Determinants of smallholder vegetable farmers' participation in post-harvest practices and market access: Evidence from Mashonaland East Province of Zimbabwe

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Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

in Agricultural Economics

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November 2017

Declaration

I, Peter Mukarumbwa, hereby declare that this thesis is my own original work and that other scholars' works referred to herein have been duly acknowledged. I also declare that this thesis is original and has not been submitted elsewhere for a degree.

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Peter Mukarumbwa Date

Dedication

To all my family members and friends. You have made a sterling contribution to my life.

Acknowledgements

I wish to acknowledge my supervisor, Professor A. Mushunje and my co-supervisor Dr A. Taruvinga. Their patience, guidance and wisdom made this work possible. I thank them so much for believing in me. My special gratitude is also extended to the Zimbabwean Government for the financial support I received. I acknowledge the Zimbabwean Government for awarding me the scholarship to study at the University of Fort Hare.

I am indebted to Mrs Susan Mujati, Supervisor, Agricultural Extension Officer for Domboshava. Her experience and strategic thinking made data collection logistics so easy, fun and enjoyable. Again, her valuable support in all the four (4) districts in which the study was undertaken in, is greatly acknowledged. The warm reception I received from all the District Administrators (DAs) is highly acknowledged. The hard work of all the extension officers in all the four districts, which made the process of data collection possible, is greatly appreciated. Without them the process of data collection could have been a nightmare. Most importantly I extend my sincere gratitude to the farmers who sacrificed their time to provide responses to the interview questions.

Finally, to all my family and friends, too many for me to mention by name who contributed in one way or the other towards the success of this study, I say a big thank you.

Abstract

Smallholder vegetable production is very vital in enhancing livelihoods in Zimbabwe's rural areas. Vegetable production generates household income and improves household food security. Despite this, smallholder vegetable farmers in Zimbabwe suffer huge post-harvest losses which reduce their profits and market competiveness. Post-harvest losses of vegetables are a major dilemma faced by smallholder farmers. They not only represent waste of scare resources such as farm inputs but they also entail wasted investment in terms of time, human effort and food. Furthermore, there are also a myriad of other challenges which constrain smallholder vegetable farmers in Zimbabwe from accessing lucrative markets.

The broad objective of the study was to assess smallholder vegetable farmers` preferred post-harvest practices for value addition as well as factors that condition their selection choices, adoption and product market access. The study was conducted in four districts: Seke, Goromonzi, Murehwa and Mutoko, in the Mashonaland East Province of Zimbabwe. A multistage sampling procedure was adopted in the selection of villages and households. A total of 385 smallholder vegetable farmers were interviewed. The survey was undertaken from August–October 2016.

Descriptive statistics were employed to analyse the socio-economic and demographic characteristics of households that were sampled in Mashonaland East Province. Age of household head, gender, educational level, household size, farming experience, main sources of income, land ownership, main vegetables produced and main causes of post-harvest losses were some of the statistics that were analysed. The average age of the farmers varied significantly across districts and it was generally high (average of 50 years). Moreover, the average household size was about six (6) individuals, which is an indication of high dependency ratio.

The study also revealed the major causes of post-harvest losses across all vegetables predominantly cultivated in the study area were pests and diseases, followed by decay. Most of the underlying causes of huge post-harvest losses were within the control of the farmer. Therefore, the study recommends strategies from policymakers and Non-Governmental Organisations (NGOs) which enhance post-harvest management. These can result in

substantial reduction in losses which can increase farmers' income without necessarily expanding land under cultivation.

The Poisson count regression model (PCRM) was used to analyse factors influencing number of post-harvest techniques adopted by smallholder vegetable farmers in the study area. The results of the PCRM revealed that the following variables were significant in influencing number of post-harvest practices adopted by smallholder vegetable growers: gender, education level, household size, age, farming experience, distance to market, market information, group membership, credit, and hired labour. The study recommends concerted efforts through public private partnerships (PPP) to provide active extension about post-harvest education. This will promote the adoption of simple, uncomplicated and innovative low-cost technologies for post-harvest management.

The binary logit model was employed to analyse factors that influence smallholder vegetable farmers' decisions to select a specific post-harvest practice for value addition. This was based on the three major post-harvest practices which were mainly being adopted by smallholder vegetable farmers' in the study area which were drying, grading and washing. The results of the binary model showed that nine (9) variables were significant in influencing smallholder vegetable farmers' decisions to select post-harvest practice for value addition. These were: gender, land size, distance to market, market information, family labour, training, target market, quantity produced and storage facilities. Policymakers and other stakeholders need to provide productive resources such as inputs to improve productivity and ultimately selection of basic post-harvest management techniques along the vegetable supply chain.

The multinomial logit model was used in the study to analyse factors that influence market channel choice of smallholder vegetable farmers in the study area. The results from the multinomial logistic regression model revealed that distance to market, group membership, adding value, road infrastructure and quantity produced influenced participation in informal markets. On the other hand, gender, distance to market, market information, group membership, producer price, adding value, road infrastructure, quantity produced and market infrastructure influenced farmers' participation in formal markets. Policies aimed at assisting resources for improved productivity of vegetables should be gender sensitive. Establishment of irrigation schemes as well as provision of credit for smallholder vegetable production are vital interventions. In the same way, crafting of appropriate policies and programmes which foster

collective action amongst smallholder vegetable farmers are required. This will enable them to produce larger volumes as well as participate in more lucrative markets. Finally, smallholder vegetable farmers' transaction costs can be reduced by investment in infrastructure such as roads.

***Keywords**: Post-harvest losses, post-harvest practices, post-harvest techniques, market access, smallholder vegetable farmers*

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List of Abbreviations and Acronyms

AGRITEX	Agricultural, Technical and Extension Services
APHLIS	The African Postharvest Losses Information System
CF	Contract Farming
CSO	Central Statistical Office
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Statistical Database
FARA	Forum for Agricultural Research in Africa
FTLRP	Fast Track Land Reform Programme
GDP	Gross Domestic Product
GFAR	Global Forum on Agricultural Research
GIPh	Global Initiative on Post-Harvest
Ha	Hectares
HPC	Horticultural Promotion Council
IAAE	International Association of Agricultural Economists
ICTs	Information and communications technologies
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIA	Independence of Irrelevant Alternatives
IRR	Incidence Rate Ratio
MNL	Multinomial Logit Model
MNP	Multinomial Probit Model
NBM	Negative Binomial Model
NGOs	Non-Governmental Organisations
NR	Natural Region
PCRM	Poisson Count Regression Model
PEF	The Post-harvest Education Foundation
PHL	Post-harvest Losses
PHVA	Post-harvest value addition

PHVAI	Post-harvest value-adding initiatives
PPVA	Post-harvest Practices for Value Addition
R&E	Research and Extension
SADC	Southern African Development Community
SD	Standard Deviation
SHFs	Smallholder farmers
SPSS	Statistical Package for Social Scientists
SSA	Sub-Saharan Africa
STATA	Statistics and Data
UK	United Kingdom
UMP	Uzumba-Maramba-Pfungwe
UNCTAD	United Nations Conference on Trade and Development
US$	United States Dollar
WFP	World Food Programme
ZIMSTAT	Zimbabwe National Statistics Agency
ZimVAC	Zimbabwe Vulnerability Assessment Committee

CHAPTER 1

INTRODUCTION

1.0 Introduction

According to Abass et al., (2014) an estimated over 70% of the population of sub-Saharan Africa (SSA) depend directly on agriculture as a primary source of income and food. Therefore, any measures which are geared towards enhancing agricultural production and productivity are vital in eradicating extreme poverty and hunger in the continent. In sub-Saharan Africa agricultural productivity and per capita value of agriculture output is the lowest in the world (Forum for Agricultural Research in Africa (FARA), 2006). Furthermore, the situation of low agricultural productivity is worsened by the high post-harvest losses which are experienced in SSA (World Bank, 2011).

Various studies have confirmed this high incidence of post-harvest losses especially in developing countries from farm to retail stage and that not much improvement in total percentage losses have been recorded since the 1970s to date (Kitinoja et al., 2011). In the same vein it has been indicated that smallholder farmers (SHFs) in developing countries particularly in sub-Saharan Africa lose an estimated 30–40% of the value of their fruits and vegetables before they reach the final consumer (Korsten, 2006; Weinberger et al., 2008; Coulomb, 2008; Tschirley, 2011; Kereth et al., 2013). In addition, Gustavsson et al., (2011) further noted that of about 1,3 billion tons of food losses and waste reported in the world, approximately 44% consists of fruits and vegetables (F&Vs) crops. These statistics indicate a very grim picture as far as the issue of post-harvest losses in fruits and vegetables is concerned.

Despite the fact that reducing post-harvest losses of vegetables and fruits produced bear more beneficial results, it has been noted that less than 5% of funding in many countries is allocated to post-harvest research areas (Kader, 2003). Kitinoja et al., (2011) reached the same conclusions that increasing research in post-harvest horticulture technologies research and extension (R&E) is lagging far behind in most developing countries regardless of its immense benefits in leading to improved incomes, reducing waste and increasing the food supply without increasing production and wasting the expenditures on all the inputs required (land, water, seeds, fertilizers, pesticides, labour, etc.).

There are various causes of post-harvest losses and quality deterioration of horticultural crops. However, the main causes are attributed to natural ripening processes, microbial infection, pests, improper post-harvest handling and environmental conditions such as heat and drought (Idah et al., 2007; Olayemi et al., 2010). Post-harvest losses are incurred throughout the chain from harvesting, handling, storing, processing, packaging, transportation and marketing (Mrema & Rolle, 2002).

Different strategies have been employed to curb post-harvest losses. One way which has been tried is the application of new handling techniques and technologies to improve product quality and prolong the shelf life of produce (Kitinoja et al., 2011). That kind of action is considered very crucial as 68% of the total post-harvest losses in SSA have been ascribed to inadequate post-harvest technologies to carry out activities such as harvesting, handling and storing which can prolong the shelf life of fruits and vegetables (Kaminski & Christiaensen, 2014). Despite such kinds of strategies and interdisciplinary efforts to try and curb post-harvest losses, the magnitude of fruits and vegetable post-harvest losses is still very high in SSA.

Regrettably, efforts to curb the effects of post-harvest losses in certain parts of the world such as East Africa have recorded very minimal success as stated by various scholars (Kitinoja, 2013a; Rickman et al., 2013; Affognon et al., 2015). These failures are attributed to lack of knowledge related to appropriate technology and value-adding initiatives amongst SHFs in handling, harvesting and storage of fruits and vegetables to avoid or delay decay (Kaminski & Christiaensen, 2014; Affognon et al., 2015).

The discourse, however, on how to deal decisively and map a clear way forward with the issue of post-harvest losses in fruits and vegetables amongst SHFs is not conclusive. Other scholars such as Wakholi et al., (2015) postulate that factors contributing to post-harvest losses can be mitigated by introducing appropriate technologies, notwithstanding that such kinds of technologies entail huge capital investments which SHFs lack. Furthermore, Wakholi et al., (2015) state that there are various socio-economic aspects which compound the complexity of finding appropriate solutions to the challenge of post-harvest losses. These include invalid marketing systems, inadequate transporting facilities, insufficient research and development capacity, weak government policies and poor policy implementation, lack of information, lack of appropriate skills for handling the expense of post-harvest technologies, and cultural diversity, *inter alia*.

High post-harvest losses, if left unabated, are a great threat to SHFs' income, food and nutritional security. Therefore, in light of this background, a need arises to investigate how SHFs' participation in value-adding initiatives can help them reduce post-harvest losses, minimising quality deterioration of horticultural crops and act as a pathway towards improving their welfare.

1.1 Background

Zimbabwe's horticultural sector can be categorised into three groups which are: the large-scale commercial segment (the remaining whites, company-owned farms and the A2 farms), the smallholder sector comprising communal, resettlement (old resettlement schemes and A1 farms) and small-scale commercial areas (Heri, 2006; Chigusiwa et al., 2013). A new fourth category that is emerging is the peri-urban and urban producers practising gardening in greenhouses in the backyards of residential properties (Heri, 2006). Vegetable production in Zimbabwe varies from those that produce for family consumption only to those that sell a certain portion to local urban markets, through to large producers who produce large quantities for urban markets or exports (Sibanda et al., 2000). However, even though this is the situation, the majority of horticultural producers have undergone a tremendous transformation since the beginning of the fast track land reform programme (FTLRP) and have been reduced in size (becoming small- to medium-sized). The bigger producers who operate commercially can contact markets easily even for exports as well as enjoying abundant financial opportunities (Chigusiwa et al., 2013). Conversely, the SHFs operate on a subsistence level with minimum opportunities for expansion. These smallholder horticultural farmers are faced with a number of challenges in their production. They operate in a resource constraint environment with limited access to key inputs such as fertilisers and pesticides. They also face pressure due to lack of water, inadequate technical expertise in horticulture, access to markets and transport amongst others (Sibanda et al., 2000).

In the smallholder sector, traditionally, horticulture crops have been produced by women in rural gardens (Heri, 2006). As families migrated to the urban areas, many women in rural areas used their indigenous knowledge of horticultural crops and became involved with horticultural marketing in urban areas (Horn, 1997). Women are perceived to have a good understanding of the production of fruits and vegetables (Lan, 1985). Informal market structures were first

established in Harare at Highfields and subsequently at Mbare, two of the oldest urban locations in Zimbabwe (Horn, 1997). With the expansion of urban population, women growers were not able to cope with the demand, it is in this context that men came into the industry in the form of brokers and established wholesaling operations such as Mbare Musika[1] in Harare (Heri, 2006). These informal traders purchased a wide range of commodities from both the large-scale and small-scale producers throughout the year (Heri, 2006).

Heri (2000) noted that Zimbabwe's horticultural sector is a lucrative niche area because of the potentially large numbers that can be employed since it is labour intensive. On average a new horticultural project venture has the potential to generate several jobs per hectare and offers alternative livelihood openings for women who have been the most disadvantaged and side-lined in the Zimbabwean setup. Zimbabwe produces a diverse variety of agricultural outputs and horticulture is among the country's largest foreign currency generators together with sugar cane, cotton and tobacco (Chigusiwa et al., 2013). Approximately 45% of Zimbabwe's exports come from agriculture and the horticulture sector occupies fifth position after tobacco, maize, sugar cane and beef (HPC, 2012). During its heyday, the horticultural sector was the second-highest foreign currency generator behind tobacco and contributed roughly about 5% of Gross Domestic Product (Heri, 2000). Production and exports from horticulture were the biggest rising sector in the Zimbabwe's economy in the 1990s, recording a growth rate in surplus of 30% per year (Heri, 2006). Currently, however the horticultural sector's annual revenue incomes have plunged drastically from US$142 million in 1999 to US$39.1 million in 2010, demonstrating a collective 28% decline (HPC, 2012). According to HPC, (2012), it is estimated that the horticulture sector is functioning at below 20% as a result of marketing and logistical challenges. Some of these disruptions in production within this sector can be attributed to the FTLRP where infrastructure was vandalised or remained idle (Heri, 2006). This was because the newly resettled SHFs lacked the expertise and working capital to undertake such operations.

In a study that was conducted by Chigusiwa et al., (2013) it was observed that smallholder horticulture production has become a main livelihood source for the majority in Zimbabwe's communal areas. These findings confirm earlier studies by Dorward et al., (1998) that smallholder agriculture is going to be the backbone for poverty alleviation and upgrading of livelihoods for the majority of rural populations in most of sub-Saharan Africa (SSA). This is

[1] Mbare Musika is the largest traditional fresh produce market in Zimbabwe, located in the capital Harare

because SHFs have realised the potential with which horticultural production is endowed. This sector has latent opportunities to improve SHFs' lives through increasing access to cash to spend on clothes, school fees, inputs and promoting farm production. Horticultural production therefore ensures food security, employment and income generation in rural areas, thereby reinforcing the overall development and poverty reduction goals in most countries (Heinemann, 2002).

Nonetheless, Zimbabwe's horticultural sector experiences massive post-harvest losses especially in the smallholder sector, retarding farmers' returns. According to Musasa et al., (2015) one of the critical issues which needs to be addressed in Zimbabwe along the smallholder horticultural value chain is the reduction of post-harvest losses which might increase their profitability. For example, in a study which was conducted by Musasa et al., (2015) in Rusitu Valley, which is situated in Manicaland Province in Zimbabwe, it is estimated that during the 2011–2012 farming season, more than 30% of oranges were discarded due to post-harvest losses. The same study found out that these post-harvest losses were being caused by poor post-harvest management as well as pests and diseases.

Just to put things into perspective and highlight how far Zimbabwe's horticulture sector has retrogressed, FAOSTAT, (2009) reported that by 2007, orange exports in Zimbabwe had declined from 78% to 42%. Zimbabwe was once ranked number 35 in the world's orange area cultivated and harvests commanding a world proportion of 0.3% (FAOSTAT, 2009). However, Musemwa and Mushunje, (2011) highlighted that there has been a formidable decrease in orange production in Zimbabwe between 2000 and 2004, showing glaring differences between commercial farmers and resettled SHFs who had minimal knowledge in pre- and post-harvest management and lacked capital. The situation is not peculiar to orange production only. In another study which was conducted by Mvumi et al., (2016), it was revealed that during the 2001–2012 season, post-harvest losses within the banana subsector were estimated at 24–27% amounting to a total income loss of US$500,000 per annum. The study also clearly indicated that smallholder horticulture farmers incur high post-harvest losses in Zimbabwe due to lack of knowledge and poor post-harvest handling technology amongst other factors.

In light of the above, it is clear that there is still a huge gap with regards to investment in value-adding technologies amongst SHFs in Zimbabwe partly due to capital constraints and lack of knowledge amidst other factors. This clearly indicates that the issue of post-harvest losses is a

major challenge that SHFs in Zimbabwe are still grappling with. It therefore warrants that studies of this nature geared towards assessing value addition and beneficiation be undertaken.

The aspect of post-harvest losses in horticultural crops is not unique to Zimbabwe or even to Africa. Worldwide, post-harvest losses of horticulture products ranged from 30 to 40% (Meena et al., 2009; Salami et al., 2010). Although India has approximately 10% global share of horticulture products (vegetables and fruits) only about 2% is processed (Meena et al., 2009). In that regard, India alone accounts for losses estimated at 30% amounting to 40 million tons, with an approximate cost of US$13 billion (Meena et al., 2009).

Though this may be, globally post-harvest innovations have been found to play a pivotal role in alleviating the livelihoods of poor households through value addition, nutrition, production and employment creation (Meena et al., 2009). It has been postulated that for this to be attained there is a need to learn new techniques, innovations and marketing linkages that improve post-harvest systems (Hall et al., 2002). Moreover, it has been reported by Patil and Singh, (2007) that post-harvest losses can be curbed by adding value to agricultural products which in turn can unlock employment opportunities in rural areas. Furthermore, Leary and Berge, (2006) noted that innovative strategies in agriculture technologies have the potential to improve food security situation, generate income and preserve natural resources.

It has been noted that less than 5% of funding in horticultural research and extension (R&E) has been channelled to post-harvest issues over the past two decades as previous focus has been on increasing production (Kader, 2005; Weinberger & Lumpkin, 2007; Stathers et al., 2013; Kitinoja & Barrett, 2015). Further, it is only more recently that research in horticulture has begun to focus on value chain development (Kitinoja & Barrett, 2015). According to Kitinoja et al., (2011) between 1990 to the present day not many projects that were carried out in developing countries were focused on agriculture (25%[2]). Very few of these were devoted to horticulture (approximately 1% of agricultural projects), and only one-third of this 1% of horticultural projects included any kind of post-harvest component (Kitinoja & Barrett, 2015). This low level of public spending in post-harvest research and development has translated into very few people with knowledge in post-harvest issues specifically in Africa (Ferris &

[2]World Bank, Projects and Operations

Wheatley, 2001). Equally worrying is the reflection that in both developing and developed countries, the bulk of post-harvest research is confined to the laboratory (Stathers et al., 2013).

It should be acknowledged, however, that in recent years, following the global and financial crisis, there has been an increase in agricultural investment in SSA. Nonetheless, this increase has not yet matched the demand of SHFs' needs for post-harvest innovations as well as information dissemination (Kitinoja & AlHassan, 2012). This emanates from persistently high percentages of post-harvest losses that farmers still experience in many developing countries, Zimbabwe included. In light of this scenario questions arise as to what extent SHFs are aware of post-harvest value-adding initiatives? Has research and development managed to bridge the gap and increase awareness as well as coming up with tangible post-harvest value-adding initiatives that are suitable for smallholder farmers?

In this context of high post-harvest losses, particularly of horticultural produce in many rural communities in Africa a distinctive need emerges to accelerate evidence-based policy dialogues for addressing this investment imbalance between production and post-harvest management. The starting point might be to access farmers' awareness of simple low-cost post-harvest value-adding initiatives. Given this background the need arises to verify with empirical evidence the current level of smallholder horticulture farmers' level of awareness in post-harvest value-adding initiatives. This emanates from an understanding that level of knowledge of post-harvest is essential in determining attitude towards adoption of value-adding initiatives (Roy et al., 2013).

Granted that in Zimbabwe, the discourse of value addition has taken centre stage in recent years, yet there has been limited empirical data from the ground particularly focusing on the horticultural sector to support these initiatives. Muchopa (2013), concurs with these views that there is a gap in literature as well as conclusive empirical studies concentrating on the socio-economic benefits that can accrue to smallholder horticultural farmers due to value addition and proliferation of supermarkets in the SADC region. Therefore, the biggest question that policymakers have been grappling with is this: Is value addition the panacea to curb the huge losses that smallholder horticultural farmers are currently facing and can it improve their livelihoods? If that is the case, how best can technologies be introduced that smallholder farmers can afford, accept and adopt? There is also little information and research on how

accessing supermarkets rather than sticking to traditional markets can improve the livelihoods of smallholder horticulture producers. Nonetheless, the rise in urban population, the need for convenient ready-made food opens avenues for smallholder farmers to capitalise on and not only market fresh produce, but also value-added products to fulfil the demand for these changing conditions (Mashapa et al., 2014). Consequently, promotion of such initiatives in the horticulture sector are vital in enhancing employment openings and generating foreign currency which are much needed given Zimbabwe's current economic situation. It is against this background that this study aims at examining value addition to horticulture crops as a way of improving smallholder farmers' livelihoods in Zimbabwe.

1.2 Problem statement

Post-harvest losses of horticultural products (fresh fruits and vegetables) are a major dilemma that smallholder farmers in developing countries face. It has a ripple effect as it does not only represent waste of scarce resources such as farm inputs but it also means wasted investment, time, human effort and food (Hailu & Derbew, 2015). Post-harvest losses of horticultural produce impact negatively on both the household income and food security of SHFs. This is because the products are perishable in nature and the SHFs that produce them are constrained financially to come up with innovations that can curb these losses (Hailu & Derbew, 2015). In SSA the post-harvest loss of horticultural products (fresh fruits and vegetables) is attributed to a number of factors ranging from lack of technology, poor infrastructure, storage, climate, to low levels of investment and other factors (Gustavsson et al., 2011). The economic loss caused by these post-harvest losses in horticultural products in SSA is very high. It is estimated that post-harvest losses of about US$4 billion per annum are incurred in SSA (Gustavsson et al., 2011). These losses are a sign of dysfunctional horticultural value chains in SSA and they impact negatively on income generation, rural economic growth and most importantly economic loss of players along these chains (Hailu & Derbew, 2015).

According to Heri, (2006) it was observed that after the fast track land reform programme, there were disruptions in horticultural production in Zimbabwe as infrastructure was vandalised or remained idle. Hence, currently the output of the sector is way below optimum capacity due to production challenges being faced by SHFs especially those in the new resettlement areas (HPC, 2012). This contradicts the fact that during its peak period in the 1990s, horticulture was the second largest foreign exchange generator in the agricultural sector after tobacco, and

contributed about 3.5–4.5% of gross domestic product (Heri, 2006). These disruptions that occurred in the horticultural sector after the fast track land reform programme meant that production was now mainly geared towards the local markets. Furthermore, production of high value horticultural products for export was abandoned as farmers switched to production of conventional horticultural products (such as cabbages, tomatoes, rape and 'covo'). This lead to oversupply on the local market and consequently farmers incurred post-harvest losses.

On the other hand, while SHFs in Zimbabwe are able to produce different kinds of horticultural crops for the domestic market, marketing of these produce still remains a major challenge. This emanates from the fact that the country is still lagging behind in the aspect of value addition of horticultural produce especially amongst the SHFs. Therefore, they incur massive post-harvest losses which derail their returns from the market.

According to Jari and Fraser, (2012) SHFs in developing countries lack knowledge of agro-processing and value-adding initiatives which might help them to access lucrative markets. Earlier findings by Louw et al., (2008) showed that SHFs do not have adequate processing technologies and are not aware of the importance of value addition to their produce. Value addition takes various forms such as sorting, cutting, grading and packaging. The fact that some value-adding initiatives are not capital intensive, warrants that a research be undertaken to query SHFs' awareness of value-adding initiatives since they continue to market their produce without adding value in Zimbabwe. In the same way, poor quality, absence of adequate market information, research and general lack of improvements along the value chain pose a serious threat to the marketing of horticultural products in standards in Zimbabwe's local markets. Furthermore, this also seriously hinders the smallholder farmers' ability to penetrate and produce for the foreign markets (Rolle, 2005).

Thus far, value addition remains a possible alternative for SHFs highly rated in literature with enormous endorsement from government, NGOs and the private sector as a possible viable pathway to unlock value and increase profits for SHFs. Despite receiving such a lucrative claim, in practice there appear to be just a few flagship examples where smallholder horticulture farmers in Zimbabwe participate in value-adding initiatives. The need therefore arises to query SHFs' perceptions, awareness, participation and preferred value-adding initiatives. This is against a background where participation is poor in the face of several claims of its potential to add value and possibly enhance formal market access.

In Zimbabwe, it was noted that smallholder fruit and vegetable farmers tend to focus their energy on production and invest minimal or nothing in post-harvest and marketing activities (Njaya, 2014). Their concentration on production activities leads to low prices obtained through middlemen in informal markets. In light of that, there is still a big gap in research which is backed by empirical evidence on preferred value-adding activities on fruits and vegetables produced by smallholder farmers in Zimbabwe (Njaya, 2014). Identification of such kinds of preferred value addition will be important as it will be guided by the confines in which SHFs operate. This is because at times, value-adding and agro-processing technologies introduced in some instances do not match the reality of poor farmers' resource unavailability (Adepoju, 2014). Therefore, they continue to be faced by the same challenges of having to sell their perishable products at very low prices. These include amongst others, lack of financial access and poor technology which restrict smallholder horticultural farmers to their traditional ways of marketing their produce.

Poor post-harvest handling of perishable farm produce by farmers have various origins, some of which can be attributed to poor handling by farmers (Adepoju, 2014). Fruits and vegetables produced in rural areas in many developing countries fail to reach the market, because of either lack of nearby markets or lack of market information (Adepoju, 2014). The challenge is that most rural farmers do not have the means to process their output combined with the effect that there are no modern storage facilities. This therefore results in high post-harvest losses (Kader, 2005). The situation is similar amongst SHFs in Zimbabwe. This situation warrants that studies be undertaken to determine selection choices of post-harvest value-adding initiatives by smallholder horticulture farmers in Zimbabwe.

There is also widespread consensus in literature that selling of raw agricultural produce without adding value, results in lower returns than otherwise anticipated (FAO, 1995; Proctor et al., 2000; Chirwa et al., 2008). On the other hand, handling of horticultural products through applying innovative and suitable technologies is regarded as a great mechanism to minimise spoilage and it improves income returns of smallholder farmers (Proctor et al., 2000). Delgado (1999) also noted that one of the major transaction costs that smallholder farmers face, is finding reliable markets for their perishables due to their low bargaining power, resulting in enormous loses. This is the major problem that smallholder horticultural producers in

Zimbabwe are currently facing. Therefore, the need arises to identify factors influencing post-harvest value-adding initiatives adopted by smallholder horticulture farmers.

Smallholder horticultural farmers in Africa have been found to face many challenges to accessing input and output markets to sell their produce (Makhura & Mokoena, 2003). They lack capital to buy agricultural inputs, use modern technology, adequate post-harvest handling techniques, and access efficient information with regard to price fluctuations on the market amongst others (Heinemann, 2002). Such a scenario has been cited as the main problem why rural farmers in Africa fail to uplift their standards of living (Magingxa et al., 2009; Zivenge & Karavina, 2012). As a result, farmers remain trapped in the vicious cycle of poverty because they cannot access profitable markets even if they are able to produce a surplus (Magingxa et al., 2009). Therefore, most of the times farmers end up being price-takers, disposing of their outputs to the most convenient buyers and at prices set by these buyers (Magingxa & Kamara, 2003).

Although commendable strides have been made by government, private companies and Non-Governmental Organizations (NGOs) through different programmes in Zimbabwe, to improve smallholder horticultural production, marketing of the produce remains a major challenge (Zivenge & Karavina, 2012). Similar findings were echoed with distress as to how resources are being channelled towards increased production of SHFs' horticultural crops in most developing countries, whilst little is being done to curb post-harvest losses (Adepoju, 2014). Zivenge and Karavina, (2012) further concluded that Zimbabwe's SHFs' participation in horticultural markets is limited by structural and technological factors. Holding the same views Jayne et al., (2002); Kherallah and Kirsten, (2002) observed that the challenge of market access is intertwined with farmers' inability to meet market standards, low volumes of produce, wide dispersion of producers, presence of middlemen, seasonality of production and perceived low prices in the formal market.

Various studies have indicated that in developing countries there is low market participation by SHFs (Barrett, 2008). This situation has hampered the contribution of agriculture to reducing poverty levels (Zamasiya et al., 2014). Nonetheless, meaningful contribution of agriculture to economic growth can only be achieved if surpluses produced by SHFs are able to be marketed properly (Jagwe et al., 2010). However, the scenario in many Southern African countries has been that agricultural produce is lost soon after production mainly due to poor

post-harvest handling especially for horticultural crops because of their high perishability (Phiri & Otieno, 2008). This scenario is ascribed to different factors and obstacles in agricultural commodity marketing that dishearten SHFs from participating in formal markets (Zamasiya et al., 2014). These factors include amongst others high transaction costs, household characteristics as well as lack of physical infrastructure (Siziba et al., 2011; Jagwe et al., 2010). Even though this is the situation, the reason why the majority of SHFs who constitute a greater percentage of farmers are excluded from lucrative markets remains a big puzzle (Zamasiya et al., 2014). It is therefore necessary to investigate factors that influence formal market access by smallholder horticulture farmers. This will enable crafting of interventions that can resuscitate Zimbabwe's smallholder horticulture sector and improve household income.

The above scenario, compounded by the fact that marketing of horticulture output is constantly changing, without adequate information, explains why the majority of small-scale farmers end up with huge losses and this has created a dilemma for Zimbabwe's smallholder horticultural producers. This is exacerbated by the outdated way SHFs conduct their business where they produce without adequate information with regards to demand and supply of the product on the market (Sena, 1997; Thirtle et al., 2003). Unfortunately, Zimbabwe has incurred massive losses due to market flooding (60%) of horticulture produce as well as spoilage (Hicks et al., 1997; Odunfa, 1995). As a result, smallholder horticulture producers find it a nightmare to realize meaningful gains from marketing of their produce. Horticultural products being perishable in nature, this undermines the sustainability of this enterprise (Mashapa et al., 2014).

These challenges are not only peculiar to individual SHFs, even those in horticultural cooperatives, were found to market their produce independently rather than collectively (Karambakuwa et al., 2010). As a result, even the majority of horticulture irrigation cooperative schemes in Zimbabwe fail to access supermarkets to supply their produce. Therefore, they end up sticking to traditional fresh produce markets such as Mbare Musika where they get very low returns and incur huge losses.

Smallholder horticultural producers in Zimbabwe experience massive post-harvest losses and huge quantities are ruined, even before reaching the market (Poulton et al., 2000; Chigusiwa et al., 2013). This really derails farmers' efforts and returns are highly compromised. According to Chigusiwa et al., (2013), there are a number of factors that worsen this situation. First, farmers sell a narrow range of crops such as tomatoes, cabbages and onions. Secondly, prices

of these crops are low and for farmers to realise meaningful profits they have to sell large quantities at any given time. Thirdly, massive price fluctuations on the informal markets offer a high risk on returns as well as the speculative behaviour of middlemen. In view of these challenges, there arises the need to analyse factors that influence smallholder vegetable farmers' decision to select post-harvest practices for value addition.

These myriad of problems are being faced by smallholder horticulture producers in Zimbabwe despite evidence which proposes that there is actual possibility to enhance the livelihoods of poor small-scale producers of horticultural products through processing activities (Proctor et al., 2000). Again, utilisation of improved post-harvest practices through value addition has been shown to increase profit margins, quality, and longer shelf lives of products which greatly benefits both producers and marketers (Meena et al., 2009). However, Zimbabwe's smallholder horticultural sector lacks improved marketing channels, marketing innovation strategies (such as value addition) and appropriate tactics to alleviate constraints facing the sector, which are postulated to expand growth in the medium to long term (Heri, 2006). For all that, there is still a big gap in Zimbabwe smallholder horticultural producers' knowledge in as far as promoting and fostering value addition which might result in both having a secure return and a decent livelihood. Therefore, this warrants that a study be undertaken to ascertain the current status of the horticultural sector in Zimbabwe against these challenges.

1.3 Broad objective

The broad objective of this study is to assess smallholder vegetable farmers` awareness, perceptions, profit scenarios and preferred post-harvest value-adding initiatives as well as factors that condition their selection choices, adoption and product market access.

1.4 Specific objectives

1. To assess smallholder vegetable farmers` awareness and perceptions of post-harvest practices for value addition.
2. To identify smallholder vegetable farmers` preferred value addition post-harvest practices.
3. To identify factors influencing number of post-harvest practices adopted by smallholder vegetable farmers.
4. To analyse factors that influence smallholder vegetable farmers' decision to select post-

harvest practice for value addition.

5. To investigate factors that influence market channel choice by smallholder vegetable farmers.

1.5 Research questions

- What are the levels of awareness and perceptions of smallholder vegetable farmers towards post-harvest practices for value addition?
- What are the preferred post-harvest practices by smallholder vegetable farmers?
- What are the factors that influence the number of post-harvest practices adopted by smallholder vegetable farmers?
- What are the factors that influence selection of specific post-harvest practices for value addition by smallholder vegetable farmers?
- What are the factors that influence market channel choice by smallholder vegetable farmers?

1.6 Justification of the study

Horticulture is a strategic sector in the Zimbabwean economy. At one point during its peak period (in the 1990s) it used to contribute approximately 3,5–4,5% of GDP and recorded a progress level in surplus of 30% per annum (Heri, 2006). However, after the accelerated land reform programme, the sector became dominated by SHFs who lacked capacity to produce for the export markets and its contribution to the economy declined. These SHFs, who mainly produce for the local markets have been facing high post-harvest losses and market gluts. Furthermore, Chirwa et al., (2008) and Muchopa, (2013) also noted that there is minimal value addition to horticultural products by SHFs causing them to realise very low returns as most of them market their produce in their raw state. For this reason, horticultural crops such as tomatoes, onions, cabbages and other vegetables (covo, rape, etc.), which are mainly grown by SHFs, fetch very low prices at the markets.

Production of vegetables and fruits by SHFs in Zimbabwe plays a pivotal role in food security, poverty alleviation, income generation and sustainable agriculture in the country (Mvumi et al., 2016). The vital role that the horticulture sector plays in the livelihood of SHFs in Zimbabwe cannot be over-emphasised. However, the sector is still faced with a number of challenges which hinder farmers from maximising returns. For example, in a study which was conducted by Mvumi et al., (2016) it was established that there was a huge deficit in the banana

market which can be attributed to a number of constraints that are being currently faced by producers as well as other key stakeholders. Yet, one of the main factors identified as a key constraint was lack of proper post-harvest handling techniques amongst SHFs. To that end, analysing the determinants of post-harvest value-adding initiatives that SHFs are able to engage in can assist in coming up with appropriate measures to minimise post-harvest losses. Furthermore, it assists policy makers to generate vital information which can be used by horticultural experts to curb post-harvest losses amongst SHFs. Zimbabwe being a developing country this will greatly contribute to poverty alleviation and rural development.

In view of the above, the study seeks to establish current awareness and participation in value-adding initiatives by SHFs so as to improve market access. According to Zamasiya et al., (2014) the reasons why SHFs who constitute the greater majority of farmers in developing countries remain self-excluded from lucrative markets still remains an unsolved puzzle. In the same vein, Sharangi and Acharya, (2007) noted that there is a lack of empirical studies of how value-adding activities can help smallholder horticulture farmers market their produce. Therefore, this study is essential in filling in this gap and contributing to the existing body of knowledge on smallholder horticulture farmers' participation in markets through adopting value-adding initiatives. This kind of knowledge is scarce within the country as most previous studies have tended to concentrate on grain crop post-harvest losses, and so there is a gap on studies that focus on post-harvest losses within the country's smallholder horticultural sector. Therefore, this study attempted to give an insight into important factors that need to be addressed along SHFs' value chain to reduce post-harvest losses and increase profitability as well as investment in post-harvest value-adding initiatives, management and infrastructure to the benefit of smallholder producers.

Findings from this study will generate an in-depth analysis of ways in which smallholder vegetable farmers can curb post-harvest losses and enable them to access formal markets. This will improve their livelihoods and assist them in having a secure return. Overall, it will assist in the crafting of informed policies to resuscitate the horticulture sector, agro-processing and the broader economy of Zimbabwe at large.

1.7 Definition of terms

1.7.1 Value chain

Value chain can be defined *as "the full range of activities which are required to bring a product or service from conception, through the different phases of production involving a combination of physical transformation and the input of various producer services, delivery to final customers and final disposal after use"* (Kaplinsky & Morris, 2000: page 4). According to Porter, (1985) there are two broad activities into which value activities can be categorised, which are primary and support activities. Primary activities can further be classified into five categories which are inbound logistics, operations; outbound logistics, marketing and sales as well as service. Furthermore, Porter (1985), classified support activities into four categories which are firm infrastructure, human resource management, technology development and procurement. The value chain as defined by Porter, (1985) is generic and it had a focus on business management. This therefore gives rise to many different value chains depending on the commodity under study. For the purpose of this study, the value chain that will be considered will be that of smallholder vegetable farmers.

1.7.2 Value addition

Value addition is increasing the economic value of a product which occurs at various stages along the value chain done by different players with the aim of making it more preferable in the marketplace (Trienekens, 2011). Value addition takes different dimensions which might involve innovativeness, delivery flexibility, quality, costs and delivery times amongst other whole range of factors (Trienekens, 2011). Broadly, the price that the final consumer is willing to pay defines the extent of value added (Amentae et al., 2016; Trienekens, 2011). For the purpose of this study, the term value addition will mean post-harvest activities that smallholder vegetable farmers are engaged in as a way of improving product quality and shelf life so as to earn more from the market. These activities can also be referred to as post-harvest practices or techniques (Ali, 2012). Hence, in this study, the terms post-harvest practices or techniques will be used interchangeably. They include activities such as packaging, dehydration and drying, sorting and grading, preserving and cooling, washing and cleaning, storage and labelling for value addition.

1.7.3 Post-harvest losses

Post-harvest losses can be defined as a decline in food quality or quantity which can be measured (Grolleaud, 2002). Post-harvest losses occur between the period of harvesting to consumption by the final consumer (Hodges et al., 2011; Rembold et al., 2011). These kinds of losses have different consequences for resource-constrained farmers, such as poor nutrition and reduced income (World Bank, 2011). Reduction in quality may result in huge economic losses to the farmer as the product fails to be marketed or is in a state in which customers no longer prefer buying it (Kader, 2005). Such kinds of post-harvest losses impact negatively on SHFs as they either fail to access markets or volumes delivered to markets may be reduced drastically. As a result, profit margins of farmers are reduced drastically.

1.8 Limitations of the study

- Budgetary constraints resulted in the study just being conducted in only one province of Zimbabwe.
- Time restrictions and poor road networks particularly in Mutoko district made data collection very onerous.
- Challenges with some respondents failing to recall information accurately might have led to biased data.
- Household head bias might have caused the possibility of erroneous information being obtained.

There were variations between districts in terms of measurements that were used by farmers when converting to kilograms. For example, in Goromonzi District a bundle of leafy vegetables of covo and rape was estimated to weigh about 2 kg whilst in Seke it was estimated at 5 kg. As a result of these variations, average figures were used.

Nonetheless, measures were taken to ensure that data obtained from respondents was reasonably accurate. For instance, respondents were probed for clarity in cases where conflicting responses were given. Furthermore, triangulation was done with the extension officer operating in that particular area as well as other key informants' in order to verify any ambiguous information.

1.9 Organisation of the study

This study consists of ten (10) chapters which are organised as follows:

Chapter 1 introduces the study.

Chapter 2 offers the literature review of the study. The main issues highlighted are smallholder farmers' awareness of post-harvest practices for value addition and factors that influence smallholder farmers' adoption and selection choices of post-harvest practices.

Chapter 3 discusses factors that influence smallholder vegetable farmers' access to formal markets.

Chapter 4 describes the study area.

Chapter 5 covers the research methodology that was used in the study.

Chapter 6 presents descriptive results focusing mainly on demographic characteristics of farmers, main causes of post-harvest losses of vegetables and their estimated value.

Chapter 7 offers results of preference and selection of post-harvest handling practices by smallholder vegetable farmers.

Chapter 8 offers the empirical results of this study. It specifically looks at the factors influencing a number of post-harvest practices adopted by smallholder farmers in the study area. This objective was analysed using the Poisson count regression model (PCRM).

Chapter 9 presents further empirical results on selection of post-harvest practices for value addition and market channel choice of smallholder vegetable farmers in Mashonaland East Province.

Chapter 10 concludes the study by offering a summary of the research, policy recommendations as well as areas for further study.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provides a review of literature relevant to the study objectives outlined in Chapter 1 above. The chapter unfolds as follows; firstly, it provides smallholder farmers' awareness of post-harvest value-adding initiatives. A review of factors that influence smallholder horticulture farmers' adoption and selection choices of post-harvest practices for value addition are discussed. Finally, insights drawn from the literature review are provided.

2.1 Smallholder farmers' awareness of post-harvest practices

Several studies have pointed out the importance of value addition[3] in agriculture (Gandhi, V. & Marsh, 2001; Gulati et al., 2005; Ali, 2012). However, there is consensus from these different studies that there are still major gaps in value addition research particularly in developing countries that can improve rural livelihoods, diversify their economic base, increase their income as well as create opportunities for alternative markets (Roy et al., 2013). Adoption of appropriate post-harvest technologies by SHFs has potential to reduce post-harvest losses by at least 30% (Kitinoja, 2013b). For post-harvest technologies to be appropriate, they have to match the resource constrained environment in which SHFs in developing countries operate. They have to be small-scale, innovative and less expensive. Farmers' knowledge of the horticulture value chain particularly after harvest is critical in reducing post-harvest losses (Kitinoja, 2013b). Yet, it has been mentioned that lack of adequate information as well as knowledge on proper crop post-harvest and value-adding practices results in substantial losses in produce before they reach the market (Rugumamu, 2009; Musasa et al., 2013).

Farmers' knowledge and awareness of post-harvest practices for value addition is very crucial in efficient supply of vegetables since farmers are the primary source of fresh horticultural produce. For instance, India is able to produce a wide variety of vegetables but post-harvest losses are a major challenge (Meena et al., 2009). It is estimated that around 30–40% of fruits

[3] Value addition in agriculture can be defined as activities which add value to a product so as to enhance its present state and eventually fetch more from the market. In the case of vegetables, post-harvest value addition could include washing, grading, sorting, labelling, cooling and drying.

and vegetables produced in India get wasted due to post-harvest losses (Meena et al., 2009; Negi & Anand, 2016). These losses emanate from a number of challenges. However, lack of awareness and knowledge regarding the management of post-harvest handling of produce was identified as one of the major causes (Shukla & Jharkharia, 2013). Furthermore, it has been noted that most early literature reviews have focused on general issues in the supply chain of fruit and vegetables such as marketing efficiency and cold chain.

In a study which was conducted by Kereth et al., (2013) in the Bagamoyo District of Tanzania, it was pointed out that there was lack of knowledge on post-harvest losses and management amongst the SHFs. Consequently, it resulted in farmers having reduced incomes from the market. The same study also suggested that there has not been adequate investment in post-harvest technologies which suit smallholder fruit farmers so that they can secure higher income from the market. Even though the magnitude of post-harvest losses varies from area to area as well as from country to country, such kinds of findings suggest that there are still gaps in smallholder horticulture farmers' awareness on post-harvest practices for value addition.

Similarly, Tefera (2012) acknowledges that there are still some knowledge gaps in post-harvest technology processes among researchers, extension staff and farmers in Africa. The extent of these knowledge gaps especially amongst SHFs remains to be determined as well as appropriate methods which can be used to bridge them. It is under this premise that the study attempts to investigate the level of awareness by SHFs of post-harvest value addition. Such thorough understanding can only be able to inform crafting of appropriate low-cost post-harvest mechanisms which can assist farmers to maximise their market returns.

Awareness of post-harvest technologies such as drying, cleaning, storage, cooling, grading, labelling, sorting and packaging for value addition are important for improving smallholder livelihoods (Ali, 2012). Therefore, findings from this objective may help to unlock some constraining factors which may be hindering access and application of already known technologies. Hence, appropriate capacity building efforts to increase both access to and utilisation of value-adding horticulture technologies will be recommended that might help to eliminate the gap between awareness and use of these technologies for improved livelihoods. Thus, this particular objective envisages to establish baseline knowledge on key aspects of smallholder horticulture farmers' awareness of post-harvest value-adding initiative with the aim of identifying areas and gaps for capacity building interventions.

2.2 Participation of smallholder farmers in value addition

According to Njaya, (2014) the increase in urban population within Zimbabwean cities has created a surging demand for vegetables. Increase in demand for horticultural produce is seen as an opportunity for SHFs particularly those in peri-urban areas to engage in value addition and agro-processing activities so as to satisfy consumer preferences. Nonetheless, participation of smallholder horticulture farmers in post-harvest value addition is perceived to be generally low. This is because currently, the majority of SHFs in Zimbabwe continue to market their produce with minimal or no value addition (Njaya, 2014).

The need for value addition through the processing of smallholder horticulture produce has been recommended by various studies recently in Zimbabwe (Musasa et al., 2013; Njaya, 2014; Mvumi et al., 2016). However, studies that are backed by empirical evidence on current post-harvest practices for value addition (PPVA) that SHFs are engaged in are lacking. In addition, there is limited literature on previous studies that attempted to identify factors that influence smallholder horticulture farmers' adoption and selection choices of post-harvest practices for value addition. Participation of smallholder horticulture farmers in post-harvest value addition is perceived to be generally low. Further, reasons why SHFs prefer to engage in certain PPVA over others are not clearly understood. In the same way, the extent to which value addition can assist SHFs to access the market is yet to be ascertained. The objective of this study is therefore to identify determinants of post-harvest practices selection choices and factors influencing adoption of PPVA. Identifying such determinants can assist to guide and inform subsequent interventions geared towards promoting better market access of smallholder horticulture farmers in Zimbabwe. Fruit and vegetable value addition can then act as a way to promote income generation and reduce rural poverty. Some of the factors that influence SHFs' adoption and selection choices of post-harvest value-adding initiatives reviewed from literature are outlined below.

2.2.1 Access to extension services

Agricultural extension plays a vital role in the design and implementation of post-harvest loss reduction efforts in developing countries (McNamara & Tata, 2015). In a study which was conducted by Amentae et al., (2016) access to extension services was found to be a significant factor influencing farmers' value-adding decisions. Similar findings were echoed by Kumar et al., (2011) who found that access to extension services positively influenced farmers' involvement in milk value addition. The importance of research and extension services in providing wider selection choices for value addition was also emphasised by Mapiye et al., (2007) amongst communal Nguni cattle producers in South Africa. This is because access to extension services enables farmers to use modern inputs, increase their awareness to value-adding activities as well as increase their access to market information. Extension is very vital in offering information and educating farmers in different ways that they can employ to minimise post-harvest losses of their horticulture produce. Thus, extension availability or absence of it, greatly influences SHFs' selection choices of PPVA.

However, Ayandiji and Omidiji, (2011) argue that it is not just the access to extension that has a bearing on farmers' decision to select PPVA, but also the level of knowledge of extension workers on these post-harvest value-adding initiatives. For that reason, other scholars such as Kitinoja et al., (2011) maintained that research and extension in post-harvest science in developing countries should be integrated into the agricultural curriculum. They allude to the need to come up with a comprehensive capacity building in developing countries. This must incorporate aspects such as government policy formulation, technical knowledge, extension skills, access to tools and supplies in developing countries.

Nonetheless, the huge variety of crops and the many diverse post-harvest processes they require entails that post-harvest extension is complex (McNamara & Tata, 2015). This is because there are many interconnections within the supply chain from the farmer up until the final consumer (Figure 2.1). But in developing countries post-harvest losses are highest before the farm gate (Hodges et al., 2011). Therefore, in that view extension efforts in developing countries need to be guided appropriately.

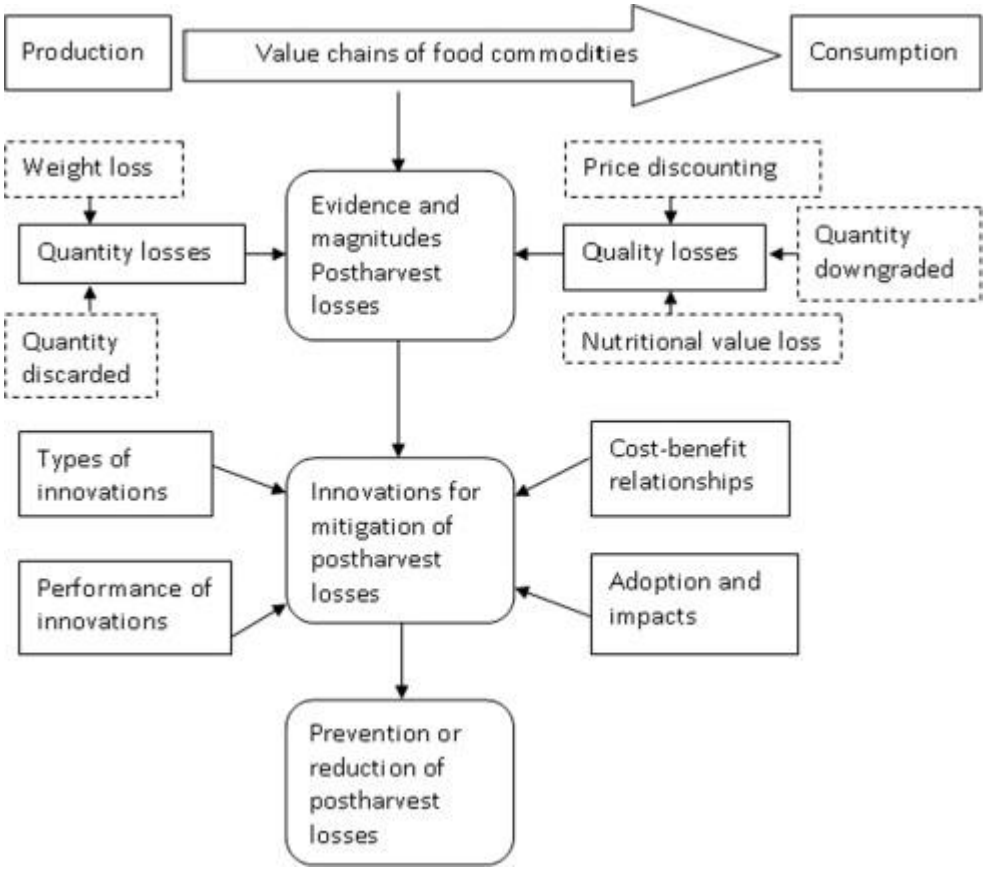

Figure 2.1: Post-harvest losses and the dynamics of mitigation

Source: Affognon et al., (2015)

Figure 2.1 shows that innovations that are required to reduce post-harvest losses are characterised by many actors. According to Affognon et al., (2015) the above diagram indicates that losses can occur at any stage of the post-production chain. Thus, the above diagram depicts post-harvest losses that can be encountered from "farm to fork". The losses encountered along the value chain necessitate that appropriate innovations must be designed to minimise or prevent losses. Such kind of innovations are guided by their technical efficacy, cost effectiveness as well as their impacts (Affognon et al., 2015; McNamara & Tata, 2015). Therefore, even if extension introduces what may seem to be technologically sound innovations, farmers are guided by potential net returns in selecting or adopting such kinds of post-harvest innovations. Hence, there are many challenges to post-harvest losses extension which require multi-faceted approaches in guiding farmers and other actors in their decision-making. Throughout the supply chain, extension plays a pivotal role in reducing post-harvest losses (Bauer et al., 2009).

According to McNamara and Tata, (2015) extension services aimed at reducing post-harvest losses (PHL) have to start by analysing current habits of farmers. This involves understanding their attitudes with regards to PHL. Further, it involves having clarity on ways they are involved at the present moment in curbing PHL and reasons guiding such kind of post-harvest losses interventions. Such kind of an analysis is envisaged as a very important departure point. It would guide interventions and technologies to improve efficiency of post-harvest processing informed by the farmers' perspective and all relevant actors involved in the value chain (McNamara & Tata, 2015). However, available literature in Zimbabwe tends to suggest that such a kind of approach and study has not yet been done specifically in smallholder horticulture farming. Consequently, this study attempts to bridge that gap by analysing current factors that condition SHFs to engage in particular PPVA. Results from the study would accordingly guide extension services and research in crafting post-harvest losses technologies for smallholder horticulture farmers.

According to McNamara and Tata, (2015) for extension programme design to be successful seven design principals need to be considered. These are:

- Begin with the audience in mind;
- Engage multiple actors and institutions at their strengths;
- Finance in a manner that corresponds to the programme goals;
- Manage for impact;
- Employ multiple modes and methods of communication;
- Embrace the tension between the technology diffusion and process approaches;
- Realise the enabling environment can swamp the programme's good work.

In Zimbabwe, SHFs engage in value-adding activities on an *adhoc* basis without proper planning (Jaravaza & Mabhungu, 2015). Lack of capital and technical knowledge concerning value addition is mentioned amongst some of the constraints that SHFs encounter. From the foregoing, SHFs' limited knowledge is attributed to inadequate access to extension services. Extension within Zimbabwe's horticulture sector is perceived to be generally weak (Utete, 2003; Proctor et al., 2000; Anseeuw et al., 2012). This is because attention in training of extension personnel tends to focus on field crops such as maize, tobacco and cotton. To that end, the majority of smallholder horticulture farmers mainly engage in drying of excess vegetables as their main post-harvest value addition (Jaravaza & Mabhungu, 2015). The rural

output markets in Zimbabwe are also not functioning at their optimal level. This can be attributed to the economic crisis of the past decade. Anseeuw et al., (2012) further pointed out that lack of agricultural extension and research in Zimbabwe has also led to limited transfer of technology and dissemination of skills to farmers. Such a scenario might also have an impact on the adoption of certain PPVAs by smallholder farmers in the country. To this end, improved provision of research and extension services through public-private entities as well as financial and marketing services is thought to improve rural output markets in Zimbabwe.

Thus, effective agricultural advisory extension services can be vital for SHFs to adopt value-added practices for vegetables. Extension is the main source of information and advisory services for the majority of SHFs. Moreover, it connects farmers to Non-Governmental Organisations (NGOs), research and the agribusiness community assisting them to engage in demand-led production (Roy et al., 2013). For this reason, extension is vital in influencing SHFs' adoption as well as selection of value-adding practices for vegetables.

2.2.2 Access to credit

Credit is an important component in agro-processing for value addition within the SHFs' value chains. Agricultural credit is vital as it improves rural development through increased agricultural production in developing countries. Hence it assists in breaking the vicious cycle of poverty as well as enhancing the standards of living of SHFs. Conversely, lack of access to adequate amounts of credit restricts SHFs from engaging in proper agro-processing activities. Numerous studies have acknowledged the importance of SHFs being incorporated into high-value chains, yet little attention has been given to addressing the issue of access to credit (Salami et al., 2010; Sikwela, 2013). In that way, incapacity of governments in developing countries to avail credit to smallholder vegetable and fruit farmers as a support measure constrains them from adopting post-harvest technologies.

Several previous studies show that SHFs lack access to credit (Kitinoja, 2013a; Baiyegunhi & Fraser, 2014; Affognon et al., 2015). Some previous empirical studies have tended to suggest that access to credit influences SHFs' decisions to engage in value addition. This was shown in a study which was conducted by Amentae et al., (2016) to explore Teff value chains' post-harvest losses in Ethiopia. Another study was conducted by Ngore et al., (2011) to assess influence of credit availability to value addition by meat agribusiness in Kenya. Nonetheless,

the majority of these studies did not focus on horticulture crops nor specifically on value-adding choices to reduce post-harvest losses. Most of these studies tended to focus on cereals in SSA.

Access to credit and services, economies of scale, business skills amongst other factors are highlighted as key in adoption of post-harvest technologies by smallholder farmers. Therefore, provision of affordable credit to SHFs can enable them to engage in higher-value-adding activities, supply processed products to supermarkets and ultimately obtain more income (Muchopa, 2013). Credit provision is identified as key in enhancing the welfare of SHFs directly and it also enables them to make investment decisions that improve agricultural productivity (Baiyegunhi & Fraser, 2014; Zeller & Sharma, 2000). It helps alleviate the liquidity challenges of SHFs thus influencing the adoption of new technologies and helping them improve income growth (Rosenzweig, 2001; Zeller, 2000).

On the other hand, non-existence of credit markets or their poor state in developing countries makes access to credit a nightmare for smallholder farmers (Kirsten et al., 2009). This is further compounded by the fact that SHFs lack collateral causing financial institutions to shun lending to them because the risk of default is high. In the same view, observations have been made of rapid decline in government support within the region in provision of subsidy programmes, agricultural input supply as well as agricultural produce markets. Thus, the dilemma of SHFs is worsened when private institutions fail to chip in to fill the void left by government.

Credit is essential for SHFs to be able to experiment with low-cost post-harvest technologies (McNamara & Tata, 2015). Clearly then, selection choices of smallholder horticulture farmers' post-harvest practices for value addition are influenced not only by available credit for them to engage in such activities but also envisaged returns from the market. Therefore, even if advanced and innovative post-harvest loss technologies are available but farmers are credit constrained they may fail to adopt such kinds of technologies (Affognon et al., 2015; Kitinoja, 2013b).

Smallholder farmers in Zimbabwe do not have a track record of borrowing from financial institutions and neither do financial institutions fully understand them (Rukuni, 2013). This is

one reason why their entrepreneurial capacity and participation in input and output markets has not been fully maximised. The present prevailing economic situation in Zimbabwe exacerbated the liquidity crunch of SHFs to access loans and credit. Generally, the economy is depressed across all sectors. Hence, there are very limited lines of credit particularly for SHFs (Kapuya et al., 2010; Makoni et al., 2014). Further, smallholder farmers are deemed to be high risk by lending institutions because of their lack of collateral security in case of default. In the same way, banks cite high transaction costs in administering loans to resource-poor farmers as another deterrent for them to extend loans (Makoni et al., 2014). According to Mwakiwa et al., (2016) the potential of horticulture crops in Zimbabwe is not being fully maximised. This emanates from credit and financial constraints *inter alia* that are experienced with smallholder farmers in Zimbabwe particularly with regards to venturing into high-value crops such as green beans. Credit availability can improve their productivity and expand their market options both in domestic and export markets.

Access to credit can give farmers diverse options to engage in different value-adding activities. This is because those farmers with access to credit may be able to purchase value-adding equipment which might enable them to engage in higher-level value-adding activities such as juice extraction. Yet, because the majority of SHFs operate in credit-constrained environments they are bound to adopt those value-adding activities which do not involve high costs such as washing of vegetables. Roy et al., (2013) confirmed this notion that SHFs tend not to adopt those value-adding practices which require substantial financial investments such as the use of mango harvesters.

2.2.3 Access to technology

In developing countries, lack of appropriate technology constrains small-scale production of value-added foods in rural areas (Aworh, 2015). Value addition to vegetables has potential to reduce post-harvest losses, improve SHFs' income, enhance food security and contribute to sustainable rural development. The challenge of lack of appropriate technology is compounded by the shortage of vital inputs such as water and electricity to carry out operations in rural areas. Further, lack of access to financial institutions, inadequate working capital and high interest rates impede SHFs from engaging in value addition (Proctor et al., 2000; Aworh, 2015). Smallholder farmers are resource-constrained and they operate on a small scale. This limits

their ability to engage in value-adding and agro-processing activities that can reduce post-harvest losses of their horticultural produce.

Kitinoja (2013b) recommends that SHFs' post-harvest technology must be easy and simple to use so as not to pose difficulties in implementation and management. From the foregoing it can be inferred that simplicity of use and management are amongst some of the factors that influence SHFs' selection choices of post-harvest technologies. Generally, evidence from literature tends to suggest that SHFs tend to prefer inexpensive post-harvest quality management techniques. However, research that focuses on such low-cost solutions which can be fused with SHFs' indigenous post-harvest handling techniques is still lagging behind (Sibomana et al., 2016).

Several previous studies have focused on access of post-harvest technology by small- and medium-enterprises (Proctor et al., 2000; Wakjira, 2010; Mhazo et al., 2012; Aworh, 2015). Yet still, little attention has been devoted to selection of post-harvest technology by SHFs. However, the Analytical Hierarchy Process (AHP) has been employed in some studies to examine post-harvest technology choice by smallholder farmers based on several criteria. Results from such studies have tended to indicate that SHFs' selection of post-harvest technologies is based on improving quality of produce, processing cost applicability of technology and increasing shelf life (Vera-Montenegro et al., 2014; Dirpan & Slamet, 2016).

According to Gatignon and Robertson (1991) technology adoption emanates from a series of decisions influenced by ease of adoption of the technology being informed by previous knowledge. There is a need to strike a balance between traditional activities and new technologies when examining technology adoption by resource-constrained SHFs. Technology adoption has been shown to be very important in agricultural research by SHFs in rural areas (Abdulai et al., 2011; Mariano et al., 2012)

In Zimbabwe, lack of appropriate technologies constrain fruit and vegetable processing (Proctor et al., 2000; Mhazo et al., 2012). The majority of processors use "home kitchen utensils as equipment". Further, other value-adding activities such as grading, peeling and cutting are done using simple tools such as hand knives and spoons. Vegetables are usually just cut into small pieces, parboiled and left to dry in the sun on a flat surface. In the same vein, absence of cold storage facilities hinders storage of raw products for marketing at a later stage

in the off season. Kitinoja, (2013b) emphasises the importance of stakeholders to work together so as to improve the use of cold chain technology, infrastructure and management skills in order to minimise post-harvest losses.

At macro level, the current prevailing harsh economic conditions hinder agro-processing in the country (Mhazo et al., 2012). This is because some equipment and technologies are imported. Hence the shortage of foreign currency limits procurement. However, Proctor et al., (2000) argue that at times imported equipment might not be suitable for local conditions giving smallholder entrepreneurs a dilemma to repair them or source the required spare parts when they break down. As a result of these challenges Zimbabwe's agro-processing subsector has been operating below capacity at low levels estimated to be between 10% to about 40% (Anseeuw et al., 2012). The depressed agro-processing subsector has caused SHFs to have limited income diversification options as agriculture alone fails to support their livelihoods (Anseeuw et al., 2012). Consequently, technology constraints encountered by smallholder horticulture farmers restricts them in the selection of processing activities which could add value to their produce. Anseeuw et al., (2012) advocates that SHFs' technology access in Zimbabwe should be improved through group service provision. Further, in the absence of alternative technology which is affordable to SHFs, selection choices of post-harvest practices for value addition tend to be informed by traditional knowledge.

2.2.4 Storage infrastructure

Availability of on-farm and off-farm storage facilities as well as agro-processing technology to add value and increase shelf life of farm produce can act as an incentive for smallholder farmers to engage in PPVA. However, in most instances, such kind of post-harvest techniques require high-energy sources like refrigeration which are not available or affordable to most SHFs (Prusky, 2011; Adepoju, 2014). For example, in India, Meena et al., (2009) reported that about 30–40% of fruit and vegetables are wasted annually due to lack of proper infrastructure such as cold chains. Hence, non-availability of such kinds of facilities discourage SHFs to engage in processing of their produce. This implies that farmers will always have to sell their produce quickly at low prices as they lack ways and means of extending its shelf life (Adepoju, 2014; Njaya, 2014). This greatly reduces the amount of income that SHFs can get. Again, lack of adequate rural development infrastructure constrains SHFs in adopting new technologies that can improve their capacity to produce better quality products.

Lack of appropriate infrastructure acts as a key impediment in marketing of horticultural produce by SHFs. Machethe, (2004) noted with concern that poor infrastructure in African countries results in high transaction costs constraining smallholder agriculture. Some of these high transaction costs may emanate from expensive transportation. This is because in most cases SHFs rely on public transport to transport their produce to the market. Therefore, the need to provide adequate infrastructure as a prerequisite for attaining increased agricultural productivity and profitability is emphasised (Machethe, 2004). In addition, the lack of processing equipment by SHFs to process their surplus produce coupled with the non-existence of modern storage facilities exposes their produce to damages and high post-harvest losses (Kader, 2005; Prusky, 2011). To this end, the highest amounts of post-harvest losses are incurred in vegetables and fruits in SSA because of poor post-production infrastructure for handling them and their perishable nature (Affognon et al., 2015).

On the other hand, the availability of key aspects of rural infrastructure such as electricity and clean water gives SHFs options to engage in post-harvest practices for value addition (PPVA). For instance, in Nicaragua, the establishment of collection centres in rural areas assisted smallholder farmers in grading and washing of their fresh produce in chlorinated water (Minot & Hill, 2007).

Non-existence of appropriate post-harvest infrastructure in Zimbabwe's rural areas like packing houses, cold-storage facilities, pre-cooling and sorting facilities limits the selection choices of SHFs PPVA. Furthermore, in Zimbabwe poor infrastructure such as bad roads and inadequacy of communication facilities affect smallholder horticulture farmers' value chains from functioning effectively and efficiently (Mvumi et al., 2016). This results in inappropriate methods being employed for sorting and storage of the produce (Njaya, 2014). This kind of scenario further exposes farmers to exploitation by informal middlemen.

2.2.5 Lack of market information

Information access is vital in farmers' decision-making with regards to production, marketing and finance (Tadesse & Bahiigwa, 2015). When farmers intend to sell their produce, they are guided by price, buyers as well as proper standards and grades required in a specific market. This array of considerations directs farmers to a great extent in the market they intend to sell

their produce in and the form it should be in. In that view, market information is very vital in helping farmers make marketing decisions as well as any value addition that they might intend to engage in. Nonetheless, gathering such kind of information involves search costs which in other instances might discourage farmers (Tadesse & Bahiigwa, 2015).

In the same way, studies in southern Africa have shown that SHFs' participation in agricultural markets are depressed as a result of lack of information, institutional constraints, high transaction costs amongst other factors (Zamasiya et al., 2014). According to Magingxa et al., (2009) smallholder farmers are disadvantaged when interacting with markets. This is because they have inadequate or no market information, they do not understand price fluctuations, they are not organised collectively, they do not have experience of market negotiation and they also do not fully understand preferred horticulture products in the market (Freeman & Silim, 2001; Heinemann, 2002). As a result, they experience high post-harvest losses as production is not planned properly. In addition, amongst other constraints middlemen take advantage of them. The fact that they are not fully aware of preferred horticulture products in the market causes them to miss opportunities on simple post-harvest value addition which might improve product value.

Marketing of horticulture produce in many instances is impeded by lack of market access and market information (Abay, 2007). This usually emanates from SHFs not having adequate information with regards to buyers, sellers, price, product demand and supply especially in developing countries. For this reason, large quantities of good quality fruit and vegetables that SHFs produce suffer high post-harvest losses before they reach the consumer.

Smallholder farmers in Zimbabwe use extension agents, radios and cell-phones to access market information (Zamasiya et al., 2014). Despite having such a wide variety of platforms to get market information, there are still gaps in access to market information by SHFs in Zimbabwe. For example, Zamasiya et al., (2014) concluded that lack of market information in the soya bean market prevents SHFs from making informed decisions for them to fully participate in the output markets. Such kinds of scenarios limit smallholder horticulture farmers' involvement in post-harvest handling techniques.

In Zimbabwe, Mbare Musika is the largest informal market where most SHFs sell their horticulture produce. However, marketing of produce at this market is very competitive

(Poulton et al., 2000). Besides that, the challenge of marketing at Mbare Musika is worsened by price fluctuations on a daily basis. Further, because SHFs grow a restricted range of crops such as tomatoes and leafy vegetables they experience seasonal glutting. It is envisaged that with better market information SHFs could add value to their products for the off season and this might enable them to target high value markets (Mhazo et al., 2012) . Earlier studies have also confirmed that the majority of smallholder horticulture farmers in Zimbabwe lacked knowledge of value-adding techniques so they sell their produce in its fresh form (Murphy, 1996). A recent study in Rusitu Valley in Manicaland Province has shown that farmers lack market information and capacity to handle seasonal gluts causing them to sell their oranges through informal middlemen (Musasa et al., 2015). As a result, they get very low prices and in other instances they may even end up making a loss. Moreover, they incur huge post-harvest losses due to lack of value-adding techniques. From the foregoing, market information *inter alia* other factors such as capital are vital in smallholder horticulture farmers' engagement in post-harvest value-adding techniques. Consequently, poor market access lead to exploitation by middlemen, unequal bargaining power and lack of understanding of market needs.

According to Mhazo et al., (2015) in Zimbabwe, small-scale processors' lack of market information and processing skills constrain them from adding value to fruits and vegetables. In addition, other factors such as lack of appropriate processing equipment, financial constraints to purchase the requisite ingredients and shortage of packaging material hinder SHFs in engaging in diverse processing activities. As a result smallholder enterprises just end up engaging mainly in fruit and vegetable drying (Mhazo et al., 2015). Smallholder farmers also lacked information with regards to customer preferences, taste and packaging which constrain them from processing vegetables according to market needs.

Lack of market information was also cited as one of the main constraints faced by emerging farmers in the Eastern Cape Province of South Africa (Khapayi & Celliers, 2015). The planning and marketing of agricultural produce by SHFs is thereby constrained. This study by Khapayi and Celliers, (2015) concluded that engaging farmers in value-adding activities, market information and improving transport logistics might assist emerging farmers to participate in remunerative agricultural markets.

According to Ejeta, (2009) the main challenges that hinder quality maintenance of horticultural produce after harvest in developing countries are lack of market information that can help

farmers to produce according to demand in the market, inadequate harvesting techniques, poor post-harvest management and logistics, and lack of processing and packaging technology. Lack of market information on required standards of horticulture produce (e.g. tomatoes) is a major cause of post-harvest losses in sub-Saharan Africa (Sibomana et al., 2016; Maliwichi et al., 2014).

Mvumi et al., (2016) emphasised the need to revamp telecommunications infrastructure and roads so as to improve dissemination of market information amongst SHFs in Zimbabwe. Such kinds of development are seen as key in improving post-harvest handling of horticulture produce in the country. Improvement of physical and information infrastructure is regarded as key to enhancing performance of horticultural produce post-harvest value chains in Zimbabwe. It will enable SHFs to have a better understanding of the market and so it greatly influences their decision to engage in post-harvest value-adding activities guided by market requirements. Mhazo et al., (2015) concluded that providing market information and skills to small-scale processors in Zimbabwe might enable them to diversify their post-harvest value-adding activities. Thus, their returns might be higher and at the same time they might also be able to access formal markets.

Value-adding decisions for agricultural produce are directed by the market price of value-added products (Mamo et al., 2014; Amentae et al., 2016). Hence access to market information to a greater extent has a bearing on the kind of value-adding activities that the farmer selects. In that way, market information can act as a guide for demand for value-added produce by the farmer. A farmer who has market information may be able to know the kind of value-added produce that is in high demand in the market. As a result, it may act as a roadmap for their selection of value-adding activities to engage in.

2.2.6 Quality control and standardisation

Poor crop quality produced by many SHFs exerts a challenge on small-scale processors. This emanates from poor handling, poor storage and poor post-harvest management (Proctor et al., 2000). In the same vein, cost of packaging material may also discourage SHFs from engaging in post-harvest value-adding initiatives. Given the resource-constrained environment in which SHFs operate, many of them fail to secure proper packaging resulting in produce deteriorating rapidly. In other instances, processing of horticultural produce requires hygienic environments

of a high level, which SHFs fail or are unable to adhere to. In such instances, it will act as an exclusion factor for SHFs to choose such kinds of processing activity for value addition.

As inferred by Muchopa (2013), the following characteristics of smallholder farmers make value addition to vegetables a challenge:

- Marketing of small volumes.
- Price uncertainties which are negotiated at every stage.
- Sales to many different buyers.
- Poorly specified quality and standards and a lack of quality control.

2.2.7 Farming experience

According to Amentae et al., (2016) farming experience influences farmers' value-adding decisions in that those farmers with more experience know the advantages and disadvantages of certain value-adding activities. Thus, with experience, farmers gain knowledge which informs them on performance of certain value-adding activities in the market. Therefore, experience influences their choice of value-adding activities based on their awareness of anticipated market returns. Furthermore, experience can also have a bearing on farmers' access to resources. More experienced farmers might have accumulated more resources which could enable them to adopt higher-level value-adding activities so they can have wider options in the selection criteria. This might not be the case with less-experienced farmers who might not have accumulated as much assets. Accordingly, their selection choices for value addition might be restricted to the simplest activities such as washing, cleaning and grading. Conversely, it can also be argued that with increasing age, a farmer's ability to adopt certain PPVA may become negatively related. The rationale is that as the farmer gains more experience and age, they may become conservative and less flexible to change in adopting new practices.

2.2.8 Education

Education level influences farmers' decision to engage in value-adding activities positively (Amentae et al., 2016; Roy et al., 2013). Farmers with a higher level of education are bound to adopt value-adding initiatives as well as participate in numerous value-adding activities. This is because education has a bearing on other factors such as management skills, income and access to credit which positively affect adoption of value addition. Moreover, education provides exposure to different communication media hence increasing farmers' information

acquisition and comprehension. It follows that farmers with higher education are bound to appreciate the importance of value addition on horticultural produce. Therefore they might adopt value-adding practices. Furthermore, they may also be engaged in a wide selection of choices of value-adding activities. Even during training by extension personnel, education level, knowledge of post-harvest and attitude towards value-adding activities is very key in influencing adoption (Roy et al., 2013). A recent study which was conducted by Mamo et al., (2014) in Welmera Woreda in Ethiopia confirmed that education status influenced participation in milk value-adding activities.

2.2.9 Access to markets

Market access by smallholder fruit and vegetable farmers is constrained by high transaction costs that emanate from lack of information on prices, quality, demand and other factors such as transport challenges, resulting in farmers getting low returns from the market (Dorward et al., 2005; Markelova et al., 2009; Hellin et al., 2009; Kitinoja, 2013a). In Africa, markets and market access are very important for improving rural incomes. Despite this, poor market access is a major constraint for SHFs to participate in both domestic and international markets (Dorward et al., 2005; Kydd & Dorward, 2004).

A study which was undertaken by Amentae et al., (2016) in Bacho and Dawo districts in Ethiopia tend to suggest that Teff farmers located near markets were more likely to engage in value addition. The rational was that they may have information concerning consumer demand which enables them to engage in value addition. On the contrary, for smallholder milk farmers in Ethiopia, results suggest that farmers who are located far away from markets tend to engage in value addition (Kumar et al., 2011; Mamo et al., 2014). Farmers who are near markets encounter low transportation costs and spoilage hence were more likely to sell raw milk instead of processing it. From the forgoing it can be inferred that the decision to adopt value addition depends on the commodity that the farmer is producing and how distant the market is to the farmer.

In other instances, SHFs may shun selecting certain effective post-harvest innovations because markets are inaccessible, unrewarding or unavailable. For instance, Tomlins et al., (2000) indicated that minimising damage to sweet potatoes during transportation through packaging

into small-sized, rigid boxes did not guarantee increased returns in the market, yet it increased transport costs. Similarly, findings from Kenya by Kiura et al., (2010) revealed that processing of cassava into dried chips did not guarantee a ready market. Therefore, adoption and selection of post-harvest value addition may be evaluated by SHFs depending on the benefits that they confer on opportunity to access markets or anticipated profits.

Smallholder farmers encounter low output prices, fewer buyers competing for their surplus production, and weak access to supporting services, which together result in a disincentive to adopt new technologies and produce for the market (Chamberlin & Jayne, 2013). These challenges further constrain their market access, specifically for vegetables. Since the farmers have little or no capacity to process their produce and coupled with the fact that there are no modern storage facilities their products are prone to damage and post-harvest losses (Kader, 2005). Even when farmers decide to take their produce to the market, they are often constrained by problems of transport and poor road networks (Adepoju, 2014).

There is evidence that if farmers take more responsibility and learn to engage in post-harvest handling such as grading and packaging they can be enabled to sell their horticultural produce directly to retailers and consumers (Kitinoja, 2013b). In that way, farmers may become active marketers and access better markets rather than being passive price takers from middlemen. Knowledge of post-harvest handling techniques and accessibility of better rewarding markets contribute to increased selection choices of post-harvest value addition. Adding value to smallholder horticultural produce through proper harvesting, sorting, grading and packaging is regarded as a potential solution to the low market value that they fetch (Kitinoja, 2013b). The low returns emanate from poor appearance, decay and damage during handling.

Access to markets influence SHFs' decisions to participate in markets. For instance, in Uganda, proximity to a village market was found to have a positive influence on farmers' decisions to participate in the potato market (Sebatta et al., 2014). In the same way, volume of surplus produced for sale has a bearing on farmers' decisions on value addition and type of market to be used. For instance a study conducted in Kabale and Mbale Districts of Uganda by Sebatta et al., (2014) showed that amount of potatoes produced influenced farmers' decision to adopt value addition. Those farmers who produced large volumes were found to be more likely to add value to their potatoes. This could be attributed to economies of scale and the bargaining power they have with the buyers. It is proposed that interventions geared towards enhancing

access to improved technologies, facilitating smallholder organisations, reducing the cost of inter-market trading are key to stimulating smallholder market access (Key et al., 2000; Barrett, 2008).

2.2.10 Farmer groups

Farmer groups are envisaged as assisting in selection choice of value addition as well as decision to adopt value-adding activities. Consequently, farmers who are members of a group are more likely to be involved in value addition compared to their individual counterparts (Berem et al., 2010; Orinda, 2013). This is because groups may have better access to credit, equipment, training, technical advice and benefit from collective marketing which individual farmers lack, hence promoting value addition. Earlier findings have confirmed that farmer groups enable better market access by increasing the bargaining power, hence marketing efficiency and institutions providing support in post-harvest innovations compared to individual farmers (Lemaga, 2005; Westby et al., 2009). In view of that, adoption of certain post-harvest techniques might therefore require farmers to form group partnerships so as to take more steps in the value chains (Affognon et al., 2015). They can take advantage of economies of scale, stronger negotiating power and shared risk. That way, farmers are more likely to adopt PPVA especially those of a higher level. According to Kader (2005) marketing cooperatives or farmer groups are important in developing countries because they offer the advantages highlighted below:

- They provide a central point for collection of harvested horticultural produce.
- Enable purchase of harvesting and packing materials in bulk.
- Proper preparation for market and storage when needed.
- Facilitate transportation to the markets.
- Assist in coordinating the marketing program.

In most instances SHFs sell their agricultural produce at the farm gate to intermediaries, often at a low price (Fafchamps & Hill, 2005). However, innovations in marketing arrangements can transform market relations in favour of SHFs (IFAD, 2001). Producer organizations as well as cooperatives are well-positioned to take advantage of these innovations and link SHFs to high value chains. 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 SHFs by introducing innovations to existing value chains or creating entry ways into new markets. For example, creating new demand for traditional products through processing and value-adding activities has proved to be an innovative route to higher prices.

2.2.11 Transaction costs

Transaction costs are defined as costs of entering into exchange or agreement contracts, sourcing trading partners, screening potential partners, sourcing and verifying information, negotiating, product transfer, monitoring and enforcing transaction (Randela et al., 2008). However, there is no standard definition of transaction costs and defining it is complex (Singh, 2008).

According to Jagwe and Machethe, (2011) transaction costs consists of information and search costs with regard to finding the price, quality, quantity and durability of the product, negotiation, transportation costs and contracting (legal) fees, communication charges, monitoring and enforcement costs among others. Transaction costs determine the amount of income that the farmer gets when they participate in a certain market. Therefore, they are important in the farmers' decision to adopt value addition and the type of value-adding activities that they choose to engage in.

Market access of different households differ because they face different transaction costs (Omamo, 1998; Key et al., 2000; Renkow et al., 2004). Coase, (1937) is renowned for making the observations that transaction costs are the foundations for the organisation of all economic activities and can explain much of the behaviour of households and firms. In that view, selection choices of post-harvest value-adding initiatives are also influenced by transaction costs that each household faces. The transactions costs that have attracted much attention from researchers are those associated with transport (Barrett, 2008). Many scholars have analysed how transaction costs affect smallholder market participation (Barrett, 2008; Jagwe et al., 2010; Okoye et al., 2016). Literature on how transaction costs influence SHFs' decision to select PPVA is scanty. According to Delgado, (1999) transaction costs are regarded as the benchmark for barriers to market access by the majority of resource-poor smallholders. High transaction costs have been recognised by numerous scholars as the main reason for SHFs' failure to participate in markets (Goetz, 1992; Key et al., 2000; Makhura, 2001). Transaction costs can

be categorised into observable and non-observable costs linked with market activities (Jagwe et al., 2010).

According to Key et al., (2000) transaction costs can be grouped into fixed and variable transaction costs. Fixed transaction costs do not change. They include, amongst others, searching for a trading partner, negotiating and bargaining, enforcement of contracts and supervision (Kirsten & Vink, 2005). Variable or proportional transaction costs are per unit costs of accessing markets that vary with the volumes traded and may affect the decision to participate in the market as well as the quantity traded. These comprise of costs related with transferring the output being traded like transport costs and time spent transporting the agricultural produce to the market. They are mainly unobservable and raise the price of the commodity sold while reducing the price received for the commodity (Jagwe et al., 2010). In that view, it is hypothesised that farmers' selection of PHVAI is influenced by factors such as price of the commodity, availability of family labour, and ownership of means of transport.

Yet, again, high transaction costs may discourage SHFs from participating in the markets or they may choose less lucrative markets such as spot markets (Makhura, 2001). These affirmations are supported by Delgado, (1999); Kherallah and Kirsten, (2002) that high transaction costs that SHFs face in rural areas of developing countries discourage them from participating in formal markets. These high transaction costs emanate from lack of adequate market information and contractual arrangements, lack of lobbies in the legal environment and farmers not being receptive to change. Consequently, SHFs usually experience high post-harvest losses of their perishable commodities because of high transaction costs. Hence, it is argued that improvements in rural road infrastructure, market information systems, collective marketing, and value addition might help reduce transaction costs and enhance SHFs' market participation (Ouma et al., 2010). However, the fact that transaction costs vary over household, agricultural produce and enterprise makes curbing transaction costs very complex. Regardless of that, lower transaction costs and improved market access are presumed to be key towards encouraging smallholder farmers to adopt PHVAI (Mosey et al., 2012).

2.3 Insights from literature review

The importance of value addition for smallholder fruit and vegetable farmers has been outlined in several studies. However, there is consensus from several studies that SHFs' awareness of these post-harvest practices for value addition is limited. Lack of awareness on post-harvest techniques result in retarded returns for smallholder horticulture farmers. A clear understanding of the level of smallholder farmers' awareness of PPVA can enable crafting of appropriate low-cost post-harvest mechanisms which can assist smallholder farmers to maximise on their market returns.

In Zimbabwe, participation of SHFs in post-harvest value addition is perceived to be generally low. This is because the majority of SHFs continue to market their produce with minimal or no value addition. The reviewed literature has highlighted that smallholder fruit and vegetable farmers are constrained by a number of factors for them to effectively select and adopt PPVA. These various factors were discussed in detail.

Even though the discourse for value addition through processing of smallholder horticulture produce has been recommended by various studies in Zimbabwe recently, studies that are backed by empirical evidence on current PPVA that SHFs are engaged in are lacking. In that regard, it is envisaged that identification of determinants of post-harvest value-adding initiatives selection choices and factors influencing adoption of PPVA can assist to guide and inform subsequent interventions geared towards promoting better market access of smallholder horticulture farmers in Zimbabwe.

Post-harvest techniques which are simple, cheap and easy to use are most likely adopted by smallholder farmers. Therefore, research must focus on such kind of technologies and fuse them with farmers' indigenous knowledge on post-harvest handling techniques.

CHAPTER 3

FACTORS THAT INFLUENCE SMALLHOLDER HORTICULTURE FARMERS' FORMAL MARKET ACCESS

3.0 Introduction

This chapter reviews literature on factors that influence smallholder horticulture farmers' formal market access. A special section was reserved for review of analytical models used in selection choice models, adoption models and market access models. The chapter also covers a brief summary of research insights and the current research impasse leading to indications in current research gaps which this study aims to bridge as suggested by the reviewed literature.

3.1 Smallholder farmers and output markets

According to Zamasiya et al., (2014: page 50) the reasons "why most smallholder farmers who happen to make the larger proportion of the poor in developing countries self-select themselves out of the remunerative markets remains largely unanswered". Studies from Southern Africa have shown evidence that SHFs' participation in agricultural output markets is subdued as a result of information asymmetries, high market transaction costs and institutional constraints, amongst other factors (Zamasiya et al., 2014). Moreover, majority of households lack access to institutional and physical infrastructure, inadequate private and public investment, and a shortage of productive assets, which restricts them from accessing lucrative markets (Siziba et al., 2011; Barrett & Swallow, 2006). On the other hand, SHFs with access to functional institutions and infrastructure are able to participate in markets.

The above scenario is compounded by the fact that in many southern African countries the bulk of agricultural produce is lost soon after production mainly because of poor post-harvest handling as well as failure to access formal markets (Phiri & Otieno, 2008). This is more pronounced in the case of vegetables because of their high perishability, low production volumes and lack of value addition. Several factors are also mentioned as barriers that discourage SHFs from participating in formal markets. Some of these factors include household characteristics such as labour shortages, low education levels, inadequate government services, high transaction costs as well as lack of physical infrastructure (Siziba et al., 2011; Jagwe et al., 2010; Pingali et al., 2005).

3.2 Formal and informal marketing channels

According to Proctor et al., (2000) the main difference between formal and informal marketing channels is that the former put more emphasis on quality and are demand driven, while the informal market place emphasis on quantity and are supply driven. Furthermore, the two marketing channels use different pricing and promotion strategies, distribution systems, and carry a different range and mix of produce. Apparently literature on the extent and nature of informal marketing systems in Zimbabwe is scarce. Kherallah et al., (2001) further explain that informal markets consist of unofficial transactions between farmers and from farmers directly to consumers within the agricultural context. In the case of Zimbabwe, the informal markets where smallholder fruit and vegetables farmers sell their produce include farm gate, spot markets such as roadside marketing and municipal markets such as Mbare Musika in urban areas. The municipal markets located predominantly in major cities such as Harare, Bulawayo, Masvingo, Gweru and Mutare are where large volumes of fresh vegetable wholesaling and retailing takes place. Formal markets are characterised by clearly defined grades, prices that are formally set, quality standards and safety regulations (Henson & Jaffee, 2007). In Zimbabwe formal markets include retail outlets, supermarkets, hotels, restaurants, hospitals and other government institutions. In most cases, SHFs often find it difficult to penetrate these formal marketing channels.

3.2.1 Market channels for smallholder farmers

Smallholder fruit and vegetable production is a very important activity in Zimbabwe, contributing significantly towards household food security, income and rural development. Farmers, particularly those who are near peri-urban areas, have a choice of accessing either formal or informal markets. According to a study conducted by Zivenge and Karavina, (2012) they found that informal markets were more accessible than formal markets amongst smallholder tomato farmers in Chinamora District. According to the study, price was the main determinant factor in selection of marketing channel. Farmers are likely to be guided by prices they receive from selling their horticultural produce, with channels offering higher price margins being logically preferred. However, price might not be the only determinant factor in the choice of marketing channel by smallholder farmers. There are also other factors and this also depends on the commodity being traded.

In Zimbabwe, the government, non-governmental organisations and the private sector have made support programmes available, geared towards addressing smallholder fruit and vegetable farmers' production constraints. Nonetheless, marketing of the SHFs' horticultural produce remains a major challenge, despite improved production (Zivenge & Karavina, 2012). Participation in markets by SHFs is still constrained by structural and technological factors. According to Dorward et al., (1998); Freeman and Silim, (2001); IFAD, (2003); Jayne et al., (2002); Kherallah and Kirsten, (2002) presence of middlemen, farmers' inability to meet market standards, low volumes of produce, wide dispersion of producers and perceived low prices in the formal market present challenges in smallholder farmers' access to markets.

Figure 3.1 illustrates the four different marketing channels that SHFs can explore. Smallholder farmers often tend to prefer to market at the farm gate. This is because this channel minimises transaction costs as usually the middlemen come to purchase at the farmgate with their own transport. In other instances, SHFs might sell their produce to hawkers who would then sell at the roadside markets. In the same way, SHFs can sell their produce to informal middlemen who would then transport it to open air markets such as Mbare Musika.

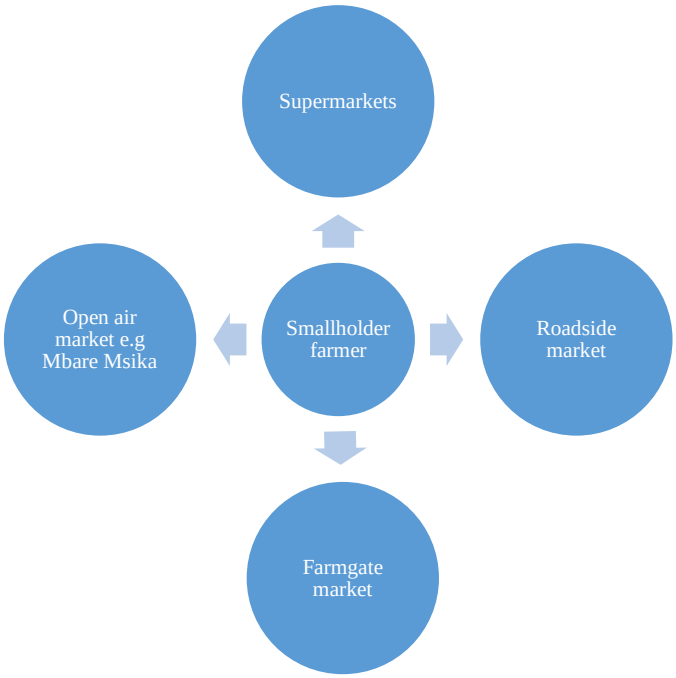

Figure 3.1: Marketing channels for smallholder farmers

Source Adapted from Louw et al., (2008)

Yet, if the farmer chooses to transport their own produce to Mbare Musika they would be responsible for finding their customers, transport as well as finding a fair price for the day. However, SHFs find it difficult to supply to supermarkets because of strict quality requirements, volumes as well as supply consistency.

Smallholder fruit and vegetable production is prevalent in districts such as Murehwa and Mutoko in the Mashonaland East Province in Zimbabwe which are in close proximity to urban centres like Harare. The major marketing channels that are used by smallholder fruit and vegetable farmers in these districts included spot markets as well as traditional wet markets such as Mbare and Machipisa Vegetable Markets in Harare (Njaya, 2014). However, it has been noted that smallholder fruit and vegetable farmers in the country generally tend to focus on production activities and pay little attention to post-harvest and marketing activities (Zivenge & Karavina, 2012; Njaya, 2014). This lack of value addition together with the presence of informal middlemen in the traditional wet markets that SHFs mainly use greatly reduce their profit margins. For instance, a study which was conducted by Musasa et al., (2015) in Rusitu Valley revealed that most SHFs market their oranges through informal middlemen. These middlemen then transport the produce to urban centres. This was caused by lack of market information as well as storage facilities to handle the seasonal glut of oranges. In the same way, SHFs are constrained to be able to use alternative market channels such as institutions (hospitals, tertiary colleges and boarding schools), food processors, supermarkets and fast food shops which are better organised and might offer better returns. Some of these challenges include poor quality produce, low volumes, inconsistency of supplies and lack of value addition which result in marketing inefficiency. Since produce is intended for the domestic market, it passes through a short and simple marketing chain up until it gets to the final consumer.

The marketing conditions set within each marketing channel in Zimbabwe heavily influence smallholder farmers' decisions. The formal market with its emphasis on supplying consistent volumes as well as quality generally excludes SHFs from using them. As a result, they resort to informal markets which have minimal emphasis on quality and they are also supply driven (Matondi & Chikulo, 2012).

According to Bindu and Chigusiwa, (2013) smallholder horticulture farmers in communal areas of Zimbabwe have a variety of possible channels to market their produce. These include

selling to restructured markets[4], urban horticultural market places e.g. Mbare Musika, selling at the farm gate, rural service centres and roadside marketing. However, the fact that supermarkets and other restructured markets require constant homogeneous quality and high volumes excludes SHFs. They therefore end up contracting large-scale farmers and avoid SHFs. The marketing channel of urban markets is envisaged to offer higher returns compared to communal markets. This is because in urban centres, there is high population where the majority of buyers are in non-farming activities and because of the growth of urban cities over the past decades. Hence, SHFs are guaranteed at least a reasonable demand level (Bindu & Chigusiwa, 2013). On the other hand, selling at the farm gate, rural service centres and roadside marketing offer low returns. Supply is very high in these markets and farmers also face low transaction costs.

3.3 Market transport

Most SHFs rely on public transport to ferry their horticulture produce to the market because the majority do not own private transport. However, public transport in rural areas tends to be sporadic and limited leading to spoilage and losses (Bachmann & Earles, 2000). Further, unavailability of reliable transport leads to high transaction costs which might restrict farmers to access distant markets. Makhura (2001) pointed out that those farmers who have their own private transport are able to move around in search of more rewarding markets. They also have a better chance of getting market information.

Again, the quantity of fruits and vegetables produced determines the marketing channel to be used as well as the mode of transport that might be employed to ferry produce to the market. In Zimbabwe, within districts such as Mutoko and Murehwa, if the quantity of produce is low and distance to the market is short, SHFs tend to resort to use of wheelbarrows, scotch carts, push carts and bicycles (Njaya, 2014). However, in cases where farmers want to transport produce to urban markets, they have to incur high transaction costs as a result of expensive transportation. They would have to use buses or other means of public transport such as lorries or trucks. Nonetheless, public transport presents challenges such as lack of control over route, efficient movement and timing, a situation that leads to rapid deterioration in the quality of the

[4] Restructured markets refer to selling to markets where produce price is determined beforehand. Such markets include food processors, canners and supermarkets.

produce. This challenge may be worsened during the rainy season when some areas become inaccessible. Inadequate transport channels present great difficulties for smallholders who lack their own means of transport. Furthermore, in other instances SHFs encounter long distances to connect to major highway roads.

Unreliable transport within Zimbabwe's smallholder farming sector results in high post-harvest losses mainly of horticultural produce. As a result, these farmers fail to reach their intended market. For example, smallholder banana farmers at times fail to access urban markets due to transport challenges (Mvumi et al., 2016). In other instances produce might deteriorate in gardens for lack of an efficient and speedy transport network (Jaure, 1997; Turner & Chivinge, 1999). An example is drawn from Rusitu Valley, where oranges end up rotting due to inaccessible roads particularly during the rainy season (Musasa et al., 2015).

In other instances, SHFs in Zimbabwe might hire unreliable transport in the form of open trucks to ferry fruit and vegetables to markets. Nonetheless, in most cases, these open trucks are not suitable to ferry delicate horticultural produce to the market. As a result, produce might fetch a lower price or fail to reach its intended market in good condition. Sometimes, hired transporters fail to deliver the fruits and vegetables to the market on time because of poor road infrastructure, technical faults or they may travel during the night to avoid traffic police since their trucks are usually not roadworthy (Mvumi et al., 2016). In other instances, the hired transport operator might fail to turn up resulting in huge losses of fruits and vegetables by SHFs. Therefore, they might be forced to find an alternative market greatly compromising price bargaining power. All these challenges constrain smallholder horticulture farmers from accessing formal markets or other more rewarding marketing channels. Consequently, farmers' ownership of own transport greatly increases their chances of accessing formal urban markets (Makhura, 2001; Bindu & Chigusiwa, 2013).

3.4 Market information

Market information particularly with regard to price which is being offered for a particular market is key in farmers' selection of market channel. Lack of market information makes it difficult for SHFs to know products that are needed at the market, when such products are needed, in what quantities and quality they are needed and at what price (Mangisoni, 2006). Despite the expansion of information and communications technologies (ICTs), smallholder

farmers in many developing countries continue to have limited or no access to market information (UNCTAD, 2015). As a result, they sell their produce at the farm gate or village markets where profits are low.

Mangisoni, (2006) argues that SHFs in Africa face serious challenges in acquiring marketing information. At times, farmers rely on middlemen, extension agents as well as their social networks for prices of horticultural produce. However, the opportunistic behaviour of middlemen greatly disadvantages farmers in accessing more rewarding markets. At times, the middlemen might not convey accurate information concerning product quality and price. Thus farmers end up accepting low prices because they are not adequately informed and they also lack bargaining skills.

According to Njaya (2014) smallholder fruit and vegetable farmers in districts such as Murehwa and Mutoko lack clear knowledge and understanding of markets. They are generally not aware of consumer demand, market facilities, marketing niches as well as there being an absence of market intelligence information. Lack of the vital market information on supply and demand leads to reduced margins to the farmers as a result of commodity gluts. Provision of marketing information to SHFs is pointed out as key in enabling them to access alternative and better-paying marketing channels, such as independent wholesalers in major urban centres (Poulton et al., 2000; Njaya, 2014). In addition, it would assist in minimising market glut through better planning of the cropping patterns by the farmers.

3.5 Farmer groups for improved market access

Evidence from literature and practice is increasingly showing that farmers' organisations[5] are a great platform for SHFs to participate in the market more effectively (Markelova et al., 2009). Stockbridge et al., (2003) earlier affirmed that "collective action"[6] enables SHFs to reduce transaction costs, secure access to new technologies, obtain the necessary market information and tap into high-value markets, allowing them to compete with larger farmers and agribusinesses. Also, collective action can help SHFs minimise barriers to entry into markets

[5] According to the International Federation of Agricultural Producers they define farmers' organisations to include any of the following: farmer groups and pre-cooperatives, farmers' associations, federations and unions, agricultural cooperatives owned and controlled by their members, and chambers of agriculture having a geared assembly elected by farmers.

[6] The term collective action is used in the sense of "voluntary action taken by a group to achieve shared objectives" (Meinzen-Dick et al., 2002).

by improving their bargaining power with buyers and intermediaries (Kherallah et al., 2002; Louw et al., 2008; Markelova et al., 2009; Fischer & Qaim, 2012). Collective action in the form of producer groups can help to compensate for other deficiencies that characterise rural markets such as poor infrastructure and market information. Smallholder farmers may be able to deal with transportation costs, overcome financial barriers and access high rewarding markets if they are acting collectively. For instance, they may be able to pool their resources together and add value to their horticulture products such as fruits and explore new market opportunities with high returns.

Previous studies have also shown that SHFs find it difficult to compete in high-value markets. Nonetheless, there are numerous examples where collective action and institutional support has helped SHFs to participate in high-value markets. For instance, a study in India by Roy and Thorat, (2008) revealed that marketing cooperatives for grapes reduced transaction costs and contributed to a better bargaining position of smallholders farmers vis-à-vis foreign traders. In Costa Rica coffee cooperatives enabled small-scale growers access to markets which offer higher prices (Wollni & Zeller, 2007).

Farmers' organisations may help SHFs to meet required quality standards and access formal markets. Thus farmer cooperation might enable SHFs to participate in markets with “long marketing channels” as they reduce coordination costs. In addition collective action is more beneficial for perishable commodities like vegetables because of high transaction costs (Fischer & Qaim, 2012; Hellin et al., 2009). Besides that, according to Stockbridge et al., (2003) farmers' organisations also offer a wide range of services to SHFs such as:

- Marketing services (input supply, output marketing and processing, market information).
- Facilitation of collective production activities.
- Financial services (savings, loans and other forms of credit).
- Technology services (education, extension, research).

The above-mentioned factors can enable SHFs to become better organised and ultimately access lucrative markets.

On the other hand, the process of establishing viable organisations is complex. Collective action and farmers' organisation may not be “panaceas” for smallholder farmers to access markets. According to Shiferaw et al., (2011) challenges may arise on establishing rules on which farmers' organisations are based as well as monitoring and enforcing compliance to those rules. To this end, the problem of free-riders who just benefit from the efforts of active members may arise. Furthermore, SHFs’ dynamics may influence functioning of farmers' organisations. Farmers are different in terms of their education level, resource endowments and social capital. In most cases, SHFs lack management and entrepreneurial skills, financial capacity and basic education which are essential assets for successful cooperation (Pingali et al., 2005). Finally, organisational and contextual challenges limit the scale, scope and spread of producer organisations, their activities, and hence, their development impact (Chirwa et al., 2008). Various attempts to foster farmers' organisations have failed. For instance, in Zimbabwe many local farming groups established to access inputs and/or output markets crumbled partly due to high level of mistrust between farmers (Masakure & Henson, 2005).

Consequently, the success of collective action in marketing hinges on factors such as group characteristics, institutional arrangements, the external environment, types of products and types of markets (Markelova et al., 2009). Smaller groups are generally thought to improve internal cohesion compared to large groups. This is because smaller groups are easier to know and monitor. Yet, larger groups can achieve economies of scale. Further, group characteristics such as shared norms and social capital, along with past successes working together, facilitate collective action areas (Agrawal, 2001). Most importantly, the type of leadership in a group is very crucial. Leaders should be able to motivate their group members, be trustworthy and also have the appropriate skills for collective enterprise. For this reason, enabling conditions need to be created for farmer groups so that collective marketing will be profitable and sustainable (Markelova et al., 2009). Provisions for monitoring and enforcement are especially important for ensuring transparency in marketing activities (Stockbridge et al., 2003). In that regard, it is vital that members of cooperatives come up with their own rules which they can easily understand rather than an external agent imposing on them. Nonetheless, for collective action and market development to be successful, it requires facilitation from public, private and civil society. Hence, if proper collective action is fostered amongst SHFs, they are able to improve quality and quantity standards, thus enhancing their access to formal markets.

In Zimbabwe a case in point of a failed farmer association is the one which was established by the European Union (EU) to assist smallholder horticulture farmers in Mashonaland East. The objective was to assist in the production and marketing of their produce. The members of the association were provided with a truck to transport their produce to the market. However, farmers simply perceived it as a way of receiving a free truck and the performance of the association was disappointing. Furthermore, because members had not invested their own money they just viewed it as donor responsibility. This issue was further compounded by poor leadership within the association's committee. The evaluation of the project in 1995 found that the association was neither sustainable nor profitable (Stringfellow et al., 1997).

3.6 Supermarkets and smallholder farmers

It has been noted that supermarkets are expanding rapidly in most developing countries (Rao et al., 2012; Andersson et al., 2015). This affects smallholder farmers' marketing channel options. Using supermarkets as a marketing channel is envisaged to give SHFs high income gains. Nonetheless, most smallholder fruit and vegetable farmers are not able to penetrate supermarkets due to a number of challenges. The majority of smallholder fruit and vegetable farmers are resource-constrained and they lack economies of scale as they usually operate individually. Further, smallholder fruit and vegetable farmers produce low volumes, poor quality products that do not meet the required safety threshold and they are characterised by inefficiencies in timely delivery. Therefore, in most cases, SHFs find it very difficult to penetrate supermarkets as an alternative marketing option (Dolan & Humphrey, 2000; Berdegué et al., 2005).

Figure 3.2 below outlines some problems which hinder SHFs from being incorporated into supermarkets, leading to low incomes. Generally, SHFs face a dilemma that they fail to meet the quality standards that are required by supermarkets, hence they get excluded from supplying them. The SHFs are omitted from supplying supermarkets because they fail to meet the volumes required and their coordination activities are also very weak. Further, the need for constant supply and high transaction costs discourage supermarkets from sourcing vegetables from SHFs.

Various studies concur that SHFs find it difficult to be competitive in supermarket chains (Dolan & Humphrey, 2000; Berdegué et al., 2005; Muchopa, 2013). Despite this, evidence

from a study which was undertaken by Emongor and Kirsten, (2009) in Zambia showed that SHFs supplying supermarkets had higher incomes compared to those relying solely on traditional markets. Similar findings were echoed by Rao and Qaim, (2011) where it was found that the income of vegetable farmers in Kenya increased by 48% due to higher prices and higher productivity from supplying supermarkets. Nevertheless, some scholars argue that there is limited knowledge in developing countries about how supermarkets impact on small farmers (van der Heijden & Vink, 2013).

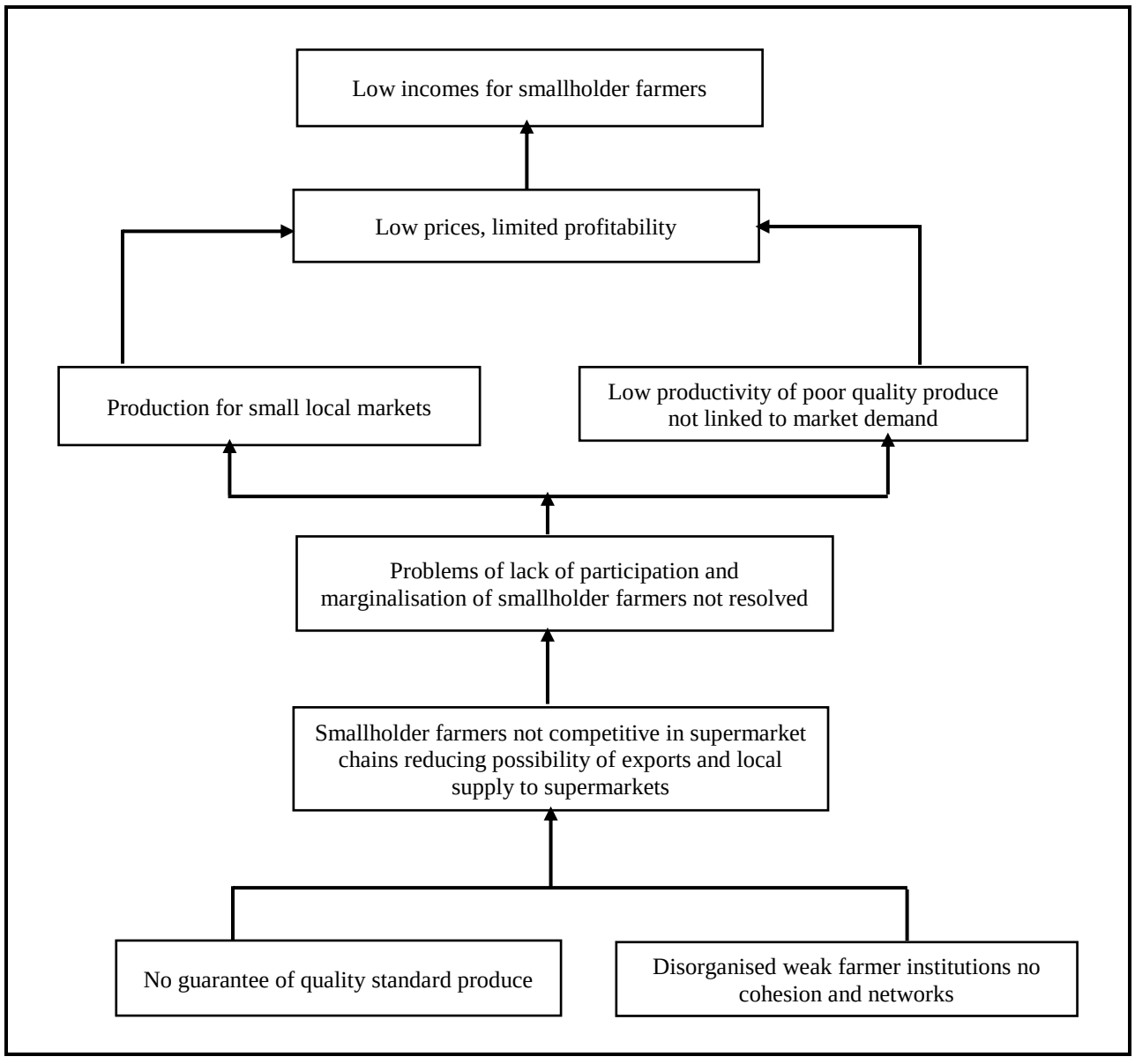

Figure 3.2: General competitiveness problem of smallholder farmers in supermarket chains

Source: Muchopa, (2013)

There has been a rapid rise in supermarkets in Southern Africa countries which include, in descending order, Zimbabwe, Zambia, Namibia, Botswana, Swaziland, and more recently Madagascar, Mauritius, Angola, and Mozambique due to Foreign Direct Investment from South Africa (Weatherspoon & Reardon, 2003). Given this scenario Weatherspoon and Reardon, (2003) acknowledge that SHFs need to be connected to supermarkets so as to improve their livelihoods in these countries. The authors further pointed out that SHFs risk being excluded from supplying supermarkets unless they improve the quality, standards and grades of their fruit and vegetables. One suggestion offered for them to adopt these high procurement demands of supermarkets is collective action. Weatherspoon and Reardon, (2003) subscribe to the wisdom of collective marketing as a means to help meet the required grades and standards as well as to access new retailers by reducing transaction costs associated with dealing with several small suppliers.

Access to output markets by smallholder horticulture farmers is vital for them to generate higher incomes. In addition, access to more remunerative markets is also often seen as an engine for increased production and the adoption of new technologies. The rise of modern markets specifically supermarkets in developing countries is generally viewed as a positive move for the rural poor (van der Heijden & Vink, 2013). Yet, scholars agree that there are many challenges SHFs have to overcome for them to obtain access to supermarkets. Some of these challenges include but are not limited to their location, business organisation and their production methods.

Furthermore, in countries such as South Africa the proliferation of supermarkets has been high so that it now resembles that of industrialised countries rather than developing countries. To this end, smallholder farmers in South Africa are increasingly being excluded from these value chains; a similar position to those in industrialised countries (van der Heijden & Vink, 2013).

On the contrary, other studies tend to suggest that integration of SHFs into supermarkets' supply chain is determined not by what small farmers do, but rather by the options that are available to supermarkets (van der Heijden & Vink, 2013). It has been noted that successful cases of SHFs being linked into supermarkets have occurred in countries which are dominated by smallholder farmers such as Kenya. Findings tend to suggest that supermarkets switch from SHFs if they have an alternative to source from large farmers (Reardon & Berdegué, 2006).

This is because supermarkets prefer suppliers who can guarantee sufficient volumes and consistent quality (Louw et al., 2006).

Expansion of supermarkets in developing countries has given SHFs marketing options. Marketing opportunities of SHFs producing fruit and vegetables has been increased by supermarkets. Through vertical coordination, supermarkets increase efficiency by sourcing from SHFs and food processors. Smallholder farmers have the option of supplying directly to the supermarkets or through other intermediaries such as food processors that supply to the supermarkets (Louw et al., 2008).

The strict requirements of supermarkets with regards to volumes, quality, consistency, food safety systems and year-round supply make it difficult for SHFs to supply them (Louw et al., 2008). The situation is even worse in countries such as South Africa where SHFs (especially emerging black farmers) are in danger of further exclusion and marginalisation by supermarkets after years of social, political and economic exclusion. According to Louw et al., (2008) SHFs are not as efficient in their production systems. Thus, they face high product rejections which *inter alia* act as barriers for them to enter competitively into formal markets.

There are several productivity and transactional barriers that SHFs in developing countries face in trying to access high value-adding food markets such as supermarkets. They include low productivity, poor market institutions, lack of credit and poor-quality produce. Despite these challenges, studies tend to suggest that SHFs may benefit from supplying supermarkets.

There has also been a rapid rise in supermarkets in Zimbabwe causing smallholder fruit and vegetable farmers in the country to face stiff competition from these supply chains. This is because of the high volumes that they require, quality standards, as well as consistency in supply which SHFs find difficult to meet. In turn, this has caused smallholder fruit and vegetable farmers to fail to supply supermarkets therefore they continue to revert to informal markets for selling their fresh produce. Smallholder fruit and vegetable farmers in the country also lack knowledge concerning production, post-harvest handling and establishment of market linkages. They are involved in “guesswork marketing” and ultimately they are left out from supplying supermarkets (Matondi & Chikulo, 2012). Hence, it is generally accepted that smallholder fruit and vegetable farmers in Zimbabwe have very weak links with supermarkets. However, farmers can take advantage of rapid urbanisation in the country where a large

proportion of city dwellers are using supermarkets rather than traditional markets. To this end, farmers can organise themselves into groups or cooperatives, to gain economies of scale and reduce transaction costs so that they can be able to supply supermarkets.

Conversely, it is worth noting that some studies suggest that exclusion of smallholder fruit and vegetable farmers from supermarkets is overestimated. This is because the traditional wet markets system still retains a greater percentage of fresh produce compared to supermarkets. Another reason for the slow uptake of market share volume by supermarkets is the selective adoption of supermarkets by consumers who may shop regularly in supermarkets but continue to purchase fresh food in traditional markets (Tschirley, 2011; Hichaambwa, Chamberlin & Sitko, 2015; Hichaambwa, Chamberlin & Kabwe, 2015).

3.7 Contract farming and smallholder farmers

There are divergent views concerning the impact of contract farming (CF) on smallholder farmers' access to domestic or export markets. Some scholars point out the positive impacts of contract farming that builds on the model and competences of large-scale agribusinesses (Williams & Karen, 1985; Barrett et al., 2012). Conversely, others highlight the potentially exploitative nature of contract farming on smallholder farmers (Watts, 1994). The argument is that contractors could set the terms of the contract to their advantage and exploit farmers because of the unequal balance of power. Further, critics of CF mention that there is increased risk of quality manipulation by the contracting firm which might leave SHFs at a disadvantage.

It has been highlighted that there is a paucity of studies that focus on motivations for small-scale producers to engage in contract farming (Masakure & Henson, 2005; Abebe et al., 2013). Masakure and Henson, (2005) argued that most studies have zoomed in on the direct impacts of contract farming on SHFs. To that end, they conducted a study in Zimbabwe to explore the motivations behind the decision of small-scale producers to grow non-traditional vegetables under contract for export. They identified four factors as motivating contracting for SHFs namely, market uncertainty, indirect benefits (e.g. knowledge acquisition), income benefits, and intangible benefits.

In addition, SHFs may be motivated to participate in contract farming as a response to missing markets. There are also several factors which can encourage farmers to participate in contract farming such as:

- information asymmetry,
- the need to access credit to overcome input supply problems,
- potential enhancements in access to extension advice, and
- increased market integration.

However, it has been noted that much of the literature takes it as given that SHFs mainly engage in contract farming to earn additional income, ignoring other reasons. Nonetheless, overall contract farming is important in creating an efficient market system for SHFs through both formal and informal institutions.

In Zimbabwe an out-grower scheme operated by Hortico Agrisystems, a subsidiary of Hortico, used to assist SHFs to produce high-value fresh vegetables for export mainly to UK supermarkets (Masakure & Henson, 2005). Hortico Agrisystems used to source from over 4 000 small-scale producers, who mainly farm on communal land. The SHFs were distributed across three districts in the Mashonaland East Province, namely, Murewa, Mutoko, and Mudzi. Hortico Agrisystems would engage in an informal contract with SHFs. Hortico Agrisystems would provide inputs in measured quantities for a particular crop on credit, the cost of which is subtracted from the value of the delivered produce. A minimum price would be stipulated for the crop prior to planting and a crop budget would be availed to the farmer. Consequently, Hortico Agrisystems assisted SHFs in the country to deal with the weak input and output market systems.

Contract farming (CF) can often be examined from different angles. It can be analysed from an institutional economics perspective, a political economy perspective, or a combination of both (Abebe et al., 2013). From a political economy direction CF is thought to cause unequal power relations (Little & Watts, 1994). There is great concern that CF increases production risk and indebtedness (Little & Watts, 1994; Singh, 2002). On the other hand, the institutional economics view emphasises the role of CF in addressing market failures (Barrett, 2008; Minten et al., 2009). Despite the divergent views including those who are critical of CF, there seems

to be a general agreement in literature that CF improves SHFs' income as well as market access. To that end, CF is regarded as one of the institutions that can link SHFs to markets.

Smallholder farmers may also tend to benefit from CF in developing countries. According to Barrett et al., (2012) because SHFs often lack efficient production and management technologies, underdeveloped information channels as well as poor infrastructure such as transportation and cold storage, contract farming may be an alternative for them to access lucrative markets and receive higher returns.

Minot, (2011) argues that contract farming is more suitable for horticultural produce destined for the export market because of the specific requirements in terms of quality, quantity, timing, or production methods which can only be met through a contractual agreement. Conversely, vegetables that are destined for local consumption in unprocessed form are generally sold through traditional market channels without contractual agreements.

The following section concludes the chapter by offering a review of analytical models which were used to come up with the empirical results of the study based on the research objectives.

3.8 Review of analytical models

This section offers a review of analytical models which were used in the study. The three objectives of the study in which models were adopted following previous similar empirical studies are explained below.

To identify factors influencing number of post-harvest practices adopted by smallholder vegetable farmers

There are various empirical methods that can be used for estimating effects of adopting agricultural technologies and innovation, which include binomial probit or logit models, multivariate ordinary least squares models, bivariate and data count models (Feder et al., 1985; Feder & Slade, 1984; Park & Lohr, 2005; Ramirez & Shultz, 2000; Wozniak, 1987). However, according to Ramirez and Shultz, (2000) the major limiting factors in probit and logit approaches are that dependent variables are rarely continuous and follow normal or binomial distribution. Nonetheless, if a variable is measured by counting, it is treated as a continuous variable, which reflects the dependent variable in a more appropriate manner. Under the count model, the adoption of different types of post-harvest practices for value addition (PPVA) as

dependent variable has been counted as adoption of events, which may be correlated and could be sequential and factors affecting adoption behaviour of smallholder fruit and vegetables farmers have been analysed accordingly. The count model is also advantageous in this study where SHFs have different options of post-harvest practices to choose from. Such kind of an analysis enables a comprehensive view of PPVA choices as well as adoption behaviour by smallholder farmers.

Conversely, the major problem with the Poisson distribution is that it assumes that the mean and variance of the dependent variable are equal. In other instances, because of over-dispersion, the conditional variance of the dependent variable(s) exceeds the conditional mean. For this reason, the negative binomial estimate is used as an alternative model in order to overcome this problem. Again, another major disadvantage of count data analyses is that they regard all PPVA as equally important to the farmer which usually is not the case as some PPVA are more important than others.

To analyse factors that influence smallholder vegetable farmers' decision to select post-harvest practice for value addition

For this objective the binary logistic model was used. The model has been widely used in related studies were farmers are faced with a binary choice (yes/no) in their decision-making process (see for example, Bime et al., 2015; Mariano et al., 2012). It has been noted that the binary logistic regression is advantageous in data analysis compared to traditional approaches such as multiple regression and t-test (Reed & Wu, 2013). Nonetheless, according to Reed and Wu, (2013) when using the binary logistic regression various vital considerations need to be accounted for which include:

- Need for a large sample size compared to the linear regression.
- Use of limited numbers.
- Categories must be mutual exclusive.
- It assumes that the independent variables and the dependent variables are not linearly related.

Hence, if some of these assumptions are violated, it limits the practical applicability of the model.

To investigate factors that influence market channel choice by smallholder vegetable farmers

The multinomial logit model (MNL) is the most-used econometric technique in the market channel choice literature (Jari & Fraser, 2009; Bardhan et al., 2012; Martey et al., 2012; Panda & Sreekumar, 2012; Ndoro et al., 2017). This study used the MNL logit model to investigate factors influencing farmers' market channel choice rather than the multinomial probit (MNP) because it is easier to compute than its alternative, the MNP. According to Hill et al., (2001) the MNL can be used to predict a dependent variable, on the basis of continuous and/or categorical independent variables, where the dependent variable takes more than two forms. Nonetheless, the main drawback of the MNL is the independence of irrelevant alternatives (IIA) property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set (Hausman & McFadden, 1984; Tse, 1987). The MNL model was also used by Xaba and Masuku, (2012) to investigate factors affecting vegetable farmers' choice of marketing channels in Swaziland.

3.9 Insights from literature review

In many developing countries SHFs who constitute a greater proportion of the poor find it difficult to access output markets. The situation is even worse for horticulture produce because of its highly perishable nature. In Zimbabwe, smallholder fruit and vegetable farmers find it difficult to penetrate formal marketing channels because of the need for clearly defined quality standards as well as consistent supply of large volumes. Hence, in most cases farmers end up sticking to informal markets. It has been noted that in Zimbabwe commendable strides have been made to improve production of smallholder fruit and vegetable farmers, however marketing of the produce still remains a major challenge. In addition, lack of value addition and presence of informal middlemen in the traditional wet markets that SHFs use greatly reduces their profit margins. Other factors that compound these challenges such as lack of market information and transport were discussed. Nonetheless, the reviewed literature tends to suggest that there is a paucity of empirical studies in Zimbabwe to ascertain how value addition can enable SHFs to access formal markets as well as improve their profits margins empirically. This study attempts to bridge that gap.

CHAPTER 4

DESCRIPTION OF STUDY AREAS

4.0 Introduction

Agriculture plays a pivotal role in the economic and social development of Mashonaland East Province. It is estimated that about 86% of the province's population resides in rural areas and a further 67% of the labour force is employed in agriculture in the province (Zimstat, 2012a; Zimstat, 2012b). Therefore, the contribution of agriculture directly or indirectly to the majority of the population within the province cannot be overemphasised. An overview of the Mashonaland East Province of Zimbabwe, the area where the study was conducted is provided in this chapter. The area's locations (including maps), topography, climate, agricultural potential and socio-economic factors are comprehensively explained.

4.1 Mashonaland East Province of Zimbabwe

Mashonaland East Province has a total population of 1 344 955 according to the national census report of 2012 (Zimstat, 2012a; Zimstat, 2012b). The total population of the province represents about 10% of the country's total population. Marondera is the provincial capital. Mashonaland East Province has an approximate total land area of 32 230 km². The province is divided into nine administrative districts namely Chikomba, Goromonzi, Marondera, Mudzi, Murewa, Mutoko, Uzumba-Maramba-Pfungwe (UMP), Seke and Wedza (Figure 4.1). Goromonzi District is the one with the largest population constituting about 17% of the provincial population whilst other districts contribute between 4% and 15% each (Zimstat, 2012a).

Mashonaland East Province has an estimated 326 825 households and an average household size of 4.1. It has a population density of 42 persons per square kilometre and 86% of the population is rural.

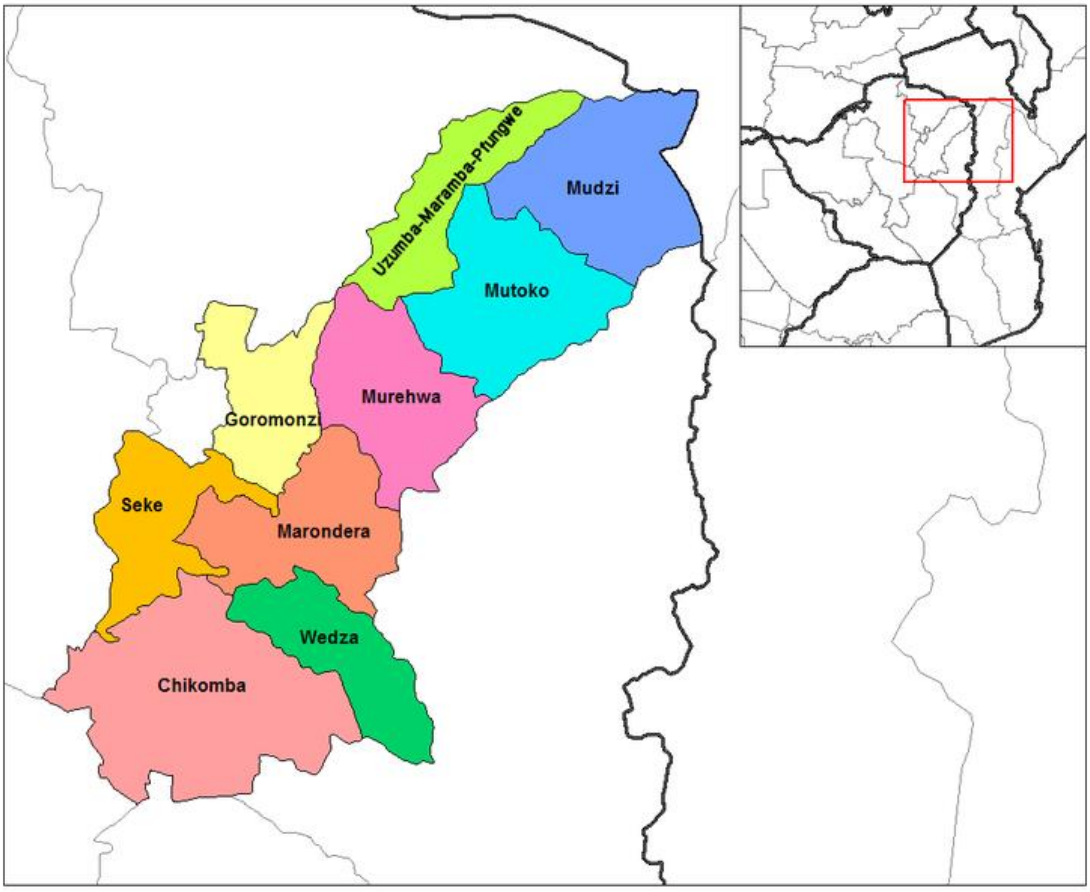

Figure 4.1: Mashonaland East[7] and its administrative districts

This province was chosen because the majority of SHFs are engaged in horticultural production as a main source of income (Heri, 2006; Bindu & Chigusiwa, 2013). This is true particularly for those districts that lie in the peri-urban spheres of the capital Harare such as Murehwa, Mutoko, Seke and Goromonzi. The proximity of these districts to the country's two largest cities of Harare and Chitugwiza guarantees them of adequate demand for their horticultural produce. This is because Harare and Chitwungwiza combined have a total non-farming population in excess of 2 million (Zimstat, 2012b). Additionally, SHFs located in these districts encounter low transportation costs when ferrying their horticultural produce to markets such as Mbare Musika and Lusaka in the capital Harare.

[7] Source: Available from: https://en.wikipedia.org/wiki/Mashonaland_East_Province Accessed 24 May 2016

4.1.1 Topography and soil characteristics

The area generally consists of a flat topography and soil types range from clays to sandy. There are just a few pockets which are mountainous. Soil fertility, in districts such as Mudzi are poor. Furthermore, part of the province with clay soils also suffer from heavy soil erosion, leaching and waterlogging. By and large soil fertility varies from place to place. In districts such as UMP which lie in agro-ecological region IV the soils are extremely shallow and found mostly on middle to upper slope positions. In areas that lie in natural regions IIb the soils are of high quality and SHFs have access to water sources (streams, *vlei*, small dams) which enable them to engage in horticulture production (Heri, 2006; Bindu & Chigusiwa, 2013). On the other hand, in terms of agricultural production smallholder farmers that are located in districts that fall in natural regions III to IV experience some limitations. Agricultural potential in communal areas such as Mutoko has been undermined by soil erosion (Muir-Leresche, 2006). Main factors that are contributing to land degradation in most parts of the province are gold panning, deforestation and overgrazing. In addition, according to Utete, (2003) following the Fast Track Land Reform Programme (FTLR) in the province, there have been great environmental concerns. This was as a result of indiscriminate cutting down of trees to open up new arable land. Despite these environmental challenges, generally most parts of the province support production of a wide variety of vegetables such as rape, covo, tomatoes, onions, cucumbers and carrots.

4.1.2 Climate

The province lies in agro-ecological regions IIa to IV and so there is a wide variety of farming activities that are practised in the province ranging from intensive crop farming, dairy, horticulture and the production of small grains (Utete, 2003). In natural region II rainfall is confined to summer and is moderately high (750–1 000 mm/annum) (Vincent & Thomas, 1960; Campbell, 2003). Districts in the province that fall within natural region III and IV practise semi-intensive farming and semi-extensive farming respectively (FAO, 2006; Muir-Leresche, 2006). In natural region III rainfall is moderate (500–750 mm/annum). It is characterised by mid-season droughts and relatively high temperatures therefore reducing its effectiveness for SHFs' dry land farming. Part of the province where Zimbabwe borders Mozambique lies in region IV. The region receives very low rainfall (450–650 mm/annum) and is subjected to severe dry spells and frequent seasonal droughts (FAO, 2006; Muir-Leresche, 2006). The

region is considered a semi-extensive farming region. The region is unsuitable for dry land cropping, however SHFs in certain localities grow drought tolerant crops such as sorghum, pearl millet, finger millet and certain varieties of maize.

Temperatures vary from place to place because the province is characterised by a wide range of different agro-ecological regions (FAO, 2006). Generally annual temperatures tend to rise with latitude and summer temperatures can rise to more than 37 degrees Celsius. Winters are generally cool to warm and dry. Dependence of SHFs in the province on rain-fed agriculture has caused them to be vulnerable to climate change leading to food insecurity. Climate change has also been reported to cause catastrophic weather phenomenon in the whole of sub-Saharan Africa. Droughts are prevalent nowadays in Mashonaland East. However, the natural regions in which most parts of the province lie support horticultural production under both rain-fed and irrigation facilities depending on the season.

4.1.3 Agricultural activities in Mashonaland East Province

Agricultural activities play a central role in the province with about 67% of the labour force in the province engaged in agriculture-related occupations (Zimstat, 2012a). Maize is the major crop grown by communal farmers in the province. This is because of its significance as a staple crop in food security and dietary needs. Other crops such as groundnuts, cotton, and small grains (sorghum, millet and rapoko) are produced by SHFs in the province. In addition, SHFs in Mashonaland East Province grow a wide range of vegetables for both formal and informal marketing. About 27 types of vegetables produced in Mashonaland East were identified by (Jackson, 1997). These include rape, tomatoes, cabbage, onions and potatoes *inter alia* (Table 3.1). Districts such as Wedza, Mudzi, Mutoko and UMP which are located in semi-arid parts of the province are prone to droughts and chronic food insecurity. For this reason, at times some households in these districts especially UMP and Mudzi turn to gold panning as an alternative livelihood option. Nonetheless, even those districts such as Goromonzi which lie in high-potential regions are also being rendered food insecure due to persistent droughts experienced in the country.

Table 4.1: Vegetables grown by smallholder farmers in Mashonaland East Province

Crop	**Total (hectares)**
Rape	861
Tomato	750
Cabbage	218
Green beans	330
Onions	233
Sweet potato	112
Kale	162
Pumpkins	36
Covo	97
Cucumber	75
Tsunga[8]	38
Okra	61
Carrots	38
Watermelon	34
Squash	27
Butternut	24
Potatoes	16
Shallots	20
Broccoli	21
Peas	4
Garlic	4
Eggplant	3
Total	**3 164**

Source: Heri, (2006)

Jackson (1997) noted that in Mashonaland East, rape is concentrated in natural regions IIa and IIb, cabbage in regions IIa, IIb and III while green beans are mainly produced in natural region IV. Tomatoes are mainly grown in natural region IIb but with substantial areas in natural regions IIa and IV and onions in natural region IIb. Horticulture production (vegetables, onions, tomatoes) is mainly dominant amongst smallholder farmers in districts such as Seke, Murehwa, Goromonzi and Mutoko.

Dairy farming is also practised in those districts that fall under agro-ecological region IIb mainly by commercial farmers because of the province's proximity to urban centres particularly Harare. Other livestock production farming activities which are practised by SHFs in Mashonaland East Province include cattle, poultry, piggery and goats. Communal farmers in the province keep cattle primarily for draught power, manure and as a store for wealth and not for beef production. This situation also resembles the state in most of Zimbabwe's rural areas amongst smallholder farmers.

[8] It's an indigenous vegetable grown by smallholder farmers.

4.2 District demographic and agro-ecological summaries

This section offers a detailed description of demographic and agro-ecological summaries of the four (4) districts in which the study was undertaken. The selection of these four districts (Mutoko, Goromonzi, Murehwa and Seke) was based on the intensity of horticultural production in the province as explained earlier in section 4.1.

4.2.1 Mutoko District

Mutoko District is situated 143 km north-east of Harare along the Harare-Nyamapanda highway. Zimstat, (2012a) estimated that the district has a total population of 146 127 and a sex ratio of 94 (males to 100 females). The population of Mutoko district constituted about 10% of Mashonaland East Province's total population. A small town called Mutoko is the capital of the district. The district is renowned for SHFs' fruit and vegetable production (e.g. tomatoes and mangoes) in the country. Certain parts of the district are very mountainous and are an important source of granite stone. The district lies in Natural Region III which is characterised by three marked seasons: a warm wet summer (November–April), a cool dry winter (May–August) and a short hot dry spring (September–October) (Matikiti, 2015). The vegetation type in the district is predominantly *miombo* woodland. Soils are mainly coarse-grained sands and sandy loams over sandy clay loams (Mariatou & Kwaramba, 1999). Average annual rainfall ranges from 450–650mm and is confined to summer. This means that rainfall is the main climatic constraint to SHFs' dryland crop production in Mutoko.

4.2.2 Goromonzi District

Goromonzi District is located about 32 km south-east of the country's capital Harare. It covers an approximate area of 9 100 km^2. According to Zimstat, (2012a) the district has a total population of 224 987. This is the district with the highest population in the province constituting about 17% of the total provincial population. Prior to the land reform, the district had viable commercial farms which used to grow horticulture produce such as flowers and gourmet vegetables for export. Subsistence farming is the mainstay of most SHFs in the district. They grow crops such as maize, groundnuts and horticultural crops (e.g. rape, pumpkin, tomatoes). The district lies in natural region IIa which is suitable for horticulture production such as tomatoes and leafy vegetables. The district is predominantly rural with less than 4% of the population living in urban areas (Zimstat, 2012a). It has some of the most fertile soils in

the country and receives an average annual rainfall of between 750–1 000 mm (FAO, 2013). The main livelihood of farmers in the district is cash crop production. Production of garden vegetables by farmers is also a major activity in the district (FAO, 2013).

4.2.3 Murehwa District

Murewa District is located 75 kilometres north-east of the capital Harare along the Harare-Nyamapanda highway. According to the Zimstat, (2012a) the total population of the district is estimated at 199 607. It has the second-highest population in the province constituting about 15% of the total provincial population. The district lies in natural agro-ecological region II, and receives average rainfall of 500–700 mm in a unimodal pattern between November and April (Vincent & Thomas, 1960; Rusinamhodzi, 2015). Extended mid-season dry spells are a common feature in the district. The soils in the area vary but they are predominantly granitic sandy soils of low fertility with small portions of dolerite-derived clay soils that are relatively more fertile (Nyamapfene, 1991; FAO, 1998). Vegetation in the area is characterised by the Miombo woodland dominated by *Julbernardia globiflora* (Rusinamhodzi, 2015). The natural farming region in which the district is located is suitable for production of a variety of vegetables as explained earlier in section 4.1.1. Moreover, its close proximity to Harare and Chitugwiza guarantees farmers adequate demand for their horticultural produce.

4.2.4 Seke District

Seke District is located in natural agro-ecological region II, with an average rainfall of 500–700 mm. However, the amount of rainfall received varies within the district. It is located approximately 25 km from the capital Harare. The district has a total population of 100 756 (Zimstat, 2012a). Horticulture production (rape, covo, and tomatoes), field crop production and livestock rearing are the main agricultural activities practised by SHFs in the district (ZimTrade, 2012).

4.3 Justification of study areas

Mashonaland East Province was selected for this study to assess post-harvest value-adding initiatives that smallholder fruit and vegetable farmers are engaged in. This is because agro-ecological conditions in other districts of the province enable SHFs to engage in horticultural production (Jackson, 1997; Heri, 2006). In that view, some specific districts within the province

are renowned for SHFs' production of vegetables in the country. The province was also deemed to be most appropriate because it has a peri-urban setting which is characterised by communal rural areas. While other provinces exhibit similar settings their peri-urban areas are mainly characterised by large-scale commercial farming.

The specific districts which were selected for the study also have suitable agro-ecological conditions for SHFs to practise horticulture production as explained in the above section. Moreover, the proximity of these districts to urban centres particularly the capital Harare offer an opportunity for smallholder horticulture farmers to produce for urban markets. The combined total non-farming population of Harare and Chitwungwiza which is over 2 million (Zimstat, 2012b) guarantees farmers adequate demand for their horticultural produce. The farmers mainly target Mbare Musika and Lusaka in Harare as well as Jambanja and Chikwanha in Chitugwiza (Njaya, 2014; Bindu & Chigusiwa, 2013). These are some of the largest municipal wet markets in the country. Nonetheless, it is noteworthy that the poor infrastructure for irrigation, processing and storage constrain proper production and marketing of vegetables leading to huge losses in these districts (Njaya, 2014; Matondi & Chikulo, 2012). With this background, the study therefore assumes that a fair representation on assessment of smallholder horticulture farmers' post-harvest value-adding initiatives will be reached using a cross-sectional survey.

4.4 Chapter summary

The majority of the population in Mashonaland East Province is rural. The province is divided into nine administrative districts namely Chikomba, Goromonzi, Marondera, Mudzi, Murewa, Mutoko, Uzumba-Maramba-Pfungwe (UMP), Seke and Wedza. The area generally consists of a flat topography and soil types range from clays to sandy. The province lies in agro-ecological regions IIa to IV which are suitable for intensive crop farming, dairy, horticulture and the production of small grains. Rainfall pattern in the province is varied depending with the agro-ecological region in which the district falls. In the same way, temperatures vary from place to place within the province. Generally, natural regions in which most parts of the province lie support horticultural production under both rain-fed and irrigation facilities depending on the season.

Farming is the main economic activity in Mashonaland East Province and maize is the main crop grown because it is the staple food. The province is also renowned for smallholder fruit and vegetable production for both formal and informal markets particularly in the selected study districts. Other livelihood options such as gold panning are also practised in certain parts of the province. Farmers in the province also keep livestock such as goats, cattle and pigs. Recurring droughts coupled with overdependence of SHFs on rain-fed agriculture has exposed them to climate change vulnerability in the province.

However, the four specific districts (Murehwa, Mutoko, Seke and Goromonzi) which were selected for the study have suitable agro-ecological conditions for SHFs to practice horticulture production. This is because these districts lie in the peri-urban spheres of Harare and Chitugwiza. The huge non-farming population found in these cities guarantees farmers of adequate demand for their horticultural produce. Additionally, SHFs located in these districts encounter low transportation costs when ferrying their horticultural produce to markets such as Mbare Musika and Lusaka in the capital Harare. These are some of the biggest municipal wet markets in the country. Nevertheless, poor infrastructure for irrigation, processing and storage constrain proper production and marketing of vegetables leading to huge losses in these four districts.

CHAPTER 5

RESEARCH METHODOLOGY

5.0 Introduction

This chapter gives a detailed explanation of the data collection and research methods used for the study. The tools that were designed and used for data collection to assess smallholder vegetable farmers' post-harvest practices for value-adding initiatives in the Mashonaland East Province of Zimbabwe are described. The chapter goes on to discuss the sampling procedure that was used in the study. Determination of sample size and sampling techniques that were employed are explained. The analytical models that were used and the data variables that were considered for each research objective are addressed.

5.1 Research design

The study employed the survey research approach as the main research design. Specifically, the cross-sectional study was used. The survey design allows a researcher to study a sample of the population and make generalisations about the population (Creswell, 2014; Leady & Ormrod, 2013). According to Leady and Ormrod (2013) the cross sectional study takes a "snapshot" of the population at a single time allowing conclusions to be drawn about the wide population. It is economical and fast, however Picardi and Masick (2014) cautions that accuracy of data in survey research design entirely lies with the willingness of respondents to provide accurate and honest information. For this study the cross-sectional survey approach was employed to obtain detailed knowledge about participation of smallholder vegetable farmers in post-harvest practices for value addition. Furthermore, it was used to analyse factors that influence market channel choice of smallholder vegetable farmers in four districts of Mashonaland East Province. The selection of these four districts was based on the explanation that was offered earlier in section 4.3.

5.2 Conceptual framework

This study assumes that farmers' selection choices and adoption of post-harvest practices for value addition are inspired by profit and utility maximisation motives subject to socio-economic, institutional and market characteristics of the farmer (Figure 5.1).

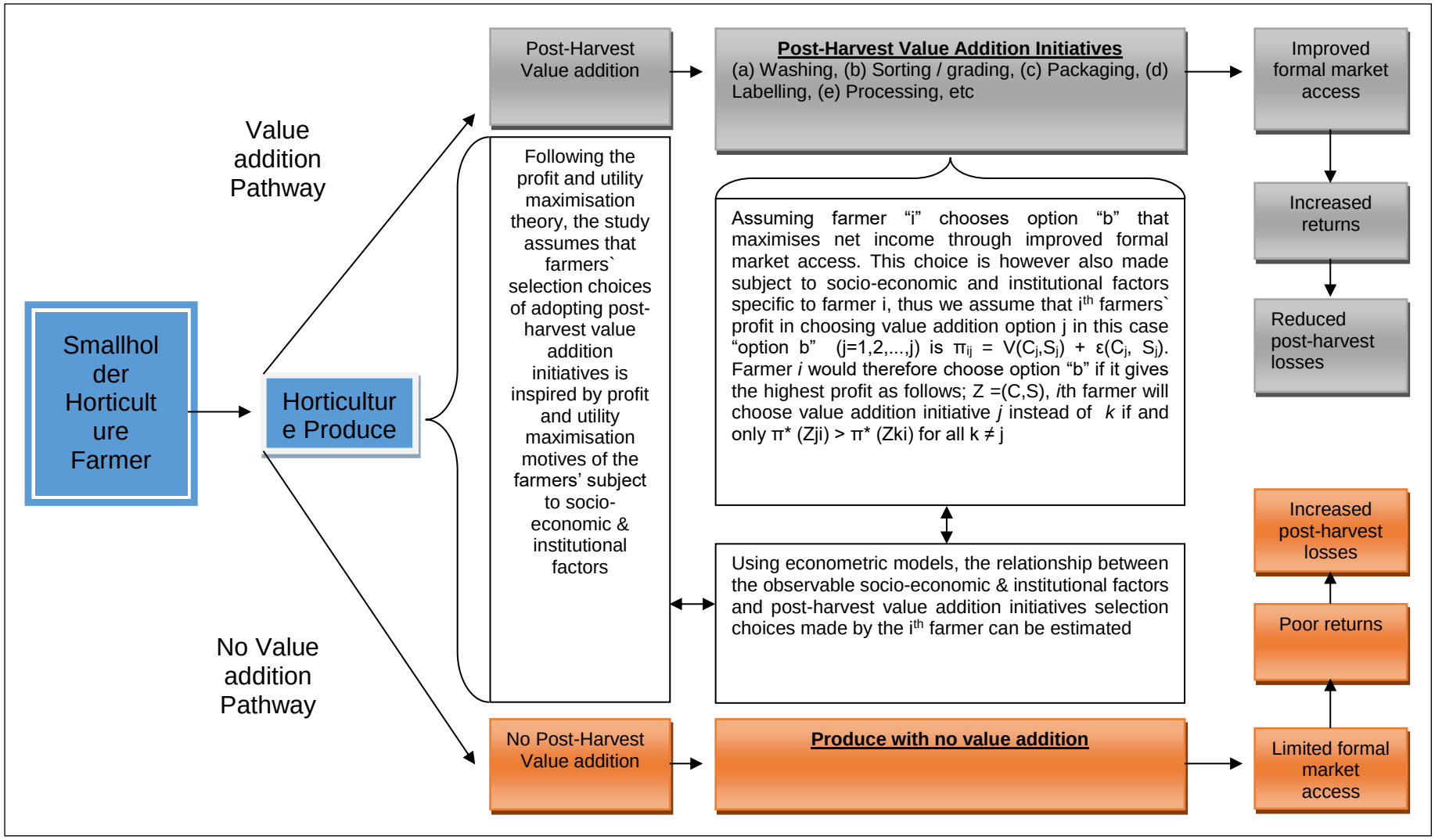

Figure 5.1: Conceptual framework

Source: Author's own computation from various sources

Post-harvest losses may affect quality and quantity of fruit and vegetables produced by SHFs. For the majority of households post-harvest losses have a ripple effect as they not only threaten income but also food and nutrition security (World Bank, 2011).

In this case smallholder vegetable farmers incur economic losses when their produce misses market opportunity due to poor quality or development of attributes that cause it to be less appealing to consumers (Hodges et al., 2011; Kader, 2005). Adoption of PPVA is envisaged to reduce quantity and quality losses of farmers' vegetables.

Those SHFs that are engaged in post-harvest practices such as packaging, dehydration and drying, sorting and grading, preserving and cooling, washing and cleaning, storage and labelling are assumed to have better access to markets (e.g. formal markets), increased returns as well as reduced post-harvest losses. On the other hand, those smallholder horticulture farmers who are not engaged in value addition are assumed to have limited market access, experience poor returns due to high post-harvest losses as well as poor product quality. Farmers engage in value addition if the perceived utility is expected to be higher. The utility maximisation hypothesis as outlined by Pryanishnikov and Zigova, (2003) is used to examine the decision to add value or not by smallholder vegetable farmers. It is expected that smallholder vegetable farmers will engage in value addition if the net benefit from doing so is greater than the case without it. Assuming that a household's utility is represented by two choices of U_i and U_j then the model is specified as:

$$\boldsymbol{U_i = \beta_n X_n + \varepsilon_i \; and \; U_j = \beta_n X_n + \varepsilon_j} \ldots\ldots \mathbf{1}$$

Where, $U_i$and U_j are perceived utilities of value addition and non-value-adding choices *i* and *j*, respectively, $\boldsymbol{X_n}$ is the vector of explanatory variables that influence the perceived attractiveness of each choice β_i and β_j are parameters to be estimated, ε_i and ε_j are error terms assumed to be independently and identically distributed (Greene, 2003). For fruit and vegetable value addition, if a farmer decides to use option *i*, then the expected utility from option *i* is greater than the utility from option *j*, which is defined as;

$$\boldsymbol{U_{ni}(\beta_i X_n > \varepsilon_i) > (U_{nj}(\beta_j X_n + \varepsilon_j) \; i \neq j} \ldots\ldots \mathbf{2}$$

The decision of the farmer to add value and choose option *i* instead of *j* is influenced by farmer and farm circumstances as well as market and institutional arrangements.

5.3 Sampling procedure

The study was conducted in the Mashonaland East Province of Zimbabwe. This province was purposively selected because the majority of SHFs produce a wide range of horticultural crops for wholesale markets in towns (Jackson, 1997; Heri, 2006). Smallholder farmers are able to produce different kinds of fruits and vegetables in this province because of enabling agro-ecological conditions (Heri, 2006). This gives them access to suitable quality soils and proximity to water sources that are appropriate for fruit and vegetable production (Heri, 2006).

A multistage sampling procedure was used to select specific locations for the study, moving from the district level to specific wards and later to specific villages and households. This technique was considered the most appropriate for this study because sampling frames were not available at district level. The first stage used purposive selection of four districts (Murehwa, Mutoko, Goromonzi and Seke) out of the nine districts in the study area. The selection of these districts was based on the intensity of SHFs' vegetable production. These districts are where there is intensive production of vegetables by SHFs for wholesale marketing. The second stage was the random selection of three wards in each district where communities are engaged in vegetable production to give a total of 12 wards. The selection of these wards was guided by information obtained from agricultural extension workers and Non-Governmental Organizations (NGOs) that were operating in the districts. Furthermore, accessibility of the area was another criteria which was considered in identifying these wards. The third stage involved use of cluster sampling to select three villages (clusters) in each of the three wards. Finally, at the village level simple random sampling was applied to select households based on the sampling frame provided by the local village extension officer. A total sample of 385 smallholder vegetable farmers was ultimately interviewed in all four districts.

5.4 Questionnaire design

A structured questionnaire was designed and used as a key instrument for data collection. Both qualitative and quantitative data were captured by the questionnaire. The questionnaire was pre-tested and it collected primary data that included demographic characteristics (such as farmer's age, sex, marital status, education), farm assets, institutional factors that include (extension, farm size and distance to the market), type of vegetables grown and the different post-harvest practices for value-adding initiatives farmers carry out (see Appendix 1 for full questionnaire). A pre-test of the questionnaire was done to check if the information which was

being gathered was addressing the study objectives adequately. Furthermore, it ensured that repetitive questions as well as some unnecessary questions were removed from the questionnaire. Questions were designed in such a way that they were easy to understand and ambiguity was avoided. The questions were grouped into categories to make it easy for the respondents as well as for data analysis.

Moreover, both closed- and open-ended questions were included in the questionnaire so as to improve the quality of data collected. The advantage that open-ended questions had was that they enabled respondents to elaborate more on their answers and they revealed more information. However, due to time constraints and the difficulty that can be imposed by answering too many open-ended questions, closed-ended questions which were easy and quick to answer were also included. The questionnaire was designed in English, and translated into Shona, the local language used in the study area during its administration.

5.5 Data collection

The questionnaire was used as the primary data collection tool in the study. Several questions were contained in the questionnaire regarding post-harvest value-adding initiatives, and their marketing channels for vegetables. Farmers were also asked questions on the challenges they faced when marketing their vegetables and how they affect their profitability (Appendix 1).

Face-to-face interviews were conducted with farmers in the study areas with the assistance of trained enumerators. In-person interviews were considered because of the advantages they offer of high "response rate" because the interviewer can ensure that all questions are answered (Hofstee, 2015; Leedy & Ormrod, 2013). Moreover, they enable the interviewer to probe with further questions in case the respondent misunderstood the question hence they can offer data which is highly reliable. Thus, household heads were the targeted respondents. However, in case the household head was absent, any adult member of the household was interviewed.

A team of enumerators was selected and trained on questionnaire administration. The enumerators were drawn from Agricultural, Technical and Extension Services (AGRITEX) workers who were operating in the districts from which the study was conducted. This gave an added advantage that the extension workers were very familiar with local norms and values. Training sessions were conducted with extension officers in each district before commencing with the administration of the questionnaires. This enabled the enumerators to understand the

objectives of the research as well as to interpret the questionnaire correctly. A pre-testing exercise was conducted to ensure a common departure point. Necessary adjustments were made to the questionnaire after the pre-test exercise. For instance, some questions which were repetitive were removed and others were paraphrased.

The scheduling of data collection between August–October 2016 was done so as not to coincide with the households' peak farming season of field crops. The time was convenient for most farmers (*chirimo*[9]), hence the high response rate.

5.6 Data analysis

Collected data was coded and entered into Statistical Package for Social Scientists (SPSS) version 23, STATA version 13 and Microsoft Excel program for analysis. Descriptive statistics such as mean, standard deviations and frequencies were used to analyse objective 1 and objective 2 on awareness, perceptions and preferred post-harvest value-adding initiatives of SHFs. The models that were employed to analyse objective 3 up to objective 5 are explained in detail in the next section below. The explanation is based on the study objectives which were offered in the introductory chapter as well as review of analytical models which was presented in section 3.8.

5.7 Analytical models

This section discusses research objectives that were stated in the introductory chapter which require analytical models together with their response variables. Their expected outcomes are also explained based on findings from literature as previously discussed in Chapters 2 and 3.

To identify factors influencing number of post-harvest practices adopted by smallholder vegetable farmers

This objective was analysed using the Poisson count regression model. The model was used following the work of Ali (2012) who identified the most likely factors affecting adoption of post-harvest practices[10] in the vegetable value chain in India using the Poisson count model. The empirical model was used to identify factors affecting adoption of post-harvest practices

[9] Time when farmers are not busy with their field crops. Usually they will be tending their vegetable gardens particularly women.

[10] Post-harvest practices of washing, sorting and grading, preserving and cooling, dehydrating/drying, packaging, and labelling and storage for value addition.

for value addition in the SHFs' vegetable value chain. Frequency of use of various post-harvest practices—that is, count of post-harvest practices adopted by smallholder vegetable farmers was the dependent variable. Socio-economic factors (that include age, education), institutional arrangements and technical factors were independent variables.

The dependent variable of the model (y) is the count number of post-harvest practices adopted by farmers that is, y = 0, 1, 2, 3, . . . , N. Since we are interested in explaining the likelihood that the farmer will adopt more post-harvest practices, the Poisson model was used. The Poisson probability density function is represented in equation 1:

$$f(Y_i|X_i) = P(Y_i = y_i) = \frac{e^{\lambda}\lambda^{y}}{Y!} y = 0,1,2,3 \ldots \ldots \quad 1$$

Where;

y_i is the number of post-harvest practices adopted by a farmer

X_i are determinants of post-harvest practices adoption

The expected mean parameter λ of this probability function is defined as illustrated in equation 2:

$$E[Y_i|X_i] = \lambda_i = \exp(x_i'\beta) \ldots \ldots \quad 2$$

Where;

$\exp(x_i'\beta)$ is the incidence rate ratio (IRR) for a one-unit change in X_i with all other variables held constant.

Equation (2) represents the Poisson regression model for count data wherein the β parameters can be estimated using the maximum likelihood procedure. This procedure is carried out by maximizing the log-likelihood function (Equation 3):

$$\ln(\beta) = ln\left[\frac{e^{\lambda}\lambda^{y}}{Y!}\right] = -\lambda + Y_i \ln(\lambda) - \ln(Y_i!) = -\exp(x_i'\beta) + Y_i(x_i'\beta) - \ln(Y_i!) \ldots \ldots \quad 3$$

The Poisson model assumes the mean and variance of the dependent variable to be equal; that is, $E(Y_i) = var(Y_i) = \lambda$. However, this assumption may not be realistic. The variance of y_i can be smaller (larger) than its expected mean which indicates under-dispersion (over-dispersion) in the count data. This will result in the over-estimation (underestimation) of

standard errors, thereby giving biased and inconsistent estimates of the Poisson regression parameters. In most cases, the count data have greater variance than their mean. The negative binomial can accommodate the over-dispersion problem by modelling the variance as a function of the mean. The variance function for the negative binomial model (NBM) is specified as (Equation 4):

$$var(y_i) = \lambda_i + \alpha\lambda_i^2 \quad \text{.....} \quad 4$$

Where;

α is the dispersion parameter to be estimated.

The NBM will be the same as the Poisson regression if α equals zero. The estimation of the NBM involves the maximisation of the following log-likelihood function expressed as (Equation 5):

$$\ln L(\alpha,\beta) = \sum_{i=0}^{n}\left\{\sum_{j=0}^{y_i=1}\ln(j+\alpha^{-1}) - \ln(Y_i!) - (Y_i+\alpha^{-1})\ln\left[1+\alpha\exp\left(x_i'\beta\right)\right] + Y_i ln\alpha + Y_i(x_i'\beta)\right\} \text{.....} 5$$

If the dispersion parameter α is known and the variance function is correctly specified, then the maximum-likelihood estimator for the NBM is robust to distributional misspecification (Cameron et al., 1988). On the other hand, if ά is unknown, the quasi-generalised pseudo maximum likelihood estimation can be made using a consistent estimator (Greene, 2005).

5.7.1 Definition of variables used in the Poisson model

Definition of variables included in the count data models together with expected signs on their coefficients are explained in Table 5.1 below. Prior expectations about the relationship of the explanatory variables to post-harvest practices adoption are deduced from previous empirical studies as well as theoretical underpinnings.

Household demographic characteristics such as gender, educational level, household size and age *inter alia*, were assessed to determine if they had a positive or negative impact on number of post-harvest practices adopted by the farmer. Gender of household head affects adoption of techniques. According to Abdul-hanan et al., (2014) males tend to prefer adoption of complicated techniques while their female counterparts tend to embrace adoption of uncomplicated techniques. Thus, a positive sign is expected, meaning female-headed

households are more likely to adopt numerous post-harvest practices compared with their male counterparts.

Smallholder vegetable farmers with high education levels have better post-harvest management strategies and interpret market information better (Ali, 2012; Musasa et al., 2015). It is therefore argued that smallholder vegetable farmers with a higher educational level are more likely to adopt a number of post-harvest practices. On the other hand, smallholder farmers with low education are less likely to adopt post-harvest practice. Thus, education is expected to have an ambiguous effect.

Table 5.1: Definition of variables used in the Poisson model

Variable	Definition	Expected Sign
Gender	1 if female; 0 if male	+
Education level	Number of years of formal education by the farmer	+/-
Household size	Number of household members	+
Age	Number of years	+/-
Farming experience	Number of years	+/-
Land size	Total area planted for vegetables	+
Distance to nearest market	Distance of the farm to the nearest market in kilometres	-
Access to market information	1 if yes, otherwise 0	+
Group membership	1 if yes, otherwise 0	+
Credit access	1 if the farmer has access to credit; otherwise 0	+
Hired labour	1 if yes, otherwise 0	+/-
Training	1 if attended training, otherwise 0	+

Additionally, bigger household size could imply a more abundant labour source for adoption of more post-harvest practices for value addition (Abdulai et al., 2008; Mariano et al., 2012). This implies a positive relationship between bigger households and adoption of post-harvest techniques. Conversely, smaller households may be constrained in adopting post-harvest practices because of labour shortage.

Age is also another variable which was assessed. It was hypothesised that with increasing age, a farmer's ability to adopt certain post-harvest practices may become negatively affected. The rationale is that as the farmer gains more experience with increasing age they may become conservative and less flexible to change to adopt new practices. On the other hand, young farmers are expected to adopt new techniques because they are deemed more entrepreneurial (Lapar & Pandey, 1999; Núñez & McCann, 2008). However, it could also be the other way around such that as farmers increase in age and gain more experience, they may be more willing to adopt post-harvest practices. Thus, the effect of age on adoption can be ambiguous.

In addition, other farmer-specific characteristics such as farming experience were investigated. Experienced farmers are thought to be in a better position to assess the importance of post-harvest practices and adopt them. Conversely, since farming experience is correlated with aging, it could be that as farmers gain more experience and with age they may become conservative and less flexible to adopt post-harvest techniques. Hence, the effect of farming experience on adoption of post-harvest techniques can be ambiguous.

Farmers who cultivated bigger land areas for vegetables are more likely to adopt numerous post-harvest practices because they are expected to produce large quantities. Hence, a positive relationship is expected between land size devoted to vegetable production and adoption of post-harvest practices.

Another important factor in the adoption of post-harvest practices is market accessibility by the farmer. The greater the distance of the farm from the market indicates poor access, hence this might hinder adoption of post-harvest practices (Mariano et al., 2012; Jari & Fraser, 2009). Therefore, a negative sign is expected for this variable.

Access to market information was measured by the farmer's ability to access market information and the aptitude to interpret it correctly. The importance of access to market information in influencing SHFs' decision-making was explained in detail in section 2.2.5. Farmers were interviewed with regards to communication channels available to them. Access to market information had been set as a dummy variable, where a farmer with access to market information[11] took the value one, or zero otherwise. According to Ali (2012) availability of market information plays a significant role in influencing smallholder vegetable farmers' adoption of post-harvest techniques such as grading, washing and drying. The sign is expected to be positive if farmers have access to market information.

The importance of farmer groups in assisting smallholder vegetable farmers to improve post-harvest management techniques and ultimately enhancing access to markets was explained in detail in section 2.2.10. Farmer groups are expected to assist in adoption of post-harvest techniques. Thus, farmers who are members of a group are likely to adopt more post-harvest practices for value addition compared to their individual counterparts (Berem et al., 2010;

[11] Smallholder farmers in Zimbabwe get access to market information through various channels such as extension agents, radios and cellphones etc. (Zamasiya *et al.*, 2014).

Orinda, 2013). Farmers were asked whether they belonged to a farmer group or not and responses were assigned dummy values. Therefore, a positive relationship is expected when a farmer is a member of a group.

Smallholder farmers often operate with insufficient savings (Mariano et al., 2012). Therefore, access to credit encourages adoption of post-harvest practices. Farmers were asked if they had access to any credit facilities in order to assess this effect. Hence, a positive sign is expected when farmers have access to credit and negative otherwise. Detailed explanation on how access to credit affects SHFs' engagement in post-harvest practices was offered in section 2.2.2.

Availability of adequate labour can influence adoption of postharvest practices. In instances where farmers find adoption of postharvest practices profitable but lack adequate labour they can resort to hiring of labour. Nonetheless, other scholars such as Sebatta et al., (2015) states that bigger household sizes supply the required labour for value addition activities, thus reducing the need for hired labour to undertake postharvest practices. Therefore, hired labour is expected to have an ambiguous effect.

Finally, trainings made available to farmers through various extension services are very vital in educating farmers about techniques they can employ to minimise post-harvest losses of their vegetable produce (Amentae et al., 2016; Bindu & Chigusiwa, 2013). Thus access to training services is expected to positively influence adoption of post-harvest practices.

To analyse factors that influence smallholder vegetable farmers' decision to select post-harvest practice for value addition

In this study farmer respondents were asked if they had selected a specific post-harvest practice for value addition or not. The aim was to analyse factors that influence smallholder vegetable farmers' decisions to select a specific post-harvest practice for value addition. The observed yes/no decision in selecting a post-harvest practice for value addition is regarded as a binary choice model outcome. The binary logistic model used for this objective was adopted from Bogale and Shimelis, (2009) and is specified as follows:

$$\boldsymbol{P_i = F(Z_i) = \frac{1}{1 + e^{-(\alpha + \sum \beta_i X_i)}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{6}$$

Where P_i is the probability that a farmer selects a particular post-harvest practice given X_i

X_i represents the i^{th} explanatory variables

$\alpha\ and\ \beta$ are regression parameters to be estimated.

$\boldsymbol{e}$ is the base of the natural logarithm

For ease of interpretation of the coefficients, a logistic model could be written in terms of the odds and log of odd. The odds ratio is the ratio of the probability that a farmer does not choose a specific post-harvest practice (P_i) to the probability of a farmer choosing a specific post-harvest practice $(1 - P_i)$. That is,

$$\left[\frac{P_i}{1 - P_i}\right] = e^{Z_i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

and taking the natural logarithm of equation (7) yields:

$$ln\left[\frac{P_i}{1 - P_i}\right] = Z_i = \alpha\beta_i X_i + \beta_2 X_2 \ldots\ldots\ldots\ldots\ldots \beta_m X_m \ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

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

$$Z_i = \alpha + \sum_{i=1}^{m} \beta_i X_i + U_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

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

Z_i = selection choice (1, if farmer selected a post-harvest practice, 0, if not)

β_i is the slope of the equation in the model

5.7.2 Definition of variables used in the binary model

The independent variables influencing smallholder vegetable farmers' decision to select post-harvest practice for value addition were derived from literature and the study area. The variables used in the model and their definitions are shown in Table 5.2 below.

Table 5.2: Definition of variables used in the binary model

Variable	Definition	Expected Sign
Gender	1 if the farmer is female, otherwise 0	+
Education level	Number of years of formal education by the farmer	+
Household size	Number of family members	+/-
Age	Number of years	+/-
Farming experience	Number of years	+
Land size	Total area planted for vegetables	+
Distance to nearest market	Distance of the farm to the nearest market in kilometres	-
Access to market information	1 if yes, otherwise 0	+
Credit access	1 if the farmer has access to credit, otherwise 0	+
Group membership	1 if yes, otherwise 0	+
Family labour	1 if yes, otherwise 0	+
Training	1 if farmer received training, otherwise 0	+
Target market	1 if farmer producing for formal markets, otherwise 0	+/-
Quantity of vegetable produced	Number of kilograms	+
Storage facilities	1 if farmer has storage facilities, otherwise 0	+

With reference to gender, production of vegetables in Zimbabwe is regarded as a "women crop", while men engage in cash crop production (Zamasiya et al., 2014). Generally women are known to be more actively involved in supplying labour for activities such as cleaning and value addition of farm products than men (Mamo et al., 2014). Hence, women are more likely to participate in basic post-harvest activities such as drying, washing and grading in comparison with their male counterparts. Therefore, a positive association is expected between female-headed households and selection of basic post-harvest practices.

Farmers with a high level of education are expected to have better information and understanding about post-harvest practices for value addition as well as markets (Kuma & Getnet, 2011; Ali, 2012; Roy et al., 2013; Amentae et al., 2016). A positive relationship is hypothesised between farmers with high levels of education and selection of post-harvest practices.

Household size is a key factor in determining selection of post-harvest practices for value addition. Large household sizes are expected to provide labour for post-harvest practices such as grading, washing and packaging amidst other competing agricultural activities (Sebatta et al., 2015). Several studies have also confirmed that large households are more likely to engage in other farm activities than smaller households (Souza Filho et al., 1999; Abdulai et al., 2008; Mariano et al., 2012). This is because for the majority of farmers, household labour is the major source of labour since they lack resources to employ hired labour. In most cases such kind of labour is provided mainly by women and children since vegetable production is considered

women crop. Hence, a positive sign is expected for large household size and negative otherwise.

It was hypothesised that with increasing age, a farmer's ability to select post-harvest practices may become positively related. The rationale is that with increasing age the farmer gains more experience and they appreciate the importance of post-harvest practices. Thus, drawing from their experience, older farmers are expected to select more post-harvest practices. Ramirez and Shultz, (2000) confirmed that there is a relationship between age of a farmer and their experience. Conversely, with increasing age farmers may become conservative in their selection choices of certain post-harvest practices, whilst young farmers who are deemed to be more enterprising might be more willing to select a wide variety of post-harvest practices (Lapar & Pandey, 1999; Núñez & McCann, 2008). Therefore, the effect of age on selection of post-harvest practices can be ambiguous.

Amentae et al., (2016) stated that farming experience influences the decision of farmers to engage in post-harvest practices that add value to their products. Experienced farmers might have gained knowledge over time pertaining advantages and disadvantages of specific post-harvest practices in the output market. Thus, experience influences choices of post-harvest practices based on anticipated market returns. A positive sign is expected on this variable in the study.

Land size is an important factor in selection of post-harvest practices such as washing and cleaning, grading and sorting, drying and storage (Ali, 2016; Ali, 2012). It is envisaged that those farmers who devote more land to vegetable production will produce large quantities. Therefore, they are more likely to select more post-harvest practices for value addition. Thus a positive association is anticipated on this variable in this study.

Increase in distance to the nearest market discourages SHFs from participating in output markets due to transaction costs (Zamasiya et al., 2014; Siziba et al., 2011; Alene et al., 2008). Therefore, as distance to market increases it is expected that the selection choice of farmers on post-harvest practices will become limited. A negative sign is expected between distance to market and selection of post-harvest practices.

Market information plays a vital role towards influencing farmers' decisions in production and marketing of their vegetable produce (Tadesse & Bahiigwa, 2015; Ali, 2012). Farmers were interviewed with regards to communication channels available to them. Access to market information had been set as a dummy variable, where a farmer with access to market information took the value one, or zero otherwise. Available market information is expected to positively influence SHFs' selection of post-harvest techniques.

Previous studies have revealed a strong relationship between SHFs' access to credit and their decisions to engage in value-adding activities (Amentae et al., 2016; Ngore et al., 2011). Thus, a positive association is expected between farmers with access to credit and negative otherwise.

Numerous scholars have alluded to the importance of farmer groups in improving SHFs' access to credit, technical advice and promoting of value addition (Markelova et al., 2009; Louw et al., 2008; Kherallah et al., 2002). Given this background a positive relationship is conjectured between farmers who are group members and selection of post-harvest practices.

Some post-harvest practices are labour intensive such as grading. Hence availability of labour is hypothesised to positively influence selection of post-harvest practices. In the same way, **training** in post-harvest management strategies was noted to improve SHFs' participation in lucrative markets within Zimbabwe (Bindu & Chigusiwa, 2013). Farmers were asked if they have had access to any form of training in vegetable production. Dummy values were assigned (1 if they have had access; otherwise 0). A positive relationship is expected for this variable in this study.

Furthermore, the type of market that SHFs target when producing their output influences their selection choice of post-harvest practices. The issue of grades and standards tends to be more emphasised in formal markets compared to informal markets (Jari & Fraser, 2009). Hence, a positive or negative sign is hypothesised for this variable.

The quantity of vegetables produced is hypothesised to positively affect farmers' decision to select post-harvest practices. This is because previous studies have highlighted that quantity of fruits and vegetables produced by farmers influences the type of post-harvest management techniques that they engage in (Musasa et al., 2015; Sebatta et al., 2015).

Availability of storage facilities maintains vegetables in a good state, minimises losses and also reduces the urgency of selling the produce (Jari & Fraser, 2012). It is envisaged that those farmers with storage facilities like sheds are more likely to participate in post-harvest practices. To that end farmers were asked if they have storage facilities. Dummy values were assigned to this variable where farmers who had storage facilities took the value of 1; 0 otherwise. A positive relationship is expected for this variable.

To investigate factors that influence market channel choice by smallholder vegetable farmers

This objective was analysed using the multinomial logit model (MNL). The multinomial logit model (MNL) and the multinomial probit (MNP) models are widely used when there are multiple choices. In this study, drawing from the work of other scholars it was hypothesised that smallholder vegetable farmers are faced with three choices; formal, informal and non-market participation. It is assumed that these decisions are made based on the option that maximises utility subject to technical, institutional and socio-economic constraints. The MNL model used in this study was adopted from Gujarati and Porter (2010) and is represented as follows (Equation 10):

$$P_i = E(Y = |X_i) = \frac{1}{1+e^{-(\beta_1+\beta_2 X_i)}} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .10$$

Where

P_i represents probability

The equation is written as Equation (11) for ease of exposition

$$P_i = \frac{1}{1+e^{-z_i}} = \frac{e^z}{1+e^z} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots 11$$

Where $z_i = B_1 + B_2 X_i$

Z_i ranges from $-\infty$ to $+\infty$

P_i ranges between 0 and 1 and is nonlinearly related to Z_i

Equation (10) can be linearised as shown in equation 12:

$1 - P_i = \frac{1}{1+e^{z_i}}$ 12

Therefore, it can be written as illustrated in equation 13

$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} = e^{Z_i}$ 13

Taking the natural log of equation [13] yields the following result (Equation 14)

$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i = B_1 + B_2 X_i$ 14

For estimation purposes equation (14) is written as follows (Equation 15):

$L_i = ln\left(\frac{P_i}{1-P_i}\right) = B_1 + B_2 X_i + u_i$ 15

$ln\left(\frac{P_i}{1-P_i}\right) = logit\ for\ market\ channel\ choice$

$P_i = participating\ in\ markets$

$1 - P_i = not\ participating\ in\ markets$

$X_i = independent\ variables$

$B_i = parameters\ to\ be\ estimated$

$u_i = error\ term$

In the model, market participation choice represents the dependent variable where non-market participation has been set as the reference category. Market participation choice describes the decision to market or not, and the different marketing channels (informal markets or formal markets) used by SHFs to market their vegetables. In that respect Pi represents either informal

market or formal market participation and (1 – Pi) represents the probability of not participating in vegetable marketing. In other words, the model was used to assess the odds of: informal market participation vs. not participating; and formal market participation versus not participating.

5.7.3 Definition of variables used in the multinomial logit model

Table 5.3 provides the explanation of the independent variables that were used in the model and their *a priori* expectations.

Table 5.3: Description of variables used in the multinomial logit model

Variable	Definition	Coding of Variable	Category	Expected Sign
X_1	Gender	1 if female, 0 if male	Dummy	+/-
X_2	Education level	Years	Continuous	+
X_3	Household size	Number of family members	Continuous	+
X_4	Age	Number of years	Continuous	+/-
X_5	Farming experience	Number of years	Continuous	+
X_6	Distance to market	Number of kilometres	Continuous	-
X_7	Market information	1 if yes, 0 if no	Dummy	+
X_8	Credit	1 if yes, 0 if no	Dummy	+
X_9	Group membership	1 if group, 0 if individual	Dummy	+
X_{10}	Price	Output price (US$)	Dummy	+
X_{11}	Extension	Number of extension visits per year	Continuous	+
X_{12}	Family labour	1 if yes, otherwise 0	Dummy	+
X_{13}	Add value	1 if yes, otherwise 0	Dummy	+/-
X_{14}	Road infrastructure	1 if good, 0 if poor	Dummy	+
X_{15}	Quantity produced	Number of kilograms	Continuous	+
X_{16}	Marketing stalls	1 if good, otherwise 0	Dummy	+

Gender has an effect on market participation of female- and male-headed households (Zamasiya et al., 2014). Gender of the farmer was set as a dummy variable where female took the value of 1 and zero otherwise. It is assumed that male SHFs tend to have better access to productive resources necessary to meet quality requirements hence they might have a wide option of marketing channel choices compared with their female counterparts.

Smallholder farmers' level of education can improve production and marketing practices. The higher the level of education, farmers are expected to have high productivity, engage in value-adding activities and ultimately have better access to markets (Birthal et al., 2005; Kuma & Getnet, 2011; Mamo et al., 2014). Thus, the greater the number of years in formal education of the household head, is expected to increase access to markets with high returns.

According to Alene et al., (2008) household size can be used as a proxy for available family labour that can be channelled towards production activities. Nonetheless, bigger household sizes may mean higher household consumption and reduced marketable surplus. Reduced market surplus means farmers might only be able to access informal markets due to low quantities. Therefore, a negative sign is expected if a household size leads to reduced marketable surplus.

Age was measured in years of smallholder vegetable farmers. Age influences participation in markets through various ways such as experience, risk preference and access to resources (Ochieng et al., 2017; Zamasiya et al., 2014). Younger farmers are expected to be risk-takers, innovative and to be involved in activities such as value addition so as to access other alternative markets. Alternatively, older farmers are expected to have gained experience and have access to resources (Mamo et al., 2014). Therefore, the expected sign might be negative or positive.

Farming experience improves market participation of smallholder vegetable farmers through improved bargaining power in the output market and enhanced connection with traders such as middlemen. Experience was noted as a key factor which improves farmers' negotiation skills in the output market (Vakis et al., 2003). A positive sign is expected for this variable in this study.

Distance to market was measured in kilometres from the smallholder farmer's production area to the market. Several studies have established the negative influence of distance on SHFs' participation in markets (Mariano et al., 2012; Siziba et al., 2011; Alene et al., 2008; Makhura et al., 2002). The greater the distance from the farmer's production area to the market, the less likely the farmer is to participate in that particular marketing channel. This is because the farmer's profit returns are bound to be reduced as a result of increased transportation costs and the encountered opportunity cost of time. A negative sign was hypothesised for this variable.

Access to market information was measured by the farmer's ability to access market information and the aptitude to interpret it correctly (Jari & Fraser, 2009). Farmers were interviewed with regards to communication channels available to them. Access to market information had been set as a dummy variable, where a farmer with access to market

information took the value one, or zero otherwise. Access to market information was expected to influence market channel decisions positively.

Access to credit may enable smallholder vegetable farmers to have increased output. Therefore, they can have bulk marketable surplus, which might enable them to participate in formal markets. The variable was measured as a dummy (1 if farmer had access, 0 if not). A positive correlation was expected for this variable.

Studies have highlighted the importance of SHFs working collectively to access lucrative markets (Markelova et al., 2009; Abdul-Hanan et al., 2014). Farmers were interviewed as to whether they belonged to a farmer group or operated individually. The responses were allocated dummy values. Group marketing is anticipated to impact positively on market participation and choice of marketing channel amongst SHFs

Producer price denoted the price offered by a particular vegetable marketing channel. Farmers spend a considerable amount of resources and time searching for markets which offer lucrative prices. A marketing channel offering higher price is likely to act as an incentive for farmers to participate in that particular marketing channel (Zivenge & Karavina, 2012; Mmbando et al., 2016). Therefore, a channel offering a better price was hypothesised to have a positive effect on the selection of that particular marketing channel. Farmers were asked about the producer price being offered in a particular marketing channel and how it influenced their decision to use that channel. A higher producer price offered in a particular marketing channel is likely to influence farmers to use that marketing channel. Hence, a positive sign is expected for this variable

Extension services convey knowledge, market information and technical skills to smallholder vegetable farmers (Roy et al., 2013; McNamara & Tata, 2015). This is also very important for smallholder vegetable farmers to participate in marketing channels that offer higher premiums. Farmers who get regular contact from extension services are expected to have better market access. A positive sign is expected for this variable in the study area.

Availability of family labour is expected to boost productivity and increase marketable surplus. Farmers were asked whether they had family labour for vegetable production or not, and

responses were assigned dummy values. Thus, a positive relationship is expected for this variable if the farmer has family labour available.

The ability of smallholder vegetable farmers to add value to their produce enables them to access lucrative markets and curb post-harvest losses. The variable was set as a dummy (1 if farmer adds value, 0 otherwise). The expertise of farmers in grades and standards improves participation in both informal and formal markets (Jari & Fraser, 2009; Panda & Sreekumar, 2012). It is expected that value addition influences market participation positively in formal markets.

Availability of good roads is expected to have a positive influence on market participation. Roads that are accessible to farmers, particularly feeder roads that can link farmers to major highways are central to the marketing of perishables. Thus, poor road infrastructure constrains market access of smallholder farmers (Ochieng et al., 2017; Panda & Sreekumar, 2012; Mmbando et al., 2016). Farmers were asked about the condition of their roads. Dummy values were assigned to this variable (1 if road is in good condition, otherwise 0).

The quantity of vegetables produced was measured in kilograms. The greater the quantity of vegetables produced, the more likely the chances that the farmer would participate in formal markets. Hence, it was expected to have a positive influence on market channel choice.

Marketing stalls: This variable was measured by the availability of infrastructure like marketing stalls and their condition. Availability of proper storage facilities like marketing stalls in the marketplace reduce post-harvest losses and ultimately increase farmers' income. Dummy values were assigned to this variable where one indicates availability, zero is either unavailability or poor condition. A positive sign is expected for this variable.

5.8 Chapter summary

This study was conducted in four (4) districts of the Mashonaland East Province of Zimbabwe. The four districts in which the study was conducted are Mutoko, Goromonzi, Murehwa and Seke. A structured questionnaire was designed and used as a key instrument for data collection. Ultimately, a total sample size of 385 smallholder vegetable farmers was interviewed in the study area. Various analytical methods were employed to answer the research questions which

were posed in the introductory chapter. The Poisson count regression model was used to analyse factors influencing number of post-harvest practices adopted by smallholder vegetable farmers. Moreover, the binary logistic model was used to analyse factors that influence a smallholder vegetable farmers' decision to select specific post-harvest practices for value addition. Finally, the multinomial logit model was employed to investigate factors that influence market channel choice by smallholder vegetable farmers. Description of variables in each model was done based on findings from literature as previously discussed in Chapters 2 and 3. The following chapter offers results that were obtained from the statistical analysis describing demographic characteristics of respondents as well as major vegetables grown in each district.

CHAPTER 6

DESCRIPTIVE RESULTS AND DISCUSSIONS

6.0 Introduction

This chapter presents findings of the descriptive results for the study. The chapter begins by summarising the demographic characteristics of farmers in the survey area. This is followed by socio-economic characteristics of the respondents in the study districts. The farmers' main sources of income, land ownership, major crops grown and livestock ownership in the four districts of Seke, Goromonzi, Murehwa and Mutoko were revealed. Furthermore, the main vegetables that are produced in each district as well as estimated revenue generated from marketing of these vegetables are presented. Findings on the main causes of post-harvest losses of vegetables and estimated post-harvest losses for vegetables predominantly cultivated in each of the four districts are offered. The total sample size for the study was 385 respondents.

6.1 Demographic characteristics of farmers

Table 6.1 provides the household demographic characteristics of farmers from the study areas. A total of 385 respondents were considered for this sample. The majority of households in the study area were male-headed (68.1%)[12], with all the household heads in the four districts having attained some primary education. This could be attributed to the country's high literacy rate which is estimated at 96% (Zimstat, 2012b). Mutoko District had the highest proportion of farmers with post-primary education (74.7%) followed by Seke (56.9%). However, a small proportion of vegetable farmers in Mashonaland East Province had attained some tertiary education (1.6%). Murehwa District did not have any farmers who reported to have attained any tertiary education. According to Musasa et al., (2015) literacy level of smallholder farmers and middlemen is very important as it allows for better flow of product information and knowledge within the value chain. The majority of interviewed vegetable farmers were married (76.6%). Mutoko district had most of the household heads being married (82.7%) followed by Seke District (76.5%) and the least was Goromonzi District (73.3%).

[12] During the interviews in as much as most respondents were females (and vegetable farming is regarded as a female activity) they reported that the household head was male.

Table 6.1: Household demographic characteristics of farmers

Variables	District				Total
	Seke	Goromonzi	Murehwa	Mutoko	
Sample size (N)	**102**	**105**	**103**	**75**	**385**
Gender of household head (%)					
Males	70.6%	56.2%	68.9%	80.0%	68.1%
Females	29.4%	43.8%	31.1%	20.0%	31.9%
Marital status (%)					
Married	76.5%	73.3%	75.7%	82.7%	76.6%
Single	3.9%	2.9%	2.9%	0.0%	2.6%
Divorced	2.0%	3.8%	4.9%	2.7%	3.4%
Widowed	17.6%	20.0%	16.5%	14.7%	17.4%
Education level (%)					
Primary education	41.2%	45.7%	47.6%	24.0%	40.8%
Secondary education	56.9%	51.4%	52.4%	74.7%	57.7%
Tertiary education	2.0%	2.9%	0.0%	1.3%	1.6%

Source: Survey Data

Table 6.2 below summarises the socio-economic characteristics of farmers in the surveyed districts. The average age of farmers varied significantly ($P < 0.05$) among the surveyed districts, ranging from a mean of 45 years in Mutoko District to 54 years in Goromonzi district. The mean age of all districts combined was 50 years. Therefore, Mutoko District was the one which had youngest farmers while Goromonzi District was characterised by old farmers. The high concentration of young vegetable farmers in Mutoko District might be attributed to availability of irrigation schemes which tend to be lucrative and profitable hence attractive to young farmers.

Table 6.2: Summary statistics of socio-economic characteristics of respondents

Variables	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Sample size (N)	**102**		**105**		**103**		**75**		**385**	
Farmer Characteristics										
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age	50.31	11.94	54.20	15.61	48.91	12.93	44.69	9.42	49.90	13.25
Household size	5.78	2.14	5.07	3.35	5.50	1.90	6.32	1.65	5.62	2.43
Source of household income and amount										
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Crops amount	1179.23	1014.63	1835.42	1681.63	1317.54	1107.32	3208.79	2196.98	1885.25	1543.60
Livestock amount	696.15	947.38	1301.76	1561.57	1320.69	2720.57	468.57	274.92	961.63	1731.15
Salary amount	2465.58	2401.86	1614.29	1834.82	1695.29	1086.45	0.00	0.00	1868.76	1772.58
Pension amount	660.00	2	352.00	10	1370.00	712.58	0.00	0.00	936.00	742.32

SD= Standard Deviation

Source: Survey Data

The average household size comprised about 6 individuals and on average the respondents had about 13 years of vegetable farming experience. The mean household size varied significantly ($P < 0.05$) among the survey districts. Mutoko had the highest average household size compared with all other surveyed districts. The average household size obtained from the study was slightly higher than the average size of household obtained during the last census in 2012 which was 4.1 (Zimstat, 2012a). Hence, this might be attributed to the average rate of natural increase in the province over the years since the last census was conducted, five years ago. The highest average amount of income per year was realised from crops at US$1 885.25 and the least amount was obtained from pension with an average of US$936. The average household income from crop farming obtained in Mashonaland East Province amongst the sampled households was higher than the one which was reported by ZimVac (2016) for the month of April 2016 which was US$78/month. This revealed the potential of vegetable farming to improve household income particularly in the sampled districts. This is because vegetable farming is one of the dominant cropping activities in the sampled districts. Among the districts, Mutoko had the highest average income from crops per year which was reported at US$3 208.79[13] while Seke district had the least amount income reported per year at US$979.22. The

[13] The US$ has been Zimbabwe's legal tender since 2009 to date. The country adopted the US$ as a way of curbing hyperinflation and stabilizing the economy.

high average income from crops per year from Mutoko can be attributed to the irrigation schemes of Chitora 1, 2 and 3 where the majority of farmers were sampled. However, it should be noted that a very small proportion of farmers in the study area were obtaining their income from salaries and pension that is 13.5% and 5.2% respectively.

6.2 Main sources of income

Sampled households from Mashonaland East Province obtained their income from multiple sources such as crop farming, livestock, salary, pension and a negligible amount from other sources such as remittances. However, the majority of farmers across all the four districts ranked crops, particularly vegetable farming as their main source of income and livelihoods as depicted in Figure 6.1. Livestock rearing was ranked as the second main source of income in all the four districts. Respondents reported that rearing of livestock particularly small livestock such as poultry, contributed a considerable amount of income to their livelihoods. Salaries and pensions were ranked as the least important sources of income in all the surveyed districts. Hence, the majority of respondents in the study area depend on crop farming and livestock rearing for their livelihood.

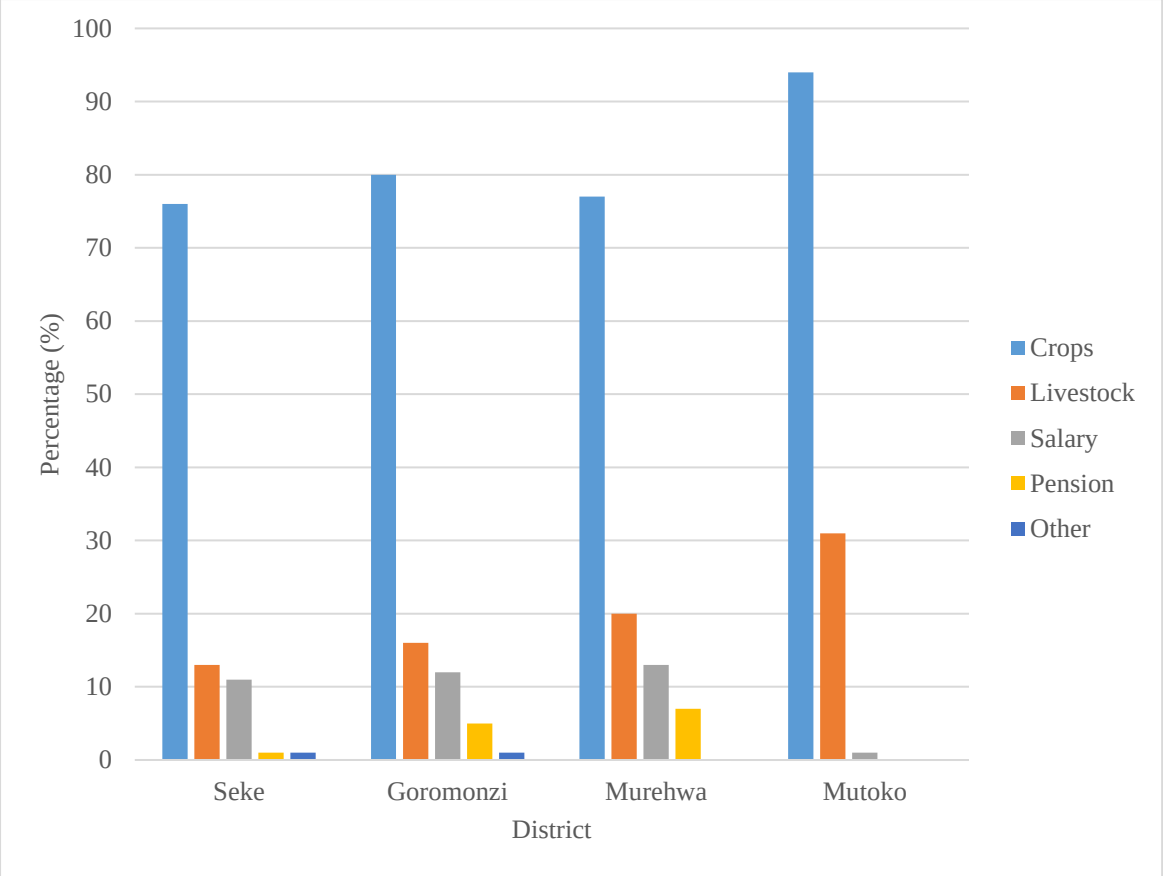

Figure 6.1: Main sources of income of smallholder farmers

Source: Survey Data

Mutoko District did not have any respondents who were receiving any pension for their livelihood. In Mutoko District crop farming contributed the highest amount of average annual income as explained earlier in section 6.1. These results are also consistent with the findings of ZimVac (2016) which revealed that sales from vegetables and livestock were amongst the most important sources of income for about 11% of the rural population nationally. This is despite the El Niño-induced drought which ravaged the country during the 2015/16 agricultural season.

6.3 Land ownership

The average land size for the sampled vegetable farmers in Mashonaland East Province was 1.74 hectares. Though this may be, farmers reported that on average, total arable land they owned was about 1.45 hectares. In the same way, during the previous farming season, on

average, about 1.05 hectares had been allocated to crop production. The majority of farmers owned about 1 hectare of land size and arable land as shown in Table 6.3. Most farmers during the 2015 agricultural season had utilised only 0.4 hectares of their land for field crop production. The major difference between arable land and land that was allocated to crop production can be attributed to the El Niño-induced drought which affected the country during the 2015/16 agricultural season. Hence, farmers allocated smaller portions of their land for crop production. However, earlier findings by Masakure and Henson, (2005) pointed out that smallholder vegetable farmers in Zimbabwe fail to adequately utilise their arable land due to inadequate finance to purchase inputs, weak output markets and shortage of family labour. These constraints, in other instances, may hinder farmers from devoting their pieces of land to high cash crops which offer higher returns in the output markets. According to Martey et al., (2012) and Olwande and Mathenge, (2012) large farm sizes have a positive impact on output markets if managed properly as they enable farmers to generate marketable surplus for the production market.

Table 6.3: Land ownership overall sample

	Land size owned (ha)	Arable land owned (ha)	Allocated to crop production (ha)
N	385	385	385
Mean	1.74	1.45	1.05
Median	1.00	1.00	0.80
Mode	1.00	1.00	0.40
SD	3.342	1.788	0.916

SD = Standard Deviation

Source: Survey Data

Additionally, Hichaambwa et al., (2015) pointed out that improving conditions for smallholders' participation in horticultural markets presents better income-earning opportunities more than participation in maize markets, particularly for poor and land-constrained farmers. These income gains are more pronounced for SHFs cultivating less than a hectare and for poorer households earning less than US$1.25 per day per *capita*.

Table 6.4: Land ownership by district

Name of District		Land size owned (Ha)	Arable land owned (ha)	Allocated to crop production (ha)
Seke	N	102	102	102
	Mean	0.9265	0.8676	0.7382
	Std. Deviation	0.60557	0.59655	0.59570
Goromonzi	N	105	105	105
	Mean	1.2890	1.1500	0.8085
	Std. Deviation	0.94411	0.71690	0.49517
Murehwa	N	103	103	103
	Mean	2.7641	2.0291	1.2097
	Std. Deviation	5.47670	2.61866	0.79626
Mutoko	N	75	75	75
	Mean	2.0667	1.8613	1.6040
	Std. Deviation	3.47953	2.16501	1.44526

Source: Survey Data

Results obtained in this study revealed that in terms of land size, farmers in Murehwa had bigger pieces of land (average of 2.76 hectares) and farmers in Seke District had the smallest pieces of land (average of 0.9265). From the foregoing, it is not surprising that the observation for arable land ownership followed a similar pattern with Murehwa having the highest and Seke the least. However, the highest average arable land allocated for crop production was in Mutoko District (1.604 hectares) and the least was in Murehwa District (average 0.74 hectares). The issue of smaller plots of land holdings in Seke District can be attributed to its proximity to Chitungwiza[14] town which is fast expanding into Seke making it a peri-urban settlement where demand for land is quite high with consequent increase in land prices. Despite Mutoko having a high average of arable land allocated to crop production during the previous agricultural season of 2015/16, the majority of farmers in the district owned very small portions of land (0.5 hectares) as shown in Table 6.4. The majority of farmers in Mutoko District who were into vegetable production just owned small pieces of land in the Chitora irrigation scheme and they tended to hire land if they want to engage in production of other crops. The results of this study revealed that there is land shortage for the majority of smallholder vegetable farmers in Mutoko who are in the Chitora irrigation scheme to participate in farming of other field crops. Smallholder farmers' size of land holdings and ownership of other productive agricultural

[14] Chitungwiza is a dormitory town for Harare.

assets plays a pivotal role in determining participation in output markets. According to Barrett, (2008) farming households with the least land buy most of their food from the market, but chances of making gross purchases decline progressively as a household's land holdings increase. Hence it is important that SHFs are provided with an adequate amount of land and other productive agricultural assets.

6.4 Land devoted to vegetable production

Table 6.5 below shows the proportion of average land area allocated to production of different vegetables in the study area. The results of the survey showed that overall, carrots (0.2340 hectares) had the highest average land devoted for their production. This was followed by butternuts with approximately 0.1973 hectares on average allocated for its production. These two vegetables were mainly being produced in Mutoko District under irrigation facilities. The reason for this is the high producer price that they offer to farmers when sold at municipal wet markets such as Mbare Musika. The least amount of land across all districts was being allocated to cabbage production which had an average hectarage of about 0.1120 ha.

Table 6.5: Land area devoted to vegetable production by district

Average area(ha) devoted to different vegetables								
Name of District	**Rape**	**Tomatoes**	**Cabbage**	**Onion**	**Covo**	**Carrots**	**Butternuts**	**Cucumber**
Seke	0.0863	0.1214	0.1667	0.0692	0.0932	0.0836	0.000	0.0300
Goromonzi	0.1200	0.1932	0.0100	0.1182	0.12547	0.0000	0.1800	0.0700
Murehwa	0.1571	0.1682	0.0500	0.19105	0.0934	0.0100	0.2167	0.2460
Mutoko	0.1162	0.2000	0.0000	0.0000	0.13778	0.2528	0.1958	0.1563
Overall	0.1213	0.1659	0.1120	0.12119	0.10533	0.2340	0.1973	0.1538

Source: Survey Data

For the three major vegetables that were being predominantly grown in the study area, rape had the highest average land area in Murehwa District at 0.1571 hectares. On average highest amount of land for covo production was allocated in Mutoko District which was 0.13778 hectares. The trend follows a similar pattern for tomatoes with about 0.2000 hectares on average being allocated for its production in Mutoko District. The allocation of these large portions of land for most vegetables in Mutoko district can be attributed to the presence of

irrigation schemes. The average land area allocated to different vegetables in the study area almost followed a similar pattern as the one which was noted by Heri (2006) as explained earlier in section 4.1.3. Generally, the low average hectarages devoted to various vegetables by farmers was an indication of the various constraints they encounter in vegetable production.

6.5 Major crops grown by farmers

The major crops grown in the surveyed areas are shown in Table 6.6 below. The three major crops grown were maize, groundnuts and round nuts. According to Maiyaki, (2010) crops such as maize and groundnuts are considered principal crops in the Zimbabwean communal areas. Nevertheless, the most important and the most favoured crop across all the four districts was maize. This is because maize is the staple diet in the country. Results of the survey also revealed that 93% of farmers in the study areas reported that they had grown maize during the previous season. The second most important crop reported by farmers was groundnuts with 36% of farmers reported to have grown groundnuts during the previous season. In the same way, the largest proportion of farmers who reported to have grown maize in the surveyed area were located in Murehwa District with about 49%. Moreover, a large proportion of land area was also allocated to maize production with an average of 0.62 hectares being devoted to maize production. The largest average area allocated to maize production was in Mutoko District with approximately 0.95 hectares being reserved for maize production. Furthermore, the least amount of land area devoted to maize production was in Goromonzi District with an average of 0.46 hectares being devoted to maize production. A possible explanation for this could be the small land holdings of the respondents particularly in the surveyed wards of Domboshava, given its proximity to Harare.

Table 6.6: Major crops grown

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Major crops	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Maize	100	98	98	93	100	97	59	79	357	93
Groundnuts	23	23	27	26	50	49	35	34	139	36
Round nuts	9	8	20	20	35	34	1	1	66	17
Land area allocated (ha)										
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Maize	0.51	0.28	0.46	0.25	0.69	0.49	0.95	0.77	0.62	0.48
Groundnuts	0.12	0.12	0.69	2.86	0.26	0.16	0.79	3.86	0.94	1.62
Round nuts	0.07	0.06	2.00	8.71	0.22	0.11	0.25	0.36	0.37	0.61
Total produced (tonnes)										
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Maize	0.85	1.03	0.84	0.87	1.10	0.93	2.00	1.51	1.11	1.13
Groundnuts	0.09	0.12	0.12	0.091	0.22	0.25	1.21	1.10	0.46	0.76
Round nuts	0.06	0.06	0.11	0.12	0.24	0.28	0.11	0.11	0.21	0.36

SD= Standard Deviation

Source: Survey Data

Respondents were also asked on how they utilised their crop produce. The results of the survey revealed that a large proportion of the harvested crop was used for home consumption. Farmers also sold the surplus of their harvested crop over and above home consumption. However, with an average of 1.11 tonnes of maize being produced, in most cases, it was not enough to last households up until the next season given their household sizes. Farmers often sell a proportion of their harvested crop produce soon after harvest when prices are low. This is predominant with deficit producers who would like to fulfil immediate cash needs after harvest, only to buy food later in the season (Randela, 2003). This also confirms earlier findings of Stathers et al., (2013), that farmers sell off their crops soon after harvest in order to meet some immediate financial needs. Smallholder farmers in Mutoko District were found to produce more output of maize on average (2.00 tonnes) and groundnuts (1.21 tonnes) whilst SHFs in Goromonzi District only managed an average of (0.84 tonnes) of maize and an average of (0.12 tonnes) of groundnuts. These differences, can be explained by the presence of the Chitora irrigation scheme in Mutoko which enabled farmers to plant early in the season and benefit from high heat units leading to improved yields compared to dry land maize production. Nonetheless, it should be noted that results from the study revealed that farmers in the surveyed areas also produce a wide variety of other field crops such as sugar beans, sorghum and finger millet to a lesser extent.

The fact that smallholder vegetable farmers do at times engage in production of other field crops is a clear indication that in most cases, vegetable farming cannot be relied upon entirely as a sole means of livelihood. Furthermore, it also revealed the seasonality of vegetable production by SHFs. Farmers, particularly those that are not in irrigation schemes, mainly tend to focus on vegetable production during the off season for peak field crop production (usually around May–September). In the same way, vegetable production is seasonal by nature, for example tomatoes do not do well during winter. An understanding of the seasonal calendar for crop production might inform programmes that are geared towards improving smallholder vegetable farmers' productivity.

6.6 Livestock ownership

The smallholder farmers in the study area kept cattle, goats, donkeys, sheep and chickens as shown in Table 6.7 below.

Table 6.7: Livestock ownership by respondents

Livestock	**% of smallholder farmers livestock ownership**				
	Seke	**Goromonzi**	**Murehwa**	**Mutoko**	**Average % across all districts**
Cattle	26 (5.2)	43 (3.4)	56 (4.4)	95 (5.8)	52 (4.8)
Goats	41 (4.8)	32 (3.7)	35 (3.6)	45 (3.9)	38 (4)
Donkeys	2 (6.5)	1 (2)	0 (0)	0 (0)	1 (5)
Sheep	1 (3)	2 (6.5)	0 (0)	24 (6)	6 (5.9)
Chickens	77 (19.8)	56 (35.8)	85 (21.9)	99 (21.9)	77 (24.1)

Numbers in brackets are average number of livestock owned per household
Numbers outside brackets are percentage of livestock owned by smallholder farmers

Source: Survey Data

Results in Table 6.7 indicate that smallholder farmers in Mutoko District owned relatively more livestock compared with farmers in other districts. The average number of poultry per household was 24.1, followed by sheep 5.9 and cattle 4.8 (Table 6.7). About 95% of farmers in Mutoko District reported that they owned cattle with the highest average of 5.8 cattle per household. Seke District had the least number of farmers who owned cattle (26%). Cattle are very important in Zimbabwe's communal areas where they are used as a means of draught power and they can also be slaughtered to provide food for households. Equally important, cattle sales can also be used to meet households' immediate financial needs. Cattle sales are

more prevalent in Mashonaland East Province, with ZimVac, (2016) reporting that 40%[15] of households reported selling cattle in the previous season. Livestock ownership such as cattle and goats also provides manure for vegetable farming. Furthermore, results in Table 6.7 indicate that Mutoko District had a slightly higher proportion of farmers who owned livestock compared to other districts. The small proportion of livestock ownership in other districts such as Seke and Goromonzi can be explained due to their peri-urban locations where SHFs have limited land holdings. This results in limited available grazing land. Results of the survey through farmer and extension agent interviews indicated that in districts such as Murehwa farmers had very small quantities of livestock, especially cattle, mainly due to the fact that the council charges a fine to farmers whose cattle strayed into the growth point. This was a major challenge particularly for those wards which were near the growth point, for example ward 2. Moreover, grazing land was also limited for those peri-urban districts such as Seke and Goromonzi. Donkeys and sheep were not very popular with the majority of SHFs in the study area. This might be because besides being used as draught animals and for transportation donkeys do not provide food for households. Chickens were used for meat and sale, while goats were used for barter trade, meat, manure and an asset for immediate sale. Livestock ownership can also influence the area of vegetables grown by SHFs particularly cattle. This is because cattle can provide draught power to plough in the gardens if the plot is big. The major vegetables produced by SHFs in the study area are explained in the following section.

6.7 Major vegetables produced by districts

At least 11 major vegetables were being cultivated in the surveyed area as shown in Table 6.8 below. The three dominant vegetables; rape, covo and tomatoes were cultivated by 51.2%, 45.2% and 37.1% of the farmers across all the four districts respectively (Table 6.8). Again, rape, covo and tomatoes were the three most predominant vegetables grown in Seke, Goromonzi and Murehwa Districts. However, Mutoko exhibited a different pattern, where the three dominant vegetables were carrots, butternuts and cucumber which were being produced by 90.7%, 41.3% and 20 % of the farmers respectively. The different trend exhibited by Mutoko farmers can be explained by farmers in the Chitora irrigation scheme mainly focusing on vegetables which fetch higher prices on Mbare Musika, the informal market where farmers trade most of their vegetable outputs. All the vegetables that were being produced were

[15] This was the highest rate reported nationally.

destined for the domestic market and there were none that were being exported. The amount of income obtained from marketing of a particular vegetable type is explained in detail in section 6.8.

Table 6.8: Most cultivated vegetables in the four districts

Crop	**% of smallholder farmers growing vegetable**				
	Seke	**Goromonzi**	**Murehwa**	**Mutoko**	**Average % across all districts**
Rape	67.6	51.4	68.0	5.3	51.2
Tomatoes	40.2	61.0	35.9	1.3	37.1
Cabbage	2.9	1.0	1.0	0	1.3
Potatoes	5.9	1.9	4.9	0	3.4
Onions	23.5	9.6	18.4	0	13.8
Covo	75.5	50.5	34.0	12.0	45.2
Carrots	6.9	0	1	90.7	19.7
Butternut	0	3.8	5.8	41.3	10.6
Sweet potato	7.8	20.0	12.6	0	10.9
Cucumber	2.0	2.9	4.9	20.0	6.5
Green beans	0	0	0	18.7	3.6

Source: Survey Data

Except for Mutoko District where the majority of farmers were sampled from Chitora irrigation scheme, most gardens in the other districts were cited near sources of water such as *vleis*, streams, rivers and springs. Nonetheless, water shortages and underdeveloped irrigation facilities were hampering farmers' productivity. The least cultivated vegetables were cabbage (1.3%), potatoes (3.4%) and green beans (3.6%) respectively across all districts. There were no farmers who were producing cabbage and potatoes in Mutoko district. Furthermore, despite green beans fetching higher prices on the output market they were only being produced in Mutoko District. Production of green beans in Mutoko district can be attributed to the availability of irrigation facilities particularly in the Chitora irrigation schemes where the majority of farmers were sampled.

6.8 Income from vegetables produced

Results of the survey revealed that the two major crops that yielded the highest average monthly income were carrots (US$1415.92) and butternuts (US$1371.33). These were mainly being grown in Mutoko District under irrigation facilities in the Chitora irrigation scheme. On the other hand, results in Table 6.9 indicated that rape, covo and tomatoes were the three major dominant crops which were sold in large quantities with high average monthly income in the three districts of Seke, Goromonzi and Murehwa. However, average monthly income earned

from tomatoes and covo was least in Murehwa District compared with Seke and Goromonzi Districts. Nevertheless, even though potatoes were fetching higher average monthly income of US$979.50, not many farmers were engaged in potato production across all the four districts.

Table 6.9: Quantities and average monthly income from vegetable sales by district

	Seke		Goromonzi		Murehwa		Mutoko		Overall	
Crop	**Quantity sold (month/kg)**	**Average income (US$/month)**	**Quantity sold (kg)**	**Average income (US$/month)**	**Quantity sold (kg)**	**Average income (US$/month)**	**Quantity sold(kg)**	**Average income (US$/month)**	**Quantity sold (kg)**	**Average income (US$/month)**
Rape	2376.10	461.54	381.34	167.78	360.41	175.09	1725.00	825.00	1103.53	287.22
Tomatoes	2216.00	913.83	2041.78	727.45	868.41	250.08	4000	1000	1804.70	660.58
Potatoes	936.50	772.33	1000	6000	720.00	224.00	0	0	851.58	979.50
Cabbage	616.67	826.67	2380.00	480.00	480	50	0	0	942	602
Onions	1062.68	707.20	227.00	122.50	922.63	569.53	0	0	858.65	550.48
Covo	1586.95	724.35	610.47	131.54	159.11	41.29	787.78	1194.44	964.55	432.37
Carrots	271.43	244.00	0	0	175.00	112.00	4419.44	1555.74	3981.54	1415.92
Butternut	0	0	325	61	1562.50	478.50	4136.19	1655.61	3481.33	1371.33
Sweet potato	356.50	82	574.76	166.10	1026.15	268.85	0	0	672.9	181.88
Cucumber	625.00	115.00	83.33	870.00	870.00	215	3028.67	787.33	2055.80	534.60
Green beans	0	0	0	0	0	0	1562.50	452.86	1562.50	452.86

Source: Survey Data

Table 6.9 also showed some variations in quantities sold against prices across districts. For example, 1586.95 kg of covo sold in Seke District fetched an average monthly income of US$724.35 while a lower quantity of the same vegetable (787.78 kg) in Mutoko fetched a marginally higher average monthly income of US$1194.44. These variations can be attributed to the different markets that are used by farmers in different districts as well as differences in product quality. Farmers in Seke District sold most of their produce at *Jambanja* wholesale market, those in Goromonzi mainly used Domboshava Showgrounds market, while those in Mutoko and Murehwa mainly sold their produce at the Mbare Musika wholesale market. Prices in these markets tend to differ depending on the forces of demand and supply. None of the SHFs in the survey area were producing vegetables under contract farming arrangement.

6.9 Main causes of vegetable post-harvest losses

Figure 6.2 below summarises information on the main causes of post-harvest losses obtained from vegetable production during the 2016 cropping season as reported by respondents. The results indicated that the main causes of post-harvest losses for rape, covo and tomatoes, the three dominant crops produced in Seke, Goromonzi and Murehwa Districts are pests and diseases. According to the result (Figure 6.2) a majority of farmers (about 90%) responded that

pests and diseases were the major cause of high levels of post-harvest losses in tomatoes. Factors such as decay and rough handling were mentioned as the second and third major causes of post-harvest losses respectively by farmers in rape, covo and tomato production. The reason for high volumes of vegetables which decay (rot) can be ascribed to non-availability of buyers, and poor or no storage facilities in the study area. Mechanical damage and over-maturity were mentioned by relatively less number of respondents as causes of post-harvest losses across all major vegetables that were being produced in the survey area. Carrots, butternuts and cucumbers were mainly being produced under irrigation facilities in Mutoko District. However, butternuts recorded the least proportion of post-harvest losses. This might be attributed to the physiological nature of the crop. For carrots and cucumbers, the main causes of post-harvest losses were pest and diseases as well as rough handling, respectively. According to Kughur et al., (2015), vegetables get ruined easily as a result of high water content. There is a need for proper storage facilities to prevent spoilage; however, lack of storage facilities, and non-availability of buyers among other factors, result in farmers' energy being wasted and a substantial amount of income being lost.

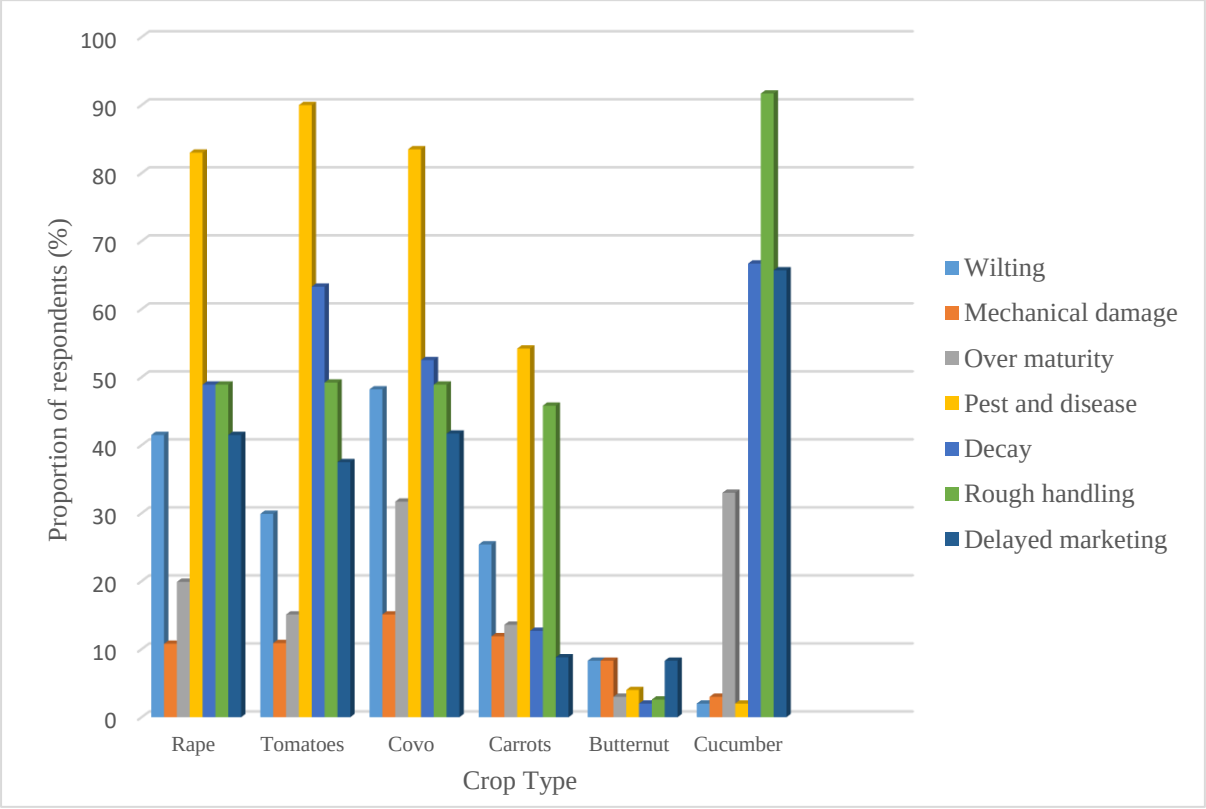

Figure 6.2: Main causes of vegetable post-harvest losses

Source: Survey Data

Problems related to rough handling as a cause for post-harvest losses in cucumber production was stated by about 91% of the respondents. Post-harvest loss and quality deterioration of vegetables in the study area occurred due to lack of chemicals to control pests and diseases, decay, rough handling emanating from poor harvesting and handling techniques as well as delayed marketing. In addition, market flooding resulting from producing similar types of vegetables at the same time, affected the market value. The following section gives a detailed estimation of the amount lost (US$/month) due to post-harvest losses of the dominantly cultivated vegetables in the study area.

6.10 Estimated post-harvest losses of the dominantly cultivated vegetables

Table 6.10 summarises information on average estimated loss (kg/month) as well as revenue (US$/month[16]) for the dominantly cultivated vegetables in the study area. The results indicated that the quantity of output lost was highest for tomatoes (298.86 kg/month) and its estimated value in monetary terms was US$202.65. Quantity of output lost for carrots was second highest (167.11 kg) with an estimated value of US$66.47. The high average quantities of output lost from carrots and cucumber are a reflection of the large volumes which were being produced in the irrigation schemes in Mutoko District. This is because during the survey farmers indicated that carrots and butternuts had minimal post-harvest losses. In most cases, post-harvest losses were below 2%.

Table 6.10: Estimated post-harvest losses of the dominantly cultivated vegetables

Crop type	Average loss (kg/month)	Average estimated loss (US$/month)	Estimated percentage (%) loss
Rape	74.79	46.24	34.81
Tomato	298.86	202.65	42.35
Covo	56.37	26.55	15.10
Carrots	167.11	66.47	13.40
Butternut	89.38	36.25	14.60
Cucumber	155	62.80	16.80

Source: Survey Data

[16] Despite providing these monthly figures it is important to note the following seasonal fluctuations that smallholder vegetable farmers encounter. The period December-March is the peak season when vegetables are fetching highest prices on the market. During the period April–October the market is depressed due to diseases and pests that affect vegetables.

The quantity of output lost was minimal for the leafy vegetable of covo (56.37 kg) with an estimated value of US$26.55. This might be explained with findings from the research which showed that covo was harvested every two weeks whilst rape was harvested on a weekly basis. Therefore, in terms of quantities and monetary returns rape gave higher returns compared to covo. Hence, for a farmer to realise returns from covo they have to produce large quantities and push large volumes on the market. Nevertheless, it should be noted that the general low crop productivity during the period under review was due to El Niño-induced drought effects. The challenges were more pronounced in districts such as Seke, Goromonzi and Murehwa where vegetable gardens were situated near intermittent water sources such as wells, streams and springs. Moreover, farmers in these districts tend to have underdeveloped irrigation facilities compared with their counterparts in the Chitora irrigation scheme in Mutoko District.

6.11 Chapter summary

The results presented in this chapter showed that the majority of households in the study area were headed by males (68.1%) and they had attained some secondary education. The average age of the farmers varied significantly across districts and it was generally high (average of 50 years). Furthermore, the average household size was about 6 individuals, which was an indication of a high dependancy ratio. The main means of livelihood in the study area was crop farming. Average annual income from crop farming was highest in Mutoko District (US$4 208.27). This might be attributed to the presence of well-developed irrigation facilities in Chitora compared with other districts. Hence the need to support SHFs with irrigation facilities to improve their livelihoods in vegetable production cannot be overemphasised.

Results of the survey also revealed that the three major field crops grown in the districts were maize, groundnuts and round nuts. Nevertheless, land allocated to field crop production was low with an average of 0.4 hectares. In the same way, quantities of vegetable produced were subdued across all districts. This might be attributed to the El Niño-induced drought which ravaged the country during the 2015/16 agricultural season. Furthermore, findings from the survey revealed that rape, covo and tomatoes were the predominantly grown crops in Seke, Goromonzi and Murehwa Districts. The Mutoko District specialised in production of crops which fetch higher prices on the output market such as carrots, cucumbers and butternuts.

On the other hand, the study has shown that tomato production was constrained with very significant post-harvest losses compared with other vegetables. The major causes of post-

harvest losses across all major vegetables cultivated in the study area were pests and diseases, followed by decay. Largely most of the underlying causes of huge post-harvest losses are within the control of the farmer.

The following chapter discusses smallholder vegetable farmers' preference and selection of post-harvest handling practices based on study objectives that were explained in the introductory chapter.

CHAPTER 7

PREFERENCE AND SELECTION OF POST-HARVEST HANDLING PRACTICES BY SMALLHOLDER VEGETABLE FARMERS

7.0 Introduction

Preference and selection of post-harvest handling practices by SHFs is guided by a number of factors. These include, but are not limited to quantity produced, available infrastructure, market availability and farmers' knowledge (Ruslan et al., 2013). Based on these factors amongst others, farmers might be conditioned to have preferences for certain post-harvest practices. The following sections provide a detailed analysis of SHFs' preferences for post-harvest handling practices. Factors that are likely to influence these preferences and subsequently their selection for actual implementation are discussed.

7.1 Preferred post-harvest handling practices

Table 7.1 below summarises the post-harvest handling practices that were mainly preferred by SHFs in the study area. The results showed that there were variations in preference for post-harvest handling practices by smallholder vegetable farmers across the districts. For example, 48% and 42 % of farmers preferred sun-drying of vegetables in Murehwa and Goromonzi Districts respectively. Packaging was preferred by 50% and 39 % of respondents in Mutoko and Seke Districts in that order. The preference and the thrust to emphasise the need for proper packaging in Mutoko District could be attributed to the high volumes of produce that farmers in this district produced due to presence of irrigation facilities. Hence, proper packaging would be required particularly during transportation of vegetables to the market as well as for the vegetables to be presented in an appealing form to the final consumer. Overall however, packaging was the most preferred post-harvest handling practice, with 36% of farmers mentioning it as their favourite. This reinforces the importance of proper packaging in helping to reduce post-harvest losses and maintaining the level of freshness of vegetables from the farm to the final consumer. These findings confirm earlier observations by Wilson et al., (1995) and Ruslan et al., (2013) that good post-harvest handling practices such as proper harvesting, careful packaging, storage and transportation assist in maintaining the quality of produce. On the contrary, washing of vegetables was the least preferred post-harvest handling practice with

only 8% of farmers mentioning it. In fact, in Seke District, none of the respondents mentioned preference for washing of vegetables. Such a scenario means the final consumer should be aware of the need to wash vegetables particularly leafy vegetables, before consumption, for hygienic purposes. Farmers attributed their failure to wash vegetables to the fact that in most cases, washing of vegetables did not increase their profits in the output market.

Table 7.1**:** Preferred post-harvest handling practices

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Preferred practice	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Sun-drying	28	32.2	53	42.1	41	48.2	25	19.1	147	34.3
Washing	0	0	5	4.0	8	9.4	21	16.0	34	7.9
Packaging	34	39.1	29	23.0	25	29.4	66	50.4	154	35.9
Cooling	14	16.1	17	13.5	2	2.4	5	3.8	38	8.9
Processing	11	12.6	22	17.5	9	10.6	14	10.7	56	13.1
Total	87	100	126	100	85	100	131	100	429[17]	100

Source: Survey Data

Farmers were also clamouring for establishment of processing industries in their areas so that they can reduce post-harvest losses of their vegetables. The responses were highest in Goromonzi district (18%) and overall (13%) of farmers mentioned the need for establishment of such kinds of industries. The preference for sun-drying (34%) as a post-harvest value-adding technique tends to suggest the constrained environment in which SHFs are operating. This is because previous findings from a similar comparable study by Masarirambi et al., (2009) highlighted that sun-drying of vegetables was very unhygienic. It exposes the product to dust contamination, insect infestation and bad weather conditions. According to Mhazo et al., (2012) vegetable processing tends to be informal in the country and they are referred as cottage industries because they operate from residential homes. Drying of vegetables[18] is deemed a good idea in the country as evidenced by surging supplies of dried processed fruits in upmarket towns and tourist resort areas (Mhazo et al., 2012). The importance of dried fruits and vegetables was evidenced by Murehwa Food Processors Association which used to export dried fruits though in small quantities, however they lacked substantive contracts. From the

[17] Deviation from the sample size of 385 is because these were multiple responses.
[18] According to Mhazo *et al*., (2012) drying of fruits and vegetables should take note of the following challenges: poor access to appropriate packaging, low volumes of produce, inadequate processing technology, lack of appropriate training, working capital as well as failure to adhere to hygienic practices and food safety requirements.

foregoing, findings of this study tend to suggest that there is room for upscaling processing of vegetables produced by SHFs and supplying niche upmarkets. In the same way, understanding these preferred post-harvest handling techniques is important as it helps in designing of post-harvest innovations guided by farmer needs. Nonetheless, it is important to note that these preferences are also directed by other factors such as amount of resources of farmers and prevailing marketing conditions. Some of these factors are explained in the following sections based on findings from the study area.

7.2 Factors considered in selection of post-harvest practices

According to Ruslan et al., (2013) there are various factors which can influence selection and implementation of post-harvest practices for fresh vegetables. These are: government policy, resources, market availability, infrastructure, knowledge, and attitude amongst others. Findings from this study showed that the highest responses were target market[19] (23%) in influencing selection of post-harvest handling practices by smallholder vegetable farmers. Seke District with quantity produced (25.6%) was the only one with a different major determining factor in selection of practices. All the other three districts were guided by the target market in selection of their post-harvest practices. These were Goromonzi (27%); Murehwa (24%); and Mutoko (29%) respectively. This revealed that SHFs in the study area are guided by target markets in their decisions to engage in post-harvest practices.

Table 7.2: Factors considered in selection of post-harvest practices

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Considered factor	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Cost of activity	45	20.9	28	15.1	23	13.9	17	11.2	113	15.8
Target market	33	15.3	50	27.0	39	23.6	44	28.9	166	23.2
Vegetable type	22	10.2	30	16.2	29	17.6	15	9.9	96	13.4
Quantity produced	55	25.6	30	16.2	31	18.8	31	20.4	147	20.5
Available labour	7	3.3	10	5.4	9	5.5	25	16.4	51	7.1
Equipment	23	10.7	18	9.7	11	6.7	16	10.5	68	9.5
Knowledge	29	13.5	17	9.2	18	10.9	4	2.6	68	9.5
Infrastructure	1	0.5	2	1.1	5	3.0	0	0	8	1.1
Total	215	100	185	100	165	100	152	100	717	100

Source: Survey Data

[19] Target market the type of market farmers intends to sell their vegetable produce as explained earlier in section 5.7.3

Nevertheless, the quantity of vegetables produced was the second most important factor considered in all the three districts in selection choices of post-harvest practices. The proportions of respondents that attributed the choice of post-harvest practices to quantity produced were as follows: Goromonzi (16%), Murehwa (18.8%) and Mutoko (20.4%). Storage infrastructure was the least important factor considered by SHFs in the selection of post-harvest practices with only 1% of respondents mentioning it. These findings tend to suggest that storage infrastructure was a challenge in the study area. Farmers did not therefore, consider it when engaging in post-harvest techniques. Similar comparable findings were inferred by Ruslan et al., (2013) who noted that proper infrastructure was a very important factor that influences smallholder vegetable farmers' implementation of post-harvest handling practices.

7.3 Reasons for implementing post-harvest practices

Table 7.3 showed the distribution of respondents by the major reasons that drove them to engage in post-harvest practices for value addition. The results showed that SHFs are driven by the profit maximising objective. Therefore, their main reason for adding value across all four (4) districts was for them to get higher prices (38.8%) on the market and improve shelf life. The highest proportion of farmers (49%) who were driven by this objective of higher prices was found in Mutoko District and the least was in Murehwa (33%). The fact that the majority of farmers strove to get higher prices on the market in Mutoko District is not surprising. This is because most of the farmers who were sampled for this study were engaged in irrigation schemes where farming is treated as a serious business.

Table 7.3: Reasons for implementing post-harvest practices

	District								**Overall**	
	Seke		**Goromonzi**		**Murehwa**		**Mutoko**			
Reason	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Improve shelf life	105	36.8	53	31.4	59	41.0	44	27.8	261	34.5
Get higher prices	97	34.0	70	41.4	48	33.3	78	49.4	293	38.8
High demand	83	29.1	46	27.2	37	25.7	36	22.8	202	26.7
Total	**285**	**100**	**169**	**100**	**144**	**100.0**	**158**	**100**	**756**[20]	**100**

Source: Survey Data

The least-considered reason for value addition amongst all districts was demand (26.7%). These findings tend to imply that fresh vegetables that undergo these basic value addition

[20] Deviation from the sample size of 385 is because these were multiple responses

practices fetched higher prices on the market. Furthermore, awareness of farmers on the importance of post-harvest techniques in improving shelf life (34.5%) and subsequently reducing post-harvest losses was reflected.

7.4 Constraints in implementation of post-harvest handling practices

Smallholder vegetable farmers were constrained from properly implementing post-harvest practices which can add value to their products because of several factors. The results in Table 7.4 showed that lack of capital (23%) was the main constraint mentioned by farmers in the study area. However, for Goromonzi District, lack of equipment (26%) was cited as the main factor constraining value addition of vegetables.

Table 7.4: Factors that constrain value addition to vegetables

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Constraint	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Lack of equipment	51	20.3	54	26.1	36	19.8	27	16.5	168	20.9
Lack of knowledge	45	17.9	40	19.3	44	24.2	37	22.6	166	20.6
Lack of capital	60	23.9	42	20.3	45	24.7	35	21.3	182	22.6
Absence of market	45	17.9	41	19.8	38	20.9	36	22.0	160	19.9
Low volume	50	19.9	30	14.5	19	10.4	29	17.7	128	15.9
Total	251	100	207	100	182	100	164	100	804[21]	100

Source: Survey Data

Low volume of produce was also noted as another constraint across all the districts (16%). However, it was a major factor particularly in Seke District (20%). Results from the study findings tend to suggest that capital and proper equipment can assist smallholder vegetable farmers to engage in their preferred value-adding practices. In addition, constraints to value addition were not uniform across all the districts. Hence, interventions targeted at improving value-adding practices should be guided by specific area needs.

[21] Deviation from the sample size of 385 is because these were multiple responses.

7.5 Challenges faced by smallholder farmers in vegetable production

This section attempts to uncover challenges faced by SHFs in vegetable production. More attention was given to the mainly produced vegetables in each district as discussed in section 6.7. Several challenges were reported from the four (4) districts as shown in Table 7.5 below.

The last column in the table provides average percentage share of each challenge as reported by respondents in all the districts. An estimated (32%) of farmers bemoaned the effects of pests and diseases as the major challenge affecting their vegetable production. Pandemic outbreak of pests and diseases coupled with lack of finance to buy the required chemicals was a major challenge according to respondents. Consequently, this also led to high post-harvest losses of vegetables as was discussed in section 6.9. These findings confirm results from previous comparable studies by Proctor et al., 2000 and Musasa et al., (2015) that high prevalence of pests and diseases cause high post-harvest losses and low productivity amongst smallholder horticulture farmers in Zimbabwe. In view of that, findings from this study suggest the need to invest in training farmers on identification and control of pests and diseases as well proper crop rotation methods.

Table 7.5: Challenges faced by smallholder farmers in vegetable production

	District								**Overall**	
	Seke		**Goromonzi**		**Murehwa**		**Mutoko**			
Challenge	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Water	68	24.5	87	34.1	53	22.8	34	17.3	242	25.2
Pests & diseases	88	31.8	76	29.8	79	34.1	66	33.5	309	32.2
Lack of markets	71	25.6	64	25.1	62	26.7	59	29.9	256	26.6
Inputs	50	18.1	28	11.0	38	16.4	38	19.3	154	16.0
Total	**277**	**100**	**255**	**100**	**232**	**100**	**197**	**100**	**961**[22]	**100**

Source: Survey Data

With reference to lack of markets the respondents in Seke (26%), Goromonzi (25%), Murehwa (27%) and Mutoko (30%) respectively cited this as a major challenge in vegetable production. Moreover, 25% of respondents in all the districts mentioned water shortage for irrigation as another major hindrance in vegetable production. Shortage of water was a main issue in districts such as Goromonzi which lacked properly developed irrigation facilities. The situation

[22] Deviation from the sample size of 385 is because these were multiple responses

of water shortage was also exacerbated by the El Niño-induced drought which ravaged the country during the 2015/16 agricultural season. The phenomenon might also be attributed to climate change which greatly reduced SHFs' productivity and profitability in vegetable farming. Farmers reported that they used the bucket system even on very large plots which made it very tedious and inefficient. Respondents also decried inadequate access to inputs as a major cause for concern. As a result, they experienced poor productivity due to lack of inorganic fertilizers, high yielding varieties and chemicals to control pests and diseases. These results suggest that establishment of irrigation facilities as well as provision of inputs to smallholder vegetable farmers might increase their productivity. Again, results pointed out the need to investment in proper post-harvest management being complemented by value-adding technologies can increase productivity in the vegetable value chain.

7.6 Marketing of vegetables by smallholder farmers

This section gives a detailed analysis of smallholder vegetable farmers' market access in the four districts of Mashonaland East Province. The section begins by describing marketing channels that are used by smallholder vegetable farmers, mode of transport used to access these markets and lastly challenges encountered during marketing. The rationale is that these factors as earlier explained have a bearing on preference and subsequently selection choices of SHFs post-harvest handling practices for value addition. Therefore, it is important to have an understanding of these factors in the study area.

Figure 7.1 below showed the various marketing channels used by smallholder vegetable farmers in the four districts of Mashonaland East Province. There were various marketing channels which were being used in these four districts. Seke District was using a wide range of marketing channels from local shops to other nearby surrounding wet markets such as Chikwana and Jambanja[23] as well as Mbare Musika. However, it can be noted that the majority of farmers in Seke preferred to sell their produce in their nearby surrounding markets rather than taking it to Mbare Musika in Harare.

[23] Chikwanha and Jambanja were local wet markets in Seke District.

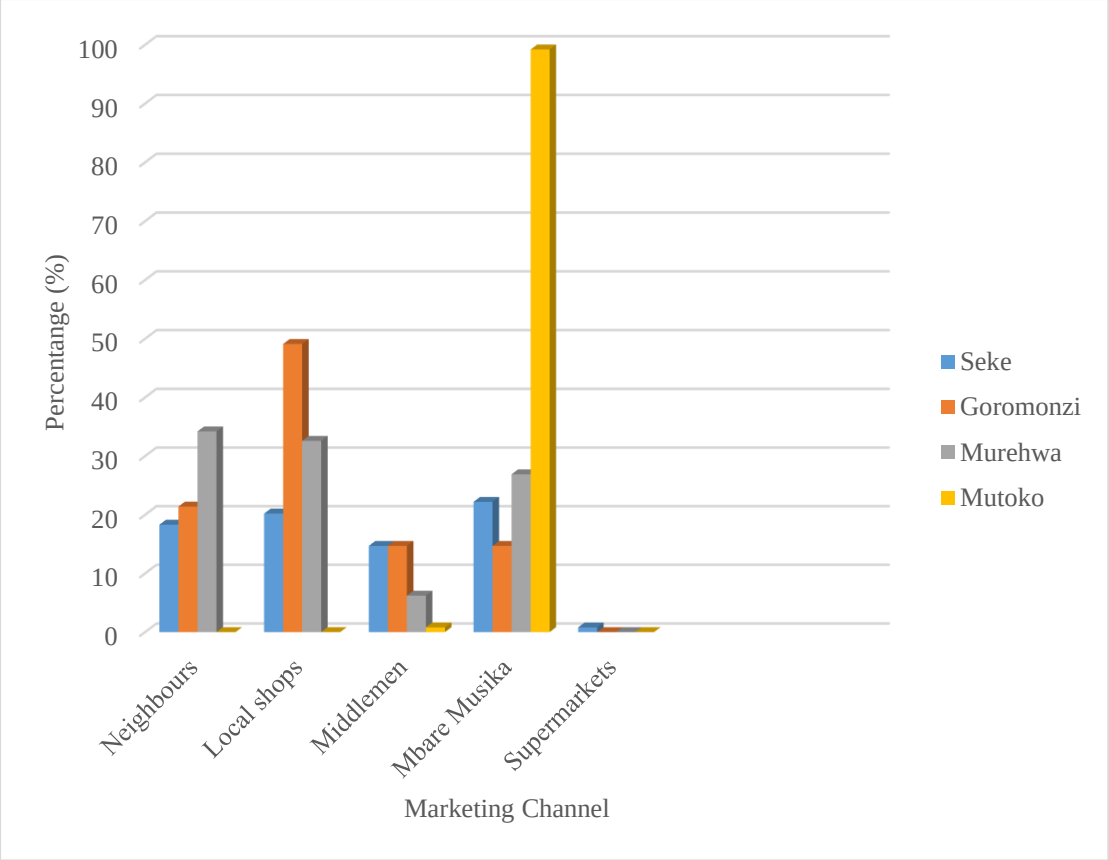

Figure 7.1: Marketing channels used by smallholder vegetable farmers

Source: Survey Data

Farmers clarified that they preferred to use these nearby marketing channels because they did not incur transport costs. Furthermore, they complained about the stiff competition that they face from large-scale producers in bigger markets such as Mbare Musika hence eroding their profits. A similar trend was exhibited in Goromonzi District where the large volumes were sold at local shops such as Domboshava Showgrounds wet market as well as to neighbours at the farm gate. A very small percentage of their produce found its way to Mbare Musika. Nonetheless, it is worth noting that for Seke and Goromonzi Districts, a sizeable percentage of their produce was also sold to middlemen. The same pattern was also noted in Murehwa District where farmers preferred to sell the bulk of their produce in nearby local markets. Conversely, Mutoko district exhibited a different trend where the bulk of the produce was being sold at Mbare Musika in the capital Harare which is located about 160 km away. However, a very small amount was sold directly to middlemen in the area. The possible explanation for this trend is that there were irrigation schemes in Mutoko District which were producing huge volumes. Hence, the local market could not absorb all of the produce. In the two districts of Seke and Murehwa, because the bulk of the produce was being sold locally at the farm gate to

local neighbours, preference and selection of post-harvest handling practices were also guided accordingly. It did not put much pressure on them to engage in practices such as washing as noted in Seke, grading as well as packaging. This was in comparison with their counterparts in Goromonzi and Mutoko Districts where large volumes were produced and traded in competitive wet markets such as Showgrounds and Mbare Musika.

The mode of transport that the farmers used to ferry their produce to the above marketing channels are shown in Figure 7.2 below. The results showed that the most commonly used mode of transport across all the districts varied. In Mutoko District hired vehicles were frequently used as the main mode of transporting produce to the market. This might be attributed to the high volume of produce that farmers were producing in the irrigation schemes, so that they were able to transport the produce to Mbare Musika. The cost[24] of transporting produce using the hired transport varied across the districts also depending on the type of vegetable.

Wheelbarrows were a common mode of transport in Murehwa District, while in Seke District use of public transport was prevalent. The use of wheelbarrows in Murehwa helps to explain the low volume of produce that farmers were transporting to nearby markets. Similarly, regular use of public transport in Seke District presents challenges to farmers such as lack of control over route, efficient movement and timing, a situation that leads to the rapid deterioration in quality of the produce. In Goromonzi District, hired vehicles and scotch carts were the commonly used mode of transport to ferry produce to the market.

[24] For example, farmers in Mutoko reported that they were charged about US$2.50 to hire transport for a 50–70 kg bag of produce (carrots, butternuts, cucumbers), while those in Seke District reported that they were charged US$2 to ferry 10 kg of tomatoes to Mbare Musika and those in Goromonzi District were charged U$1 to transport about 30 kg of tomatoes to Domboshava Showgrounds wet market.

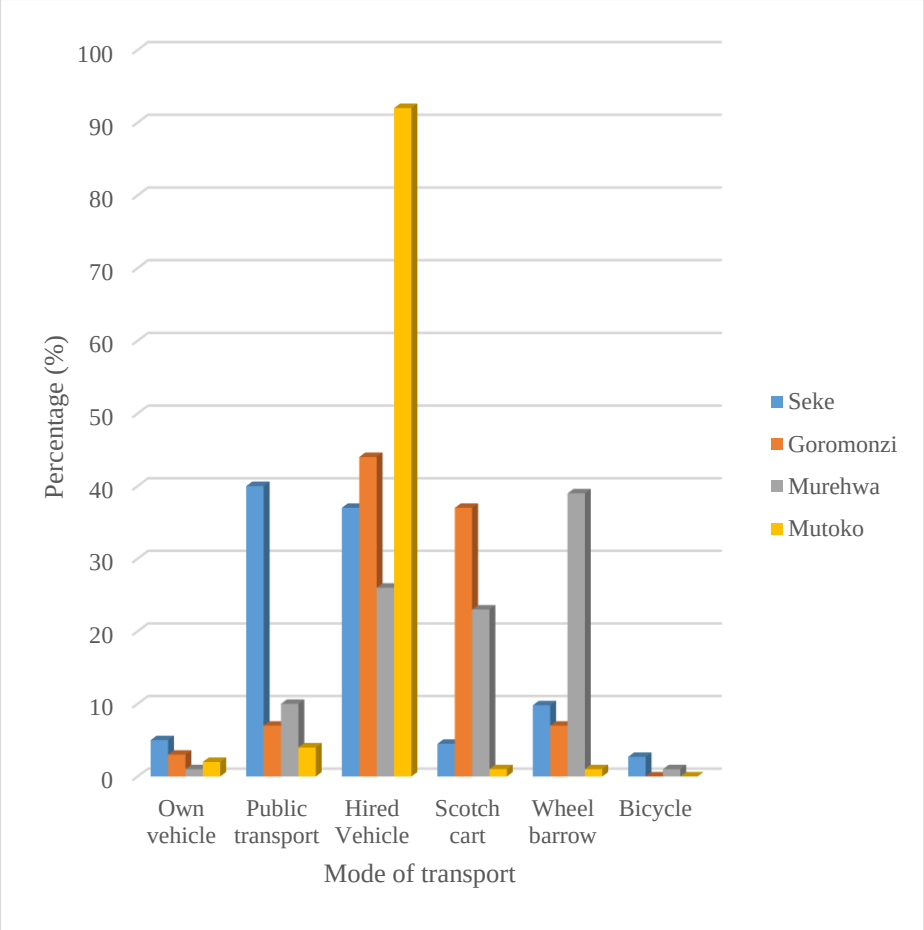

Figure 7.2: Mode of transport used to carry produce to the market

Source: Survey Data

The results also showed that a very small proportion of farmers owned their own transport. Makhura, (2001), highlighted the fact that this lack of own private transport limits farmers from moving around in search of more rewarding markets. On the other hand, the least used mode of transport was bicycle in all the four districts. Therefore, because at times, farmers had to transport their produce to the nearest market, packaging becomes a very vital and preferred post-harvest handling practice as explained earlier in section 7.1.

Group membership of smallholder farmers was also analysed with special attention being given to how marketing decisions and participation in post-harvest handling practices were made. The results showed that a very small proportion of farmers (27.8%) were attached to a farmer group.

Table 7.6: Smallholder vegetable farmers group membership

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Group member	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Yes	5	4.9	30	28.6	4	3.9	68	90.7	107	27.8
No	97	95.1	75	71.4	99	96.1	7	9.3	278	72.2
Group marketing										
Yes	0	0	7	6.7	0	0	3	4	11	2.6
No	102	100	97	93.3	103	100	72	96	374	97.4
Group functions										
Sharing ideas	2	100	18	75.0	4	100	14	14.9	38	30.6
Ploughing	0	0	3	12.5	0	0	0	0	3	2.4
Farmer shows	0	0	1	4.2	0	0	3	3.2	4	3.2
Transport hiring	0	0	2	8.3	0	0	3	3.2	5	4.0
Paying electricity bills	0	0	0	0	0	0	27	28.7	27	21.8
Maintenance of irrigation canals	0	0	0	0	0	0	47	50.0	47	37.9

Source: Survey Data

Likewise, the majority of these farmers were in Mutoko District (90.7%). This scenario might be attributed to the presence of irrigation schemes in Mutoko District. In the other districts of Seke, Goromonzi and Murehwa the proportion of farmers who belonged to farmer groups was almost the same ranging between 4–5% on average. Interestingly, for Mutoko District, despite a large proportion of farmers belonging to a group, only 4% were marketing their produce collectively. The low proportion of farmers who were in groups in the three districts of Seke, Goromonzi and Murehwa were mainly using them to share ideas. It could be inferred from these results that sharing of ideas by farmer groups will also involve implementation of post-harvest handling practices. However, for Mutoko District, the major functions of farmer groups was maintenance of irrigation canals (50%) as well as payment of electricity bills (29%). Thus, it is evident that smallholder vegetable farmers in these three districts preferred to work as individuals rather than in groups. Findings from this study further revealed that even those farmers that were in irrigation schemes such as Chitora prefer to market their output individually rather than working as a group and benefit from economies of scale. Comparable earlier findings by Zivenge and Karavina, (2012) also noted that smallholder vegetable farmers

in Chinamora District[25] prefer to produce and market their output individually rather than as a group. These results may likely reveal mistrust and lack of cooperation amongst smallholder vegetable farmers particularly in the study area. A detailed explanation of the potential benefits of smallholder farmer groups and their challenges was offered in Chapters 2 and 3.

7.7 Marketing challenges faced by smallholder vegetable farmers

Smallholder vegetable farmers in Zimbabwe encounter numerous challenges when marketing their produce. Some of the challenges include but are not limited to pests and diseases, market flooding, poor market infrastructure, price undercutting by middlemen, structural and technological factors.

The major constraints cited by smallholder vegetable farmers across the four districts were middlemen undercutting prices, low prices on the output market, thieves stealing farmers' produce and over-flooding of produce in the market.

Table 7.7: Marketing challenges faced by smallholder vegetable farmers

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Challenge	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Low prices	25	31	33	41.3	35	51.5	9	8.3	107	30.0
Middlemen setting price	53	55	9	11.3	10	14.7	48	44.0	120	33.6
Market flooding of produce	3	6	23	28.8	11	16.2	17	15.6	54	15.1
Transport unavailability	1	1	0	0	0	0	0	0	1	0.3
Thieves	14	16	0	0	9	13.2	35	32.1	57	16.0
Low demand	0	0	15	18.8	3	4.4	0	0	18	5.0

Source: Survey Data

The challenge of middlemen undercutting SHFs' prices was mainly prevalent in Seke and Mutoko Districts. Farmers bemoaned exploitation by middlemen particularly in the informal market of Mbare Musika. Combined with the challenges of low prices and market flooding, in most cases farmers end up just being passive price takers from middlemen greatly reducing their profit margins. Musasa et al., (2015) also noted that poor market access exposes

[25] Chinamora district lies in the Mashonaland East Province of Zimbabwe.

smallholder horticulture farmers to exploitation by middlemen particularly in the informal market. Table 7.7 showed that the challenge of low prices was highest in Murehwa District (51.5%) and Goromonzi (41.3%) followed by Seke (31%) and finally Mutoko (8.3%). The low percentage in Mutoko might be explained by the higher-quality vegetables that they produced which tended to fetