informant interview questions ……...64

Appendix 3: AUREC Approval Letter ……..….. 65

Appendix 4: Urkund antiplagiarism report…….66

CHAPTER 1 INTRODUCTION

1.1 Introduction

There has been a world specialized in achieving food security, ending poverty and reducing post-harvest loses which is reflected within the Sustainable Development Goal (SDG) 1 and 12,3. SDG 1 aims at eradicating poverty altogether. While 12.3 also advocates for the reduction of food loses along the assembly and supply chain including post-harvest loses by 2030 (United Nations, 2016). These goals are aimed towards ending poverty and reducing post-harvest loses mostly in developing countries like Zimbabwe which has agriculture as its mainstay. Agriculture can only function as backbone of the economy of a country if modern technologies are adopted within the processing, storage and marketing of food crops (Seidu et al., 2012). The country is dominated by the small holder farming sector which is 97,5% smallholder farmers and large scale which is 0,11% farmers (Zim Agric Survey, 2019). Matabeleland North province includes a number of small holder farmers and large-scale farmers 70% (Agritex, 2010). For these farmers horticulture is one of the practiced agricultural activities with tomatoes being the foremost cultivated vegetable.

1.2 Background of the study

Tomato production provides a source of income for the Matabeleland North farmers further as vital source of food security in so doing it reinforces the event of poverty reduction goals (Heinemann, 2002). Research in the whole value chain of tomato production has made the life of farmers better and manageable through improved varieties that are high yielding. (Arah *et al*., 2015). This has made tomato farmers enjoy good harvests in recent years. However postharvest loses have been a great threat

to farmers in Zimbabwe making them not realise desired profit. Tomatoes are perishable and have a shelf life between 5- 18 days betting on the variety and post-harvest handling done (Muhammad, 2011) Enhancing the power of tomato farmers to succeed in reaching markets and actively engage within the markets maybe a key challenge affecting tomato production in Matabeleland North. It is reported that due to inability of farmers to reach markets on time and failure to possess stable markets, there's 30 – 40% post-harvest loss (Zimbabwe Stats Vegetables 2017). The farmers sell three quarters of their produce at the farm gate at a price that's more attractive to the middle man than to the farmer (Bongani, 2018).

The level of postharvest loses between the farmer and therefore the consumer hampers the expansion of a tomato farmer. These loses maybe be observed through physical damages, physiological decay or moisture lose in most of the fruits before it gets to the ultimate consumer. Through the progression and evolving of postharvest technology and practices, the planet has embraced better ways of curbing the loses like packaging containers, improved harvesting sheds, cool transportation trucks and value addition like drying and canning. For Umguza, Tsholotsho and Lupane district, the postharvest technology investigated were the use of packaging containers, improved harvesting sheds and value addition methods like drying and canning. This results in minimization of postharvest losses encountered by farmers. Curbing loses is thought to be as one key strategy which might reduce area needed for production, improve food supply and cause conservation of natural resources (Kader, 2003). Adoption of postharvest technology by vegetable farmers provides adequate opportunities for farmers to extend their profitability through raising local value-added products, increasing bargaining power, enhancing market access and promoting greater competition among middlemen (Khatana *et al*., 1997; Mittal, 2007).

1.3 Statement of the problem

The majority of farmers in Matabeleland North region in Zimbabwe have ventured in tomato production because of the high market price related to the vegetable (ZimStats Veg 2015). Despite the high tomato market price, the farmers within the study area are faced with up to 40% of postharvest loses (Agricultural Sector Survey, 2019). Importation of finished tomato products is a sign indication that the region isn't self-sufficient in tomato production. It consumes 3000 tonnes/ per year from imports (Zimbabwe Daily, 2018). Even though there is always a glut on the market, this is only short-lived, as tomatoes are highly perishable and difficult to store if not processed. The inefficiencies within the postharvest handling of tomatoes have therefore created a requirement shortfall which is being filled with imports of processed products. Until these gaps of inefficiencies are closed by adopting the suitable intermediate technologies, producers as well as the governments in Zimbabwe will not derive the most pleasure from tomato production.

1.4 Research objectives

1. To ascertain the causes of postharvest loses that farmers are experiencing in Umguza, Tsholotsho, Lupane district
2. To establish the institutional, cultural, socio-economic factors affecting the embracement of postharvest technology for tomato farmers in Umguza, Tsholotsho, Lupane district
3. To determine the other factors affecting the embracement of postharvest technology by farmers in Umguza, Tsholotsho, Lupane district

1.5 Research questions

1. What are the causes of postharvest loses that farmers are experiencing in the Umguza, Tsholotsho, Lupane district?
2. What are the institutional, cultural, socio-economic factors affecting the embracement of postharvest technology by tomato farmers Umguza, Tsholotsho, Lupane district?
3. What are the other factors affecting the embracement of postharvest technology by tomato farmers in Umguza, Tsholotsho, Lupane district?

1.6 Assumptions

The researcher assumed that farmers were willing to participate in answering the questions. Also, the researcher assumed that there will be able to acquire an exemption letter from Agritex to freely move around during COVID 19 lockdown period. despite the emerging threats like corona virus and practice the World Health Organisation hygienic recommendations against the virus, a sanitizer always with the researcher and wore a mask always whilst talking to the farmers and everyone being interviewed. The researcher assumed that the research is going to be relevant to handle key issues in tomato market challenges and had sufficient resources to manoeuvre around.

1.7 Significance of the study

This study provided guidance to the government agricultural administrators and researchers by indicating with facts the situation at hand in each district. The added knowledge on which factors have greatest influence on postharvest technology adoption helped the ministry administrators to create more informed decisions on the way to promote postharvest technology adoption.

In addition, this study provided a basis for gauging how policy changes may affect tomato farming. Policy issues that constrain or enhance the availability of inputs that are required to hold out postharvest technology have a direct effect on how tomato farmers react to them. The results provided useful information to reinforce the success of the adoption of postharvest technology in Matabeleland and the other related program that attempts to introduce practices for adoption in settings that are almost alike to those in the study area.

The information on the factors influencing the embracement of postharvest technology helped to fill the knowledge gap and also being useful to the public and private sectors like the processing industries and insurance companies. The processing industries of tomato puree and sauces found the information from the research valuable in targeting wards and districts to get jam tomatoes or to carry out tomato farming. Additionally, the insurance companies targeting the traders in the tomato supply chain found the results useful in developing proper insurance policies towards the reduction of tomato postharvest losses

1.8 Delimitation of the study

The study was confined to Matabeleland North region in Zimbabwe specifically targeting 3 districts Umguza, Tsholotsho and Lupane. Focusing only on tomato farmers who are doing both table and processing tomatoes.

1.9 Limitation of the study

Some of the records for the farmers were missing hence recalling them took time for instance total yields they would have had previous season. To curb this problem the

researcher asked them average figures for income and yields. Farmers were not be comfortable in giving sensitive data.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter presents a review literature of factors affecting the embracement of postharvest technology by tomato farmers. The chapter also presents the theoretical frame work of the study, empirical studies, conceptual framework and the research gaps for further study

2.2 Theoretical framework

Rogers (2003) defines technology as a design for instrumental action which reduces the uncertainty in the cause – effect relationship involved in achieving a particular outcome. Adoption is also defined as a degree of use of new technology in the long run when the individual has full information about the new technology and its potential. There are a number of theories that are used to explain the adoption of technology in different sectors. Some of the theories as outlined by Obibous Daki (2005) are reasoned action, theory of planned behaviour, diffusion innovation theory and unified theory of acceptance.

2.2.1 Theory of Reasoned Action (T.R.A)

The theory of reasoned action (TRA) (Ajzen & Fishbein, 1980) developed out of social–psychological research on attitudes and the attitude–behaviour relationship. The model assumes that most behaviours and adoptions are under volitional control, and that a person's intention to perform a behaviour is both the immediate determinant and the single best predictor of that behaviour. Intention in turn is held to be a function of two basic determinants: attitude towards the behaviour which is the person's overall evaluation of performing the behaviour and subjective norm which is the perceived

expectations of important others with regard to the individual performing the behaviour in question). Farmers will have strong intentions to perform a given action if they evaluate it positively and if they believe that others think they should perform it. The relative importance of the two factors may vary across behaviours and populations. Many behaviours cannot simply be performed at will they require skills, opportunities, resources, or cooperation for their successful execution. This is given for postharvest technology that require skill and sometimes resources.

2.2.2 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) is an extension of the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980). Both models are supported by the premise that individuals make logical, reasoned decisions to interact in specific behaviours by evaluating the knowledge available to them. The performance of a behaviour is decided by the individual's intention to have interactions in it (influenced by the worth the individual places on the behaviour, the convenience with which it can be performed and therefore the views of significant others) and therefore the perception that the behaviour is within his/her control. In Reasoned Action a TPB model supported attitudes, social support, self-efficacy and intention was moderately successful in predicting and explaining self-management of arthritis (Strating *et al*., 2006).

2.3 Relevance of the theoretical framework to the study

2.3.1 Theory of random utility model (RUM)

This study is anchored on the random utility model (RUM) which assumes that the choice maker has perfect discrimination ability (Brooks et al., 2011). In selecting any of the adoption option the farmer deliberates on the prices and the benefits associated

with these adoption decisions. Also, how they'll derive maximum utility from it subject to external factors. If the prices that are linked with to post-harvest technology are higher than the advantages the farmer will not be encouraged to begin or continue using it thus choosing the following best alternative. To maximize their expected utility a farmer can attempt to adopt postharvest technology. The tomato farmers are expected not to adopt or decrease the adoption of postharvest technology if the satisfaction from not adopting or decreased intensity of an adoption is larger than adoption or increased intensity of adoption.

The utility of the farmer depends on maximum profit attained through cost maximization and productivity optimization. It is assumed that the choice made by the farmer maybe a function of technology, institutional and socio-economic characteristics. The utility of adopting or increasing the intensity of adoption is latent (unobserved) variable and might only be observed through the choice made by the farmer. Let U_n, U_a, U_d represent the utility within the state of non-adoption of post-harvest tehnology (n) adoption (a) and increased intensity (d) of postharvest technology respectively. The farmer chooses to alter from position of non-embracement thereto of embracement of postharvest technology in his or her tomato production if $U^* = U_a - U_d > 0$ where U^* is that the unobserved net benefit of adopting or increasing the intensity of adoption (Lancsar and Savage, 2004). Therefore, the choice made by the farmer to embrace or increase the intensity of adoption will be determined by

$$U_x = X_{ij}B + E_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where X_{ij} maybe a vector of observable farmer i characteristics for adopting and B represents a vector of estimated parameters and E_{ij} is that the random error term which

represents unobserved characteristics that influence the choice made by the farmer (Lancsar and Savage, 2004). In other words, it represents uncertainty since it's assumed that the farmer doesn't have perfect information. For an example in this study the farmer who is the decision maker chooses to adopt postharvest technology to achieve some level of utility U^{*}_{ij}, the model assumes that the farmer will choose the choice that offers gives him or her maximum satisfaction (Lancsar and Savage, 2004). The deterministic part (X_{ij}) of the model is a linear combination of observable explanatory variable like age, education and household size.

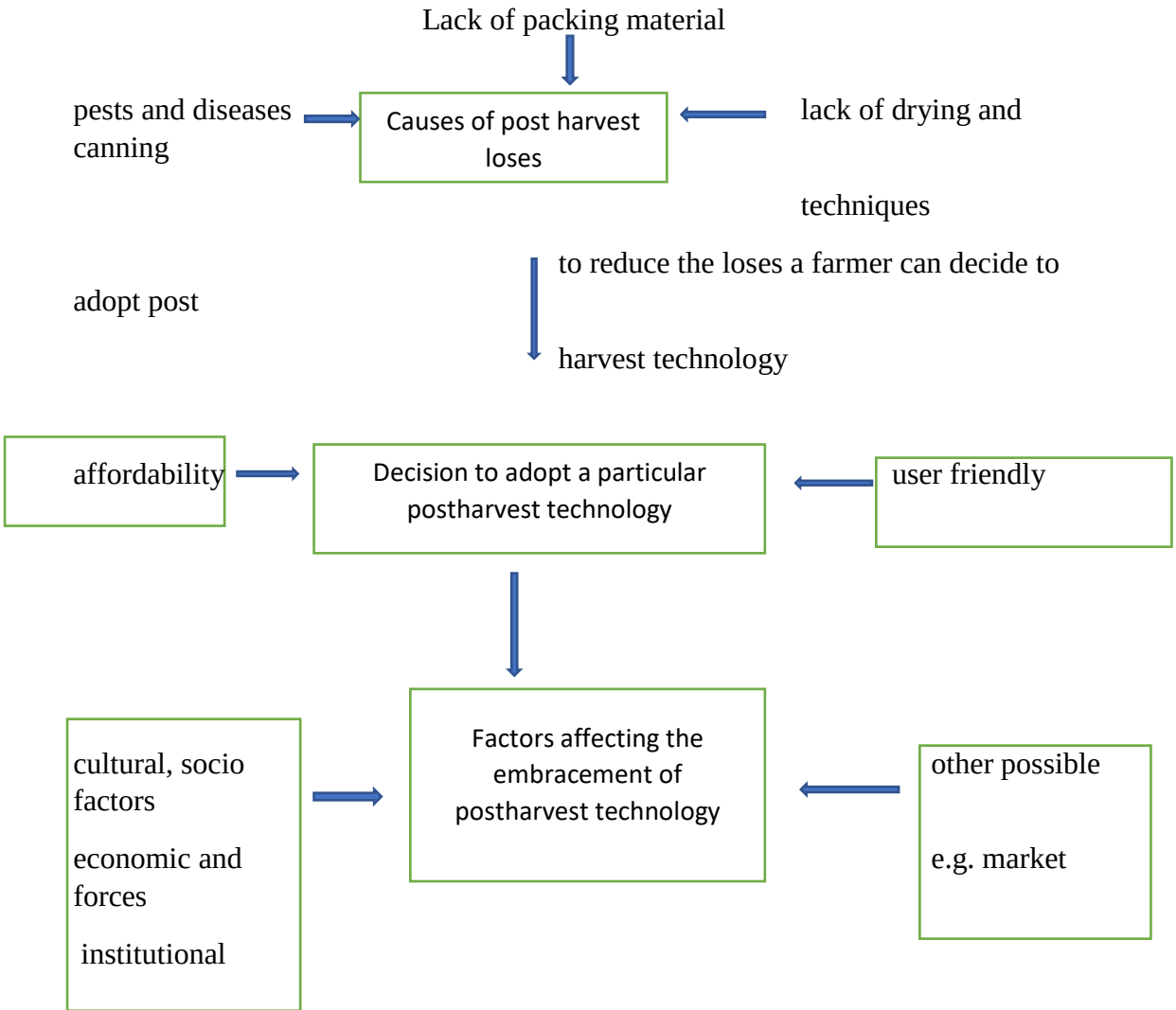

Fig 1: Conceptual model explaining the random utility theory for the factors affecting embracement of post-harvest technology

Source: (Erhie *et al*., 2018)

Fig 1 above explains how the farmer endures post-harvest loses due to lack of packing material, pests and diseases and also lack of drying and canning techniques. The farmer might decide to reduce the loses to adopt post-harvest technology. In making the decision to adopt the postharvest technology the farmer will adopt a technique that is affordable and user friendly so as to get the most out of the newly acquired technique. There will also be factors which will be affecting his decision to adopt the postharvest technology like institutional, cultural and socio-economic factors.

2.4 Empirical evidence on the main causes of postharvest loses in tomatoes

The postharvest loses happen due to several reasons. According to Isaac et al., (2015) the causes of postharvest losses in tomato production are often categorised into two major groups, the on farm and off farm causes. Under on farm causes Isaac et al, (2015) mentions inappropriate harvesting period. Beckles (2012) states that physiological maturity of the fruit at harvesting stage has major effect on quality. Fully ripened tomatoes are susceptible to bruises and injuries thus reducing their shelf life (Toivonen, 2007

Another on farm cause of postharvest lose is lack of tomato crates for harvesting. Tomatoes are harvested by manual picking in most developing countries. Isaac et al., (2015) mentions in his study that most of the in Africa use wooden crates and woven baskets which causes bruises as the tomatoes will be coming in contact with its rough surfaces. Overloading during harvesting can cause compressive stresses leading to squashing and crushing of fruits as they are being transported (Hurst, 2010).

According to Aidoo *et al*., (2014). In his study he stipulates that farmers reported that rot resulted from over use of spraying chemicals. Bruises however resulted from poor stalking and poor handling during harvesting and sorting.

Nshizirungu and Kinitoja (2019) in their study Tomato Postharvest Management identified not having precooling facilities as a cause for tomato loses. Precooling is the way of to remove/reduce the sphere heat before packing. The loss at this stage is primarily because of the high cost on the price and lack of availability of precooling facilities, inadequate training.

2.5 Review of empirical evidence on studies on postharvest technologies and practices employed in tomato production and other fruits.

Postharvest activities include harvesting, handling, storage, processing, packaging, transportation and marketing (Mrema & Rolle, 2002). The principles that dictate at which stage of maturity a fruit or vegetable should be harvested are crucial to its subsequent storage and marketable life and quality. According to Orzolek *et al*., (2006), tomatoes for the wholesale market should usually be picked at the mature green to breaker stage to prevent the fruit from rotting when they are over ripe. Usually, fresh market tomatoes are harvested by hand with harvesting operation varying among growers.

For the harvesting operation, Kitinoja (2008) recommends the utilisation of plastic buckets for harvesting fruits that are easily crushed, like tomatoes. These should be smooth with none sharp edges that would damage the produce. Arah *et al*., (2015) stipulates that physical handling can have a drastic effect on the post-harvest quality and shelf life of a tomato. As an example, rough handling during harvesting and after harvesting can cause mechanical injuries which may affect the post-harvest quality and

shelf life of a tomato fruit. Other technologies and practices are use of shade, harvesting tools and equipment, improved packaging, containers and packaging material.

Tomatoes are highly perishable and really at risk of mechanical damage with poor handling and transportation (Bani *et al*., 2006). Additionally, at the usually high temperatures fruits and vegetables transpire and respire at high rates therefore the requirement shade from the sun's heat (Harvey, 1992). In the study Postharvest Issues Rethinking technology it stipulates that post harvest damage to bananas decreased significantly in Chipinge when private company Matanuska bought a modern production technologies like handling facilities and pack sheds (Mandisvika et al., 2015). In support with this Kitinoja (2019) acknowledges that providing shade for fresh tomatoes or other produce after harvest helps to cut back the pulp temperature and extend shelf life.

One of the most important processes in packaging and marketing of fruit and vegetables is sorting and grading (Arjenaki *et al*., 2015). Grading is additionally the method of the process of categorising fruits and vegetables on the basis of colour, size, stage of maturity, or degree of ripening (Arah *et al*., 2016). Commercial tomato producers normally use sophisticated systems that need precise sorting and grading standards for their produce. Small-scale producers and retailers in developing countries in contrast might not use written down grading and sorting standards

Packaging is additionally amongst the important aspects to think about in addressing postharvest losses in fruits and vegetables. Nshinzirungu and Kitinoja (2019) stipulates that use of improved containers and packages for handling harvested produce, like wooden crates and plastic crates may be accustomed to reduce postharvest loss.

Adding a liner (such as paper or plant materials) to a rough container can help to scale back abrasion damage. The Postharvest Education Foundation performed a cost/ benefit analysis on the employment of returnable plastic crates (RPC) compared to other single use packaging containers within the USA. The results showed that the utilisation of RPCs yielded the very best amount of net profit compared to fibre board cartons, sacks and baskets which generated the lowest net profit (Kitinoja, 2013). In support with this a case study on the use of plastic crates by farmers in Afghanistan showed that RPCs reduced transport spoilage of fresh tomatoes from 50% to five percent (CNFA, 2006).

Another postharvest technology used to reduce loses in tomatoes is value addition through processing and preservation. According to Yeboah (2011) tomato gluts are an annual feature that happens just for some weeks of the year thanks to production of huge volumes of rain fed local varieties that are unsuitable for processing. Mandisvika et al., (2015) within the study Post harvest issues and rethinking technology revealed that small commercial farms like Golden Harvest and Froggy Farm make jam as the way to cut back postharvest loses in Mashonaland province in Zimbabwe. The study also acknowledges the utilisation of drying technology to preserve food. For example, donors who were engaged in the Musami area of Murehwa introduced communal drying technology to local people to reinforce food security at the village level. The normal technique of sun-drying leafy green vegetables is the commonest in Zimbabwe and has been passed down from generation to generation from an early time. This method enables households to access vegetables throughout the year. Drying of fruit and vegetable is also a preferred method to preserve foodstuffs to be used as material in other food products. For example, both dried vegetables and fruits are often pounded

into a powder and accustomed to make soup, or the powder will be added to flour for cakes.

On preservation, Kitinoja and Gorny (2009) recommend the employment of brine or vinegar to pickle vegetables like the tomato. Due to the acidic nature of vinegar, there's no need for further processing if it's decanted into sterilized containers before being filled with the tomatoes. Ashby (2005) described a straightforward home-drying method for stewing tomatoes. Ripe tomatoes are steamed or dipped into boiling water to loosen skin, chilled in cold water, peeled and cut into sections about ¾ inch wide, or slice. These are blanched for three minutes and dried within the dehydrator for 10 – 18 minutes or twice this time using the traditional oven

In a study carried out in Rwanda, Zero Energy Cool Chambers (ZECC) are found to be superb use in providing cooler temperature for the harvested fruits. This technology is formed from stuff that can easily be found (Kitinoja, 2019).

2.6 Empirical evidence on the factors affecting embracement of postharvest technology in agriculture

The socio- economic and demographic characteristics of the farmers or traders like age, income level, sex, household size, education level, and years of experience among others have been found to affect adoption of postharvest technologies significantly (Aghadi, 2017). Elemasho *et al*., (2017) conducted a study on the factors affecting the adoption of postharvest technologies of selected food crops in Rivers State, Nigeria. The study found out that age of the farmer, sex, marital status, education, household size, years of experience and source of information significantly affected the adoption of agricultural post harvest technologies in the study area. Similarly, the work of Tiamiyu *et al*., (2014) found age and education level as significant factors influencing

the adoption of on farm and post harvest technology in the study area. The study was carried out to examine the rate and determinants of the adoption of improved rice.

Furthermore, Obayelu *et al*., (2016) worked on the determinants of the perceived effects of the adoption of selected improved food crops technologies among smallholder farmers along the value chain. Some of the technologies that were examined in the study included the cabinet dryer, chipping machine, fermentation tank, flash dryer, rotary dryer, sifter, de- stoner. Grinder machine and others. The study also found household socio- economic and demographic factors like household size, years of schooling, age of household head and years of experience to significantly affect the farmer's decision to adopt postharvest technologies on cassava and grains.

Peter *et al*., (2017) in his study on factors influencing number of postharvest practices adopted by smallholder vegetable farmers in Mashonaland East revealed that distance to the market, information, group membership, credit and hired labour significantly influenced post harvest practices adopted. Also gender of the household head was found to significantly influence number of postharvest practices adopted by farmers in his study. The marginal effect results suggested that female head households will adopt one unit more postharvest practices than their male counterparts.

Mutayoba and Ngaruko (2015) found that farmer's experience increases quality and quantity of vegetables produced. Additionally, he found that experience gives farmers bargaining power as well as improve their marketing network. In another study conducted by Alshadiadeh *et al*., (2012) it says farming experience had positive and statistically significant effect on influencing farmer's decision to adopt post harvest practices in vegetable production.

According to Ali (2012) availing of market information plays a significant role in influencing small holder vegetable farmers in adopting post harvest techniques. In line with this finding Peter et al., (2017) stipulates that access to market information reveal that basic post harvest practices increase farmers profit for rape in their current marketing channels. Institutional factors and support services available in the area of study were significant factors found to determine the level of adoption of postharvest technologies. Group membership, credit accessibility, extension contact, training and electricity are primary support services and institutional factors that have been found to affect the adoption of postharvest technologies significantly (Akangbe *et al*., 2014). In addition, the work of Tiamiyu *et al*., (2014) highlighted access to credit and membership to cooperatives as major factors that influenced the adoption of improved rice quality enhancing

2.7 Conceptual framework

The decision on embracement of postharvest technology by fresh tomato farmers was dependent on the farmer's expected utility from its adoption of increased intensity of adoption (Nwabuogo, 2017). The expected utility of the farmer is further influenced by several factors which influence the farmer's decision on adoption of the technology (Teklewold *et al*., 2013). These factors are grouped into institutional, socio- economic / demographic and other factors as shown in Fig 2.

Institutional factors comprise factors such as group membership, credit access and training programs. Market groups and associations are vital platforms that could encourage the adoption of relevant innovations and technologies. A farmer's membership in an association affects their probability of adopting new and relevant technologies (Akngbe *et al*., 2014). The ability to access credit services would affect

the farmer's willingness to adopt any conventional technology in use. Training programs are also very crucial to the farmers in their adoption decisions for the acquisition of relevant information which promote technology adoption. Training programs also help to influence the farmer's awareness and perception of the new technology. Increased awareness and perceptions of postharvest technology increases its probability of adoption (Elemasho *et al*., 2017).

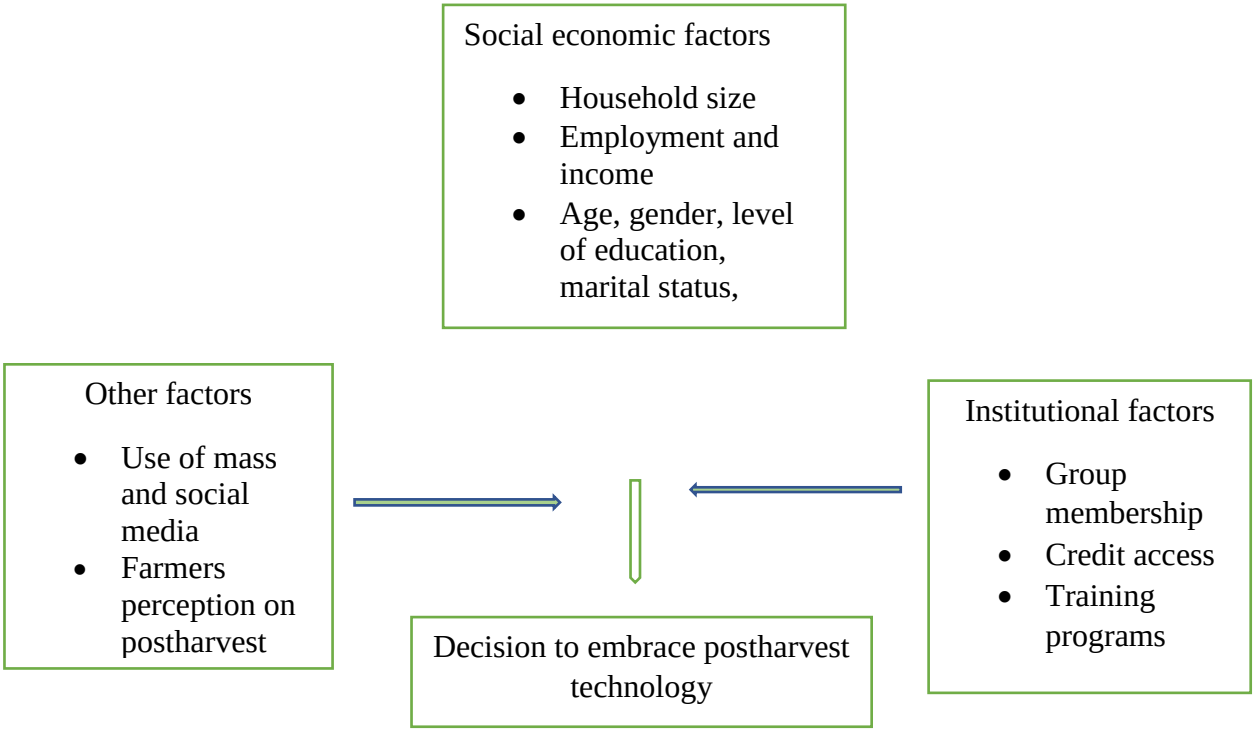

Fig 2: Conceptual framework

Source: Author's conceptualisation

Independent variables are institutional factors, socio- economic factors and other factors

Dependent variable is the decision to embrace postharvest technology

Table 1: Variables to be included in the double hurdle model

Variable	Description	Expected sign on adoption
Age	Age of the trader in years	-
HH size	House hold in size	-/+
Income	Number of income sources	+
H head	Being a household head	+
Education	Years of formal education	+
Asso member	Number of market association a trader belongs to	+
Media	Access to television and radio	+
Training	Participation in training programs	+
Perception	Perception of the farmers towards postharvest technology perception =0 positive perception =1	+
Irrigation	Access to irrigation	+

2.7.1 Age of the farmer

The age of the farmer was collected as a continuous variable in years. The effect of the age of the farmer on the adoption is hypothesized to be negative. This is because the younger population is more open and willing to try innovations and has been observed to be less risk averse (Teklewold *et al*., 2006). Elemasho *et al*, (2017) also found out that the younger respondents were more likely to adopt postharvest technologies than the older ones.

2.7.2 Household (HH) size

Household size was collected as a continuous variable in terms of the number of people living and feeding in the same house hold. The effect of the household size on the adoption of agricultural technologies has shown different patterns in literature. Large household size has increased the adoption of agricultural technologies (Obuobisa-darko, 2015). A larger household could increase the monthly expense of the farmer and could also be an additional source of income and labour of the farmer. The household size is therefore hypothesized to be either having a negative or positive effect on the adoption.

2.7.3 Number of income sources

It was expected that the higher the number of income sources a farmer has, the more diversified and open they are to technologies. It was found that farmers with secondary occupations had higher adoption levels (Olaoye et al., 2017). Also, it is expected that a higher number of income sources would signify a larger amount of income, which would provide the farmer with the financial resources to adopt postharvest technology. According to Adegbola et al., (2011) the number one reason identified by 100% of the respondents for not adopting the postharvest technology like plastic crates was due to its cost and inability to afford it. A higher number of income sources will be hypothesized to increase the adoption of post harvest technology.

2.7.4 Household head

The effect of being the household head on adoption of postharvest technology is hypothesized to be either positive or negative as it could either increase or decrease

the level of adoption of postharvest. The household heads are in charge of decision making and this hasten the process of postharvest technology adoption.

2.7.5 Education

A higher level of formal education was expected to increase the adoption of postharvest technology. Studies have shown that those with higher education possess more knowledge and exposure which leads to higher probability of postharvest technologies (Akangbe et al., 2014; Tiamiyu et al., 2014)

2.7.6 Membership to market associations

It was expected that farmers who belong to market groups and associations have access to relevant information on new technologies in the tomato markets. Studies have found out that membership to associations has increased the adoption of postharvest and value addition technologies (Akongbe et al., (2014); Tiamiyu et al., (2014); Obuobisa darko (2015) found out that membership to farmers associations also increased intensity of adopting agricultural technologies. Therefore, membership to market associations is hypothesized to have positive effect on adoption of postharvest technologies.

2.7.7 Access to media

Access to media was hypothesized to influence the embracement of postharvest technology positively. Access to media by tomato farmers was expected to enhance the level of awareness and perception of postharvest technologies and lead to increase to adoption. Access to radio and television has been highlighted as a powerful tool for obtaining information on agricultural technologies (Obidike, 2011; Elamasho et al., 2017)

2.7.8 Perception of the farmers

Positive perceptions by the farmers towards postharvest technology was expected to increase the adoption of postharvest technology. Studies have shown that a positive perception towards a particular agricultural technology would significantly increase its likelihood of adoption **(**Obidike, 2011; Elamasho et al., 2017; Esfaw et al., 2011).

2.7.9 Access to irrigation

Access to irrigation was hypothesis to positively influence the embracement of postharvest technology. This was due to the fact that access to irrigation increases production hence increasing profits that can be used to embrace post-harvest technology. Studies have shown that access significantly increases chances of embracing post-harvest technology (Akongbe et al., (2014); Tiamiyu et al., (2014); Obuobisa darko (2015)

2.8 Summary

There are couple of theories used to explain the adoption of technology. For this study the random utility model was used. The model illustrates that the farmer will be possibly experiencing loses due to lack of packing material, pests and diseases and also lack of drying and canning techniques. The farmer might decide to reduce the loses by adopting post harvest technology. In making the decision to adopt the postharvest technology the farmer will adopt a technique that is affordable and user friendly so as to get the most out of it. Some factors will affect his or her decision for example institutionally, culturally and socio-economic factors. Institutional factors comprise factors such as group membership, credit access and training programs. Socio economic factors include household size, employment and income, age, gender,

education, marital status. Also, the model used other factors like use of mass and social media including farmer's perception on postharvest.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter outlines the paradigm, research area, research design, target population, sampling technique, sample size, data collection methods, data collection instruments and finally the data analysis.

3.2 Research Design

The study used analytic cross sectional and descriptive research design due to its ability to capture the data needed for analysis. Qualitative and quantitative approach was employed to gather data on the factors affecting the adoption of postharvest technology by tomato farmers in Matabeleland North. The quantitative research approach was used to obtain cross-sectional data on the sampled tomato farmers at a selected time. The quantitatively research was collected through questionnaires that have closed ended questions. For the qualitative data, it involved open ended interview questions. Quantitative and qualitative approaches provide different pictures and therefore the more evident the better the argument.

3.3 Population and sampling

The target population for this study were respondents consisting of tomato farmers both the small holder and commercial farmers and their extension officers within the districts. Mugenda (2003) reported that the target population should have some observable characteristics, to which the researcher intends to generalize the results of the study. Population under study was of farmers growing tomatoes. The population of individuals living in Matabeleland North is comprised of 7 districts Tsholotsho, Mguza, Lupane, Nkayi, Hwange, Binga and Bubi. Three districts were selected

through purposive sampling whereby it is known that tomato production takes place in those districts through statistics provided by the provincial office in Matabeleland North region. The data was collected through a multistage sampling technique. The primary stage involved the purposive selection three of the seven districts based on prevalence of tomato farming in the area. The second stage was the use of purposive sampling technique to select wards where tomato production is prominent. The third stage comprised cluster formation where by farmers from each district was clustered into units.

The study was comprised of 80 tomato farmers plus six district extension officers who were each interviewed; in total the study had 86 respondents. Inclusion of agricultural extension officers in this study was based on two reasons, to serve as first contact persons in knowing the major production communities of the districts. Also, they helped in getting to know some farmers in the communities. This sample size was calculated using Raosoft Sample Size Calculator (Raosoft, 2004). The research used 95% confidence interval. The total number of the population is 100 and when calculating using Raosoft Sample Size

3.4 Data collection instruments

The cross-sectional data was collected through interviews of key informants and the use of a structured questionnaire in the study area. The questionnaire included household characteristics such as demographics questions (name, age, sex, education etc), challenges that farmers come across in tomato production and finally postharvest techniques that they use in their tomato production. Interviews included well structured questions that were asking the provincial agronomist and extension officers how the

government was helping the farmers in the uptake of post harvest technology in tomato production.

3.5 Data collection procedure

The purpose of the interviews was to acquire insights on the causes of postharvest loses and use of postharvest technology. The interviews and pretesting of the questionnaire were carried out in one of the biggest plots in Umguza (Thembanani farm). The questionnaire was first pretested day before it was fully administered. Questions which emerged irrelevant were deleted while other questions were rephrased accordingly. The interviews were carried out for four days. This involved tomato market association leaders, provincial agronomist and extension officers. The questionnaire was administered with the help of four trained enumerators who were selected based on qualification, data collection experience and communication skills. The semi structured questionnaire was used in collecting primary data from tomato farmers in Umguza, Tsholotsho and Lupane.this took 10 days. Data were collected on the socio- economic characteristics of the respondent, the factors affecting the uptake of postharvest technology in the 3 districts. One enumerator helped with the interview questions of the key informants.

3.6 Data analysis and organisation of the data

Data collected from questionnaire was coded and entered into a spread sheet before being analysed using Statistical Package for Social Sciences (SPSS) and STATA. Two sets of analysis were used. Descriptive analysis was employed in the form of ratios, percentages, describing household characteristics and postharvest facilities. The adoption decision was analysed in a binary regression model where by 0 was recorded for non-adopters and 1 for the adoptors. To analyse factors influencing the adoption of

postharvest technology a double hurdle model was used. According to Teklewold et al., (2006) the model is seen as a parametric generalization of the Tobit model within which two separate stochastic processes are employed to see the choice to adopt a specific technology.

3.7 Research ethics considerations

The ethical clearance letter for this study was sought from AUREC department at Africa University after the proposal had been approved. The letter was submitted to the provincial agronomist then to the three districts under study for permission to undertake the study in the Matabeleland North region. Once permission was granted at provincial level the researcher ensured farmers and all stakeholders that all information, ratings and assessments of any of the research instruments was going to be treated with strict confidentiality. Data generated was analysed and processed as group information with no discrimination on grounds of colour, tribe, nationality, religion, race or background.

3.8 Summary

This research used analytic cross sectional and description research design. The targeted population for this study had smallholder farmers, commercial farmers and extension officers within Lupane, Umguza and Tsholotsho district. The cross-sectional data was collected through interviews of key informants and a structured questionnaire. Once the data was collected it was analysed using Statistical Package for Social Sciences. To gain entrance within the districts an ethical clearance letter was sought from AUREC department at Africa University and also from the provincial agricultural extension officer of Matabeleland North.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This section discusses and interpret the socio-economic demographic and support services that characterised the tomato farmers in Umguza, Lupane and Tsholotsho districts. These factors are presented in Table 2 and Table 3. These tables show the mean of the sampled population adopters and non-adopters of post harvest technology. Only 16 (19%) out of 86 sampled tomato farmers had adopted at least one form of post harvest technology amongst the selection of improved cooling shades and value addition like canning and drying. Whilst 65 farmers out of 86 (76%) were using proper packaging containers (plastic crates). 19% rate shows a low percentage of post harvest technology adoption in the study area which is in line with other studies that have also highlighted the low adoption of post harvest technology and practices (Elemasho et al; Olumunyiwa et al., 2017)

4.2 Data presentation and analysis

4.2.1 Socio – economic and demographic characteristics of tomato farmers

Variables **Districts**

	UMGUZA	TSHOLOTSHO	LUPANE	ALL	ADOPTERS	NON-ADOPTERS
Sample size	58%	18%	24%		19%	81%
	50	15	21	86	16	70
Females	21 (24%)	14 (16%)	4 (5%)	39 (45%)	10	30
Males	29 (34%)	1 (1%)	17(20%)	47 (55%)	6	40
MARITAL STATUS						
Married	24 (28%)	10 (12%)	16 (17%)	50		
Single	5 (6%)	0	3 (3%)	8		
Widowed	20 (23%)	5 (6%)	2 (3%)	27		
Divorced	1 (2%)	0	0	1		
EDUCATION						
Primary	28 (33%)	13 (15%)	9 (10%)	50		
Secondary	12 (13%)	2 (3%)	12 (14%)	26		
Tertiary	10 (12%)	0	0	10		
	MEAN	**MEAN**	**MEAN**			
AGE	42	40	45	42.3		
HOUSEHOLD SIZE	5.78	5.06	5.91	5.58		
YEARS IN TOMATO FARMING	5.43	4.1	5.6	5.04		

Table 2: Socio – economic and demographic characteristics of tomato farmers

The results in Table 2 show that the majority of households in the study area were male headed 55% for the overall districts. There is also a significant difference between the adopters and non-adopters in terms of their sex. The results show that the adopters had higher number of males compared to non-adopters. This could stem from the less time spent by men at home to care for the children and more time with their co farmers from which they gather more information about post harvest technology. The finding is in

line with the work of Teklewood et al., (2006) where the male household heads had a higher probability of adopting agricultural technologies.

4.2.2 Main causes of tomato postharvest losses

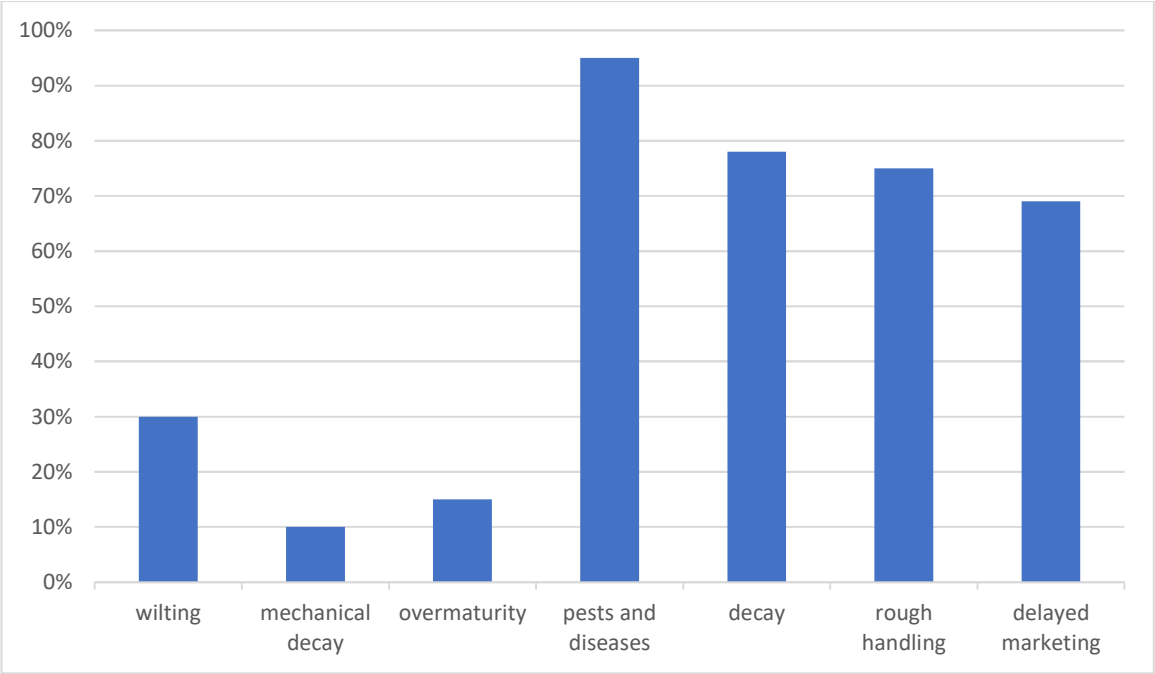

Figure 3: Main causes of tomato postharvest losses

Fig 3 summaries information on main causes of postharvest losses which are pests and diseases. According to the results Fig 3 bout 95%) responded that pests and diseases were the major cause of high levels of postharvest loses in tomatoes. Factors such as rot and rough handling were mentioned as second and third causes of postharvest loses respectively. The reason for high volumes of tomato rot can be ascribed to unreliable transport and poor roads that the farmer mentioned as challenges that their facing. Also, the non-availability of buyers and no storage facilities in the study area.

4.2.3 Institutional factors and support services characterizing tomato farmers in Umguza, Lupane and Tsholotsho

Variable	Max	Min	Pooled mean (n= 86)	Adopters (n= 16)	Non-adopters (n= 70)
Access to credit (1= access)	0	1	0.009	0.11	0.09
Training program (1= participation)	0	1	0.03	0.07	0.01
Group membership (1=member)	1	0	0.6	0.86	0.45

Table 3: Institutional factors and support services characterizing tomato farmers in Umguza, Lupane and Tsholotsho

The results in Table 3 show a generally low level of credit access with a mean of 0.09. The table shows a low level of access to credit among adopters and non-adopters of post harvest technology. There was a slight difference between the adopters and non-adopters as a higher percentage of the adopters had more access to credit than the non-adopters. The low level of credit access among tomato farmers could be one of the reasons for the low adoption of post harvest technology. The findings correspond with the study of Obayelu et al (2014) where up to 18% of the sampled farmers identified a lack of access of credit as the major barrier, they face in tomato farming.

4.2.4 Source of market information among tomato farmers

The results in Figure 4 show the major sources of market information outlined by the tomato farmers in the study area. It was revealed that 70% of the farmers sourced their market information from media. Also, up to 23% of the farmers indicated that their major source of information was from family and friends (23%). This result shows that

interpersonal interactions, mass and social media are vital sources of information for the farmers. The finding is in line with other studies where the major sources of information on agricultural technologies were highlighted as interpersonal communication and mass media (Obidike, 2011; Nwabeze et al., 2013; Elemasho et al., 2013)

17). A lower percentage of the tomato farmers sourced their market information from buyers (0.5%) and training program (0.5%)

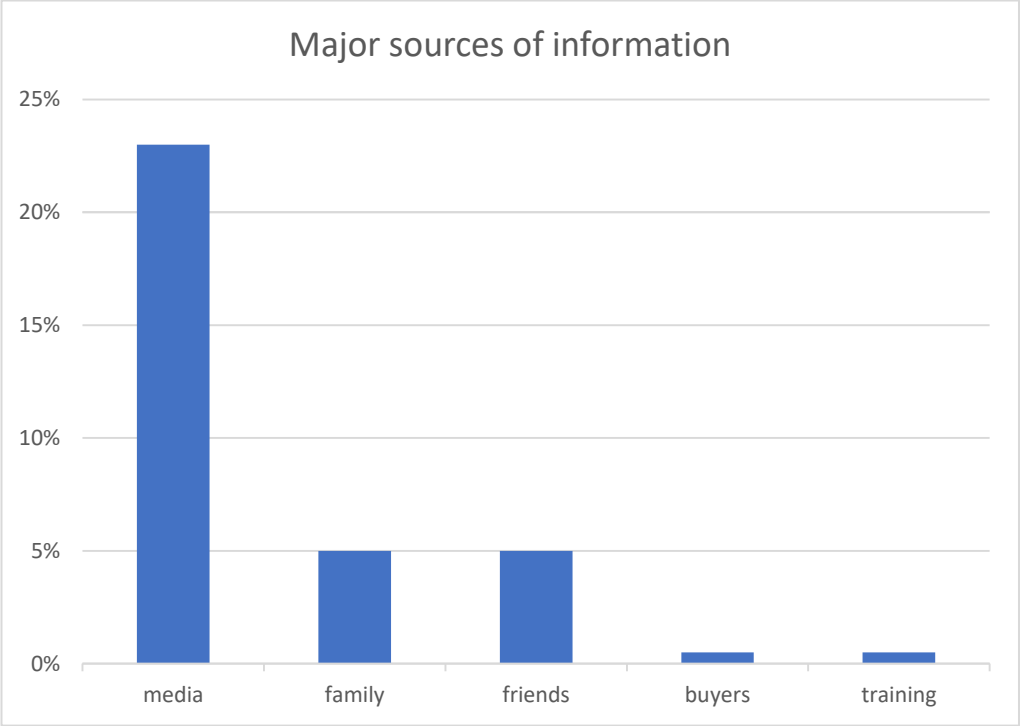

Figure 4: Major sources of information

4.2.5 Major constraints faced by tomato farmers

The constraints faced by the tomato farmers in the course of their tomato production are presented in Table 4. Up to 41% of the farmers identified high postharvest loses resulting from tomato diseases, inadequate storage facilities and other associated risks. This constraint was also pointed out in the study by Obayelu et al., (2014) where 29%

of the tomato farmers mentioned a lack of storage facilities as one of their major challenges. Also, the issue of lack of storage facility leading to high losses was pointed as a threat in the tomato market by Haruna et al., (2012).

Another constraint was low access to funds this was confirmed by 14% of the farmers. This finding tallies with the study of Obayelu et al., (2014) where lack of access to credit was identified by 18% of the sampled tomato farmers. The inability to access adequate market for the produce was highlighted by 12% of the farmers. Other constraints included lack of adequate training and knowledge about tomato market, bad road networks and long distance from farm to the market.

Table 4: Constraints faced by tomato farmers

Constraints	**Percentage (%)**
High postharvest losses (resulting from tomato diseases, lack of adequate preservation and other associated risks)	41
Low access to funds	14
Bad road networks and long distance from the farm to market	22
Lack of adequate training and knowledge about post harvest technology	12
Inability to access adequate market for the produce	10

4.2.6 Factors affecting the adoption of the postharvest technology for the tomato farmers

Table 5 shows the results of the diagnostic test of the double hurdle model against the tobit regression model.

	Probit regression	Truncated regression (Y (Y>0)	Combined (Double – hurdle)	Tobit regression
Wald x	166.70	41.00	92.79	227.82
Prob> x	0.00	0.00	0.00	0.00
Log likelihood	-72.13	-370.66	-442.03	-449.99
Number of observation (n)	86	16	86	86
AIC (-LOG- L+K) /n	0.31	1.59	1.86	1.89

Table 5: Diagnostic Test of the double hurdle model

The Likelihood Ratio (LR) test resulted in a test statistic of 15.939 and a significant p value of 0.00035 using the log likelihood value of the two estimated models. The test statistics (T = 15,939) exceeds the critical value of the x distribution. The use of the double hurdle model therefore results in a statistically significant improvement in model fit. The Akaike's Information Criterion (AIC) was also used to test for the fitness of the model and the double hurdle model which had the lowest AIC was preferred.

Table 6 shows the estimated marginal effect of the factors influencing the adoption of postharvest technology and practices

4.2.7 Marginal effect of the factors affecting adoption of postharvest technology

Variables	**Probability of adoption** **Marginal effect**
Age of the farmer	-0.004*

Household size	-0.003
Group membership	0.141***
Number of income sources	0.236***
Years of schooling	0.014
Access to radio	0.267***
Participation of farmers	0.119***
Gender of the household	0.127***
Access to irrigation	0.211***

Table 6: Marginal effect of the factors affecting adoption of postharvest technology

* And *** refers to the statistical significance at 5% and 1% respectively

The farmer's decision to adopt postharvest technology was significantly and positively influenced by group membership, the number of income sources, the use of radio and participation in training and perception of the farmers. However, the age of the farmers negatively affected the adoption of postharvest similarly affected the intensity of adoption negatively. This is due to the fact that the younger the farmer is the more willing they are to be innovative and adopt technology and as they grow older, they resist technology.

Group membership showed a positive significant (at 1% significant level) effect on the adoption of postharvest. This indicates that the tomato farmers who belong to market group or association have a higher probability (14%) of adopting postharvest technology than farmers who do not belong to any market group.

The number of income sources had shown a positive and significant effect on the probability of postharvest technology adoption at 1% significant level. This means an additional income source obtained by the farmers increases their probability of adopting post harvest technologies by 24%. One reason for this is that a higher number of income sources increases the amount of income a farmer has. Also, the farmers who have more sources of income or secondary occupations are more diverse and open minded to innovation. This result is in line with the work of Oluoye at al., (2017) where farmers with a secondary occupation had a higher probability of adopting agricultural innovation.

Access to radio significantly influenced the adoption of postharvest technology. The result showed that those who had access to radios had approximately 27% higher probability of adopting postharvest technology compared to those who had no access. The farmers who had access to the radios can obtain vital information and are more open and willing to adopt new technologies. Radio had been highlighted by different studies as a powerful tool for getting information on postharvest technologies and other useful information for stakeholders in the agricultural value chains (Obidike, 2011). Also, Masuki et al., (2006) emphasized the importance of an agricultural information pathway in the adoption of agricultural technology.

The perception of the farmers towards postharvest technology was observed to positively influence the adoption of postharvest technology at 1% significant level. This means that the farmers who have a positive perception towards postharvest technology have approximately 12% higher probability of adopting postharvest technology. The farmer is more likely to adopt new technology if they perceive it to be better than their current one in terms of the properties, they consider relevant to

them. Other studies have also emphasised the vital role that the perception of the farmer plays towards the adoption of postharvest and other agricultural technology (Asfaw et al., 2011, Barua et al., 2017; Elemasho et al., 2017)

Participation in training programs related to tomato farming positively and significantly affected postharvest technology adoption at a 1% significant level. Those who participated in training programs had an 18% higher probability of adopting postharvest technology than those who had not.

Being a household head significantly and positively affected the decision to adopt postharvest technology at a 1% significant level. The result in Table 6 shows that being the household head increases their probability of adopting postharvest technology by approximately 13%.

Having an irrigation system significantly affected embracement of postharvest technology. The results in Table 6 shows that having irrigation system increases their probability of embracing post-harvest technology by 21%.

4.3 Discussion and interpretation

Table 2 shows that the mean age of the tomato farmers was 42.3 years. This result could be indicative of the fact that the farmers within this age are able and willing to take risks associated with tomato farming and bear the physical labour it entails. The adopters had a lower mean age of 36 years when compared to non-adopters in terms of their age. The lower mean age of the adopters means that the younger farmers are more likely to adopt new technology than the older ones as other studies have shown (Obuobisa – darko 2015; Elemasho et al., 2017).

According to the results in Table 2, the mean household size was 5.73. This shows that most of the farmers had about 6 people living and feeding in the same household. The result is similar to other studies that have also found that the largest percentage of tomato farmers had household size between 5 and 10. (Haruna et al 2012; Osuji et al 2016). Furthermore, the mean of the marital status for the sampled farmers was 0.87. This shows that the majority of the tomato farmers were married which could mean married people have more responsibilities to carry and would stay in tomato production as long as it remains profitable. The studies of Adeoye et al, (2009), Osuji et al (2016) similarly found out that the majority of the tomato farmers were married. This was because tomato farming is a complex task best done by families There was no significant difference between adopters and non-adopters in terms of household size and marital status. Access to irrigation significantly affected embracement of post-harvest technology. This shows that irrigation increases production for a farmer hence more income for the farmer making it easier for him or her to venture into innovative ways of farming.

4.3.1 Marginal effect of the factors affecting embracement of postharvest technology

The mean years of formal education among the tomato farmers was 8 years which is junior secondary level. This shows that a larger percentage of sampled farmers had primary and secondary education. There was also a significant difference (at a 1% significant level) between the adopters and non-adopters regarding their years of formal education. The adopters had a higher mean year of formal education. One reason for this might be because the adoption requires some technical knowledge.

The mean years of experience of tomato farmers according to Table 2 was 5 years. The average mean years of experience are indicative of the fact that most of the tomato farmers still need assistance in terms of technical and financial help to grow their businesses. There was significant difference between the adopters and non-adopters in terms of their years of experience in tomato production.

Study findings in Table 3 also show that there was a very low level of participation in training programs among the sampled tomato farmers as mean was 0.03. The mean level of participation was higher for the few adopters than for the non-adopters. This shows that the higher percentage of the adopters had participated in training programs. There was an averagely high level of group membership among tomato farmers in the study area with the mean of 0.6 as shown in table 3. There was a significant difference between adopters and non-adopters of postharvest technology in terms of their group membership. The results in Table 3 show a higher number of adopters compared to non-adopters belong to a market group. This result is in line with studies that have found out that most adopters of agricultural postharvest and value addition technologies are members of an association meaning that associations help farmers with post-harvest adoption information (Akngbe et al.,2014; Tiamiyu et al., 2014)

Results in Table 6 show that the age of the farmer had a negative significant (at a 5% significance level) effect on the adoption of postharvest technology. The results showed that an increase in the age of the farmer reduces the probability of adopting postharvest technology by 0.4%. This indicate that younger farmers adapt post-harvest technology more than older farmers. A possible explanation is that younger farmers are more willing and open to try innovations and less risk averse (Teklewold et al., 2006; Elemasho et al., 2017). This finding is similar to other studies that have also

found out that the younger population is more likely to adopt postharvest technologies (Bokusheva et al., 2012; Elemasho et al.,2017).

Group membership showed a positive significancy at 1% meaning that market groups play a vital role in the adoption of postharvest technologies through information dissemination and other mechanism. These findings are in line with other studies that have also found group membership and networking to increase the probability of adopting postharvest significantly and other agricultural technologies (Masuki et al., 2006; Akangbe et al., 2014; Tiamiyu et al.,2014; Obuobisa-darko, 2015). This was because when farmers are exposed to networking and group membership, they learn new technologies and innovations to improve their farming.

Number of income sources has shown positive significancy. This means that the farmers who have more sources of income or secondary occupations are more diverse and open minded to innovation. This result is in line with the work of Oluoye at al., (2017) where farmers with a secondary occupation had a higher probability of adopting agricultural innovation. Also, the results showed that access to radio positively influenced adoption of post-harvest technology.

Participation in tomato training programs positively influenced postharvest adoption. Participation in training programs helped increase the farmer's awareness and knowledge of the use of new technologies. Also, an increase in the level of awareness and sensitisation on postharvest technologies has been found to increase its adoption (Adegbola et al.,2011; Elemasho et al., 2017)

A farmer who was a household head had a positive influence on postharvest adoption. This could be because the household heads are in charge of decision making which could hasten the process of postharvest technology adoption. The finding is similar to

the work of Teklewold et al., (2006) a male household head significantly and positively influences the decision to adopt an agricultural technology

4.4 Summary

The results of the study revealed that the factors that affect the embracement of postharvest technology in Matabeleland North districts (Umguza, Tsholotsho and Lupane) are the age of the farmer, household size, group membership, number of income sources, years of schooling, access to radio, participation of farmers and gender of the household. The main cause of postharvest loses were pests and diseases do to the fact that pesticides are too expensive and out of reach for many farmers.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Tomato production has a potential to contribute to the growth in the rural areas of Matabeleland North province of Zimbabwe. At the same time, it plays a very crucial role in reducing poverty and income inequality and hence contributes to economic growth. It is unfortunate that this full potential has not been used because tomato farmers in Umguza, Lupane and Tsholotsho districts experience loses that measure up to 40%. Tshuma, N (2018) argues that if tomato farmers in Matabeleland North province could increase postharvest technology adoption, they will increase profit, food quality and market competitiveness. However, it has been acknowledged that tomato farmers are constrained by number of factors which include farming experience, distance to the market, market information and group membership amongst other factors.

The main objective of this research study was to analyse the factors affecting the adoption of postharvest technology in Umguza, Tsholotsho and Lupane districts. Postharvest technology plays an important role in transforming tomato farming into value addition business. Minimising postharvest loses needs strategy which can reduce area needed for production, improve food supply and lead to conservation of natural resources (Kader, 2003). Therefore, it is important to identify the factors affecting the adoption of postharvest technology. The identification of both technical and institutional factors could assist in the formulation of policy intervention and institutional innovations.

5.2 Discussions

5.2.1 Socio economic and socio demographic characteristics of the study area

Results of demographic profile of tomato farmers as shown in Table 4.2 indicate that farmers are generally within the years of active life 40-45 years with a mean of 42 years for the 3 districts. This was because work on tomato farms require great deal of dedication and energy that usually provided by middle aged 40 years people

5.2.2 Education level of farmers

The study showed that there is generally low literacy level among farmers. Farming requires some degree of understanding of some basic principles. For example, a farmer with low level of education would find it difficult to appreciate the basic principles of production that can have negative postharvest consequences. They may also be unresponsive to the principles underlying perishability of tomatoes which would inform them on steps to take to reduce or prevent losses. Also, they may not strictly adhere to manufacturer's instructions on use of their products culminating in their rampant abuse which is one major cause of postharvest loses (Ellis et al., 1998). Kodjogbe et al., (2010) described the main causes of postharvest loses to have their root at producer level to the use of local seeds/ auto propagated seeds, excessive use of fertilisers and pesticides, poor harvesting practices which cause losses during transport and storage.

5.2.3 Causes of postharvest loses

Main cause of losses of tomatoes were attributed to pests and diseases by all districts. In the same related study by Mukarumbwa et al., (2017) postharvest loss and quality deterioration of tomatoes is due to pests and diseases that are caused by very expensive

chemicals that are out of reach for many farmers to buy and control the diseases. These are out of reach for some tomato farmers. The major pest was Tuta absoluta. This pest decreases the shelf life of the tomato to the point that it contributes to the postharvest loses.

5.2.4 Factors affecting the embracement of postharvest technology

Group membership in the results showed a positive coefficient. Similar sentiments were echoed by conventional wisdom in literature that farmers who are group members in associations or co-operatives are more likely to be involved in value addition practices compared to their individual counterparts (Berem et al., 2010). This is because groups may have better access to credit, equipment, training, technical advice and benefit from collective marketing which helps the farmer groups to promote value addition. Furthermore, according to Markelova et al., (2009) in addition to filling in the gaps created by market imperfections, collective action can open up new marketing opportunities for tomato farmers by introducing innovations to existing value chains or creating entry ways into new markets.

Access to radio was positive and significant at 1% meaning that an increase in access to radio increases the chances of getting market information which is vital for tomato farmers. This market information is generally broadcasted weekly to help the farmer to plan accordingly. A possible explanation in this present study is that access to market may be revealing that basic post harvesting practices thus increasing farmer's profit. These findings are in line with similar comparable study by Ali, (2012) which established that access to radio plays a significant role in influencing tomato farmers in adopting innovative value addition ways as they will be broadcasted.

5.3 Conclusion

The study also examined the factors affecting the adoption of postharvest technology in the study area. The main cause of postharvest loses was pests and diseases with decay and rough handling also topping the list. The farmers were also experiencing delayed marketing, wilting, over maturity and mechanical decay as some of the causes of postharvest loses.

The institutional factors that were affecting the adoption of postharvest technologies and practices included access to credit, training program and group membership. The likelihood of adopting postharvest technology was significantly higher for the farmers who belong to a market association, who participated in training programs and had access to radios. The study shows that market associations training programs and radios are vital tools that encourage the adoption of postharvest technology in the districts of the study. An increased number of income sources influenced the farmer's decision to adopt postharvest technology. The way the farmers perceived the usefulness, availability and accessibility of postharvest technology was very pivotal in their decision to adopt postharvest technology. However, the study showed that the younger the farmer is, the more likely they are to adopt postharvest technology than older farmers due to that they will still be active to carry out the demanding duties of tomato farming.

5.4 Implications

The results of this study shows that postharvest adoption training and sensitisation amongst farmers has not been done extensively. This implies that the perception of the farmers towards the innovation and practices of postharvest technology will be negative and hence a low adoption rate. A study like this will help the ministry of

agriculture to know the key areas to work on as far as postharvest technology is concerned. In so doing food production will be increased. Value creation of the tomato produce will also be enhanced.

5.5 Recommendations

The study recommends that training and sensitisation programs on the importance of postharvest technology should be made available to the farmers. The extension officers should be trained and taught about postharvest technology so as to share the information with the farmers. The training should not be left to associations and non-governmental organisations only but the government has to also take a lead in implementing these programs. Policies should focus on strengthening the effectiveness of the tomato market association to help intensify the adoption of postharvest technology. The policy makers should adopt a bottom – top approach in formulating policies regarding the postharvest technologies and the tomato farmers as their perceptions are very essential in their adoption of postharvest technology.

The tomato farmers should be educated on the advantages gotten through the use of postharvest technologies. The government and non-governmental programs focused on the adoption of postharvest technology should also indulge more young people as they are more likely to respond favourable than the older farmers.

5.6 Suggestions for further research

There is a gap in a study that deals with introduction of inexpensive, unsophisticated but efficient small scale tomato processing methods. Also, there is need for introduction of cheap but appropriate postharvest handling and preservation methods of tomatoes for farmers. Another research can be done on consumer's preference and

acceptability for value addition practices like drying of tomatoes. These studies could help to ensure effective and sustainable tomato production industry as a way of developing the rural economy of the study area and other communities with similar socio-economic background.

There is a gap in consistent policies which support postharvest technologies for tomato farmers so there is a need for further study in that area.

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Appendix 1

Questionnaire

Instructions

Kindly respond to the following questions by ticking or filling in appropriate spaces provided.

Demographics and Farm characteristics

1.1. What is your age?

( ) 20 – 30 ( ) 31 – 40 ( ) 41 – 50 ( ) 51- 60 ( ) 61+

1.2. What is your gender? ( ) Male ( ) Female

1.3. What is your marital status?

() Married ( )Single ( )Divorced ( )Widow ( )Widower

1.4. What is your highest level of education?

( ) Did not go to school ( ) Primary ( ) Secondary ( ) Tertiary

1.5. What are you in this tomato farming project?

( ) Owner ( ) worker ( ) Other: .....

1.6. What is your household size (including you)? .....

1.7. How many extended family members do you have? .....

1.8. Number of paid employees in tomato farming? .....

1.9. For how many years have you been involved in tomato farming? .....

1.10. Do you own or rent the land you use for tomato farming?

( ) Owned ( ) Rented ( ) Other: .....

1.11. What other income generating activities are you involved in? e.g. livestock production etc

……

……

……

……

Section B Causes for postharvest loses

2.1 Do you keep records on your farming activity? Yes [ ] / No [ ]

2.2 How would you describe your output in tomato production over the years? Stagnant [ ] Fluctuating [ ] Decreasing [ ] Increasing [ ] NB. (If your answer was (c), please continue from Q. 22) 2

2.3 What do you think accounts for this (fluctuation or decreasing)?

Lack of financial support [ ] Lack of technical support [ ]

Unwilling to expand [ ] Poor market for produce [ ]

Other [ ] (Please specify)……...

2.4 If there is an increase what do you think accounted for that

Good production practices [ ] Financial support [ ]

Technical support [ ] Good market [ ]

Minimal postharvest losses [ ] Other [ ] (Please specify)…… 2.5 Which of the following challenges do tomato farmers face in your community?

Lack of storage facilities [ ] Lack of financial support [ ]

Lack of technical support [ ] Lack of ready market [ ]

Unreliable transport system [ ] High cost of production [ ]

Low pricing [ ] Other [ ] (Please specify)……

2.6 Do you get any form of support to help improve on production?

. Yes [ ] No [ ]

2.7 What form of support do you usually get?

Financial [ ] Subsidy of farm equipment [ ]

Technical [ ] Free farm equipment [ ]

Free Agrochemical supply [ ] Subsidy on agrochemicals [ ]

Other [ ] (Please specify)…….

2.8 Would you describe this support as useful / beneficial to farmers? Yes [ ] / No [ ]

2.9 Is there a ready marketplace for your produce? Yes [ ] / No [ ]

2.10 Are you always able to store your produce to stop / reduce spoilage? Yes [ ] / No [ ]

2.11 If "Yes", did you acquire this knowledge through a special training in storage? Yes [ ] / No [ ]

2.12 Do farmers in your community often get training in postharvest management of tomatoes?

Yes [ ] / No [ ]

2.13 Do you think you need such training? Yes [ ] / No [ ]

2.14 Are you willing to adopt innovative storage methods if they prove more practical than what you currently use? Yes [ ] / No [ ]

2.15 Do you get any financial / or infrastructural support to assist store your produce? Yes [ ] / No [ ] 2.16 Is there any cooperative farmer group in your community? Yes [ ] / No [ ]

2.17 Are you a member of this group? Yes [ ] / No [ ]

2.18 What are the assorted causes of postharvest losses of tomato in your community?

(Tick as many as applicable)

a. Lack of market avenues [ ]

b. Unreliable means of transport to transfer produce to market [ ]

c. Lack of adequate storage facilities [ ]

d. Lack of adequate storage technology [ ]

e. Non-exposure to modern trends of tomato production [ ]

f. Lack of processing plants [ ]

g. Limited alternative uses of the produce [ ]

h. No idea [ ]

i. Other [ ] (Please specify)……

2.19 Have you ever experienced any massive loss of your produce before? Yes [ ] / No [ ]

2.20 Which of the following forms was / were the losses? Breakages [ ] Rot [ ] Other [ ] (Please specify)……

……

……

2.21 If the loss was due to breakages, did you identify what led to this? Yes [ ] / No [ ] 42. If "Yes", could you please share them with us? ……

……

……

2.22Do you have a personal storage facility for your produce? Yes [ ] / No [ ]

Section C PRE-HARVEST AND POSTHARVEST PRACTICES

3.1 Do you pre arrange for market before harvesting? Yes [ ] / No [ ]

3.2 Do the buyers do the harvesting? Yes [ ] / No [ ]

3.3 At what time of the day do you usually harvest your produce?

Morning [ ] Afternoon [ ] Evening [ ] No specific time [ ]

3.4 Do you have any special reason for harvesting at a particular time of the day? Yes [ ] / No [ ]

3.5 Does your reason have anything to do with the shelf life of the produce? Yes [ ] / No [ ]

3.6 At what stage of maturity do you harvest your produce?

Mature unripe [ ] Half ripe [ ] Red ripe [ ] Other [ ](Please specify)……

3.7 What packaging material do you use for your produce?

Shallow wooden boxes [ ] Long big wooden boxes [ ]

Other [ ] (please specify)……

3.8 Do you subject the produce to any special condition before packaging them for market?

Yes [ ] / No [ ]

3.9 If "Yes", are you able to share them with us? ……

……

3.10 How do you prolong the shelf life of your produce just in case there is no ready market?

Stored in a specially conditioned storage facility [ ] Frozen fresh [ ]

Boiled and stored [ ] Formed into puree and stored [ ]

None of the above [ ] Others [ ] (Please specify) ……

Section D Extension officers (Agritex)

4.1 Does the Ministry have any special focus on tomato production? Yes [ ] / No [ ]

4.2 Does the Ministry have any records on tomato production within the Region? Yes [ ] / No [ ]

4.3 How does the Ministry rate tomato production in the Region? 107 Very high [ ] High [ ] Low very low [ ] No data [ ]

4.4 Are all the tomatoes consumed within the Region cultivated in the Region? Yes [ ] No [ ] No idea [ ]

4.5 Does the Ministry have data on postharvest losses of tomato in the region? Yes [ ] / No [ ]

4.6 How would you rate postharvest losses of tomato within the Region?

Very serious [ ] Serious [ ] Fairly serious [ ]

4.7 What are the key causes of postharvest losses of tomato within the District / Region?

Lack of ready market [ ] Lack of transport of produce [ ]

Lack of storage facility [ ] Lack of postharvest storage technologies for the produce [ ]

Poor storage practices [ ] Disease attack [ ]

Others [ ] (Please specify)……

4.8 Does the Ministry train tomato farmers in postharvest storage technology? Yes [ ] / No [ ]

Thank you for your time and participation

Appendix 2 Key informant interview questions

1. How can you describe the tomato farmers you are working with?
2. What is the level of adoption of postharvest technology for tomato farmers in your district?
3. Describe constraints and opportunities of tomato farming?
4. What are your current interventions in postharvest technology for tomato farmers?
5. What plans do you have for the future interventions?
6. Who are the actors/partners in tomato farming in your area? Please mention them and state their roles in tomato farming
7. What are the current policies and planned initiations to improve or promote postharvest technology for tomato farming at national level?
8. Do you have any suggestions in terms of strategy to promote postharvest technology in tomato farming? If yes, give your suggestions

Appendix 3 AUREC Approval Letter

AFRICA UNIVERSITY
(A United Methodist-Related Institution)
INVESTING IN AFRICA'S FUTURE

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 website: www.africau.edu

Ref: AU1937/21 5 March, 2021

SENAMISO NDLOVU
C/O CHANS
Africa University
Box 1320
Mutare

RE: **FACTORS AFFECTING THE ADOPTION OF POSTHARVEST TECHNOLOGY BY TOMATO FARMERS IN UMGUZA, TSHOLOTSHO AND LUPANE DISTRICTS IN MATABELELAND NORTH REGION**

Thank you for the above titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal
b) Data collection instruments
c) Informed consent guide

- **APPROVAL NUMBER** AUREC1937/21
  This number should be used on all correspondences, consent forms, and appropriate documents.
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** March 5, 2021
- **EXPIRATION DATE** March 5, 2022
- **TYPE OF MEETING** Expedited
  After the expiration date this research may only continue upon renewal. For purposes of renewal, a progress report on a standard AUREC form should be submitted a month before expiration date.
- **SERIOUS ADVERSE EVENTS** All serious problems having to do with subject safety must be reported to AUREC within 3 working days on standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

AFRICA UNIVERSITY
RESEARCH ETHICS COMMITTEE (AUREC)
APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

Yours Faithfully

Mchinzou

MARY CHINZOU – A/AUREC ADMINISTRATORFOR CHAIRPERSON, AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE

Appendix 4 Urkund Antiplagiarism Report

Curiginal

Document Information

Analyzed document	Senamiso 2 FINAL THESIS.docx (D120941582)
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Submitted by	
Submitter email	ndlovusenamiso@gmail.com
Similarity	4%
Analysis address	mukumbik.africa@analysis.urkund.com

Sources included in the report

W	URL: https://www.hindawi.com/journals/aag/2016/6436945/ Fetched: 2021-12-03T13:09:00.0000000	9
SA	**crop storage assignment 1.pdf** Document crop storage assignment 1.pdf (D88145753)	4
W	URL: https://www.researchgate.net/publication/287343539_Determinants_of_Postharvest_Losses_in_Tomato_Production_in_the_Offinso_North_District_of_Ghana Fetched: 2021-12-03T13:09:00.0000000	3
W	URL: http://www.postharvest.org/PEF_White_Paper_19-04_Tomato_Postharvest_Management_Rwanda.pdf Fetched: 2021-12-03T13:09:00.0000000	6
W	URL: https://www.grin.com/document/982806 Fetched: 2021-12-03T13:09:00.0000000	1
SA	**Africa University / 170333 post harvest.docx** Document 170333 post harvest.docx (D119113494) Submitted by: mutsaum@africau.edu Receiver: dvc.africa@analysis.urkund.com	1
W	URL: https://www.ejfood.org/index.php/ejfood/article/view/368 Fetched: 2021-12-03T13:09:00.0000000	1
W	URL: https://www.ajol.info/index.php/jasr/article/view/166704/156143 Fetched: 2021-12-03T13:09:00.0000000	1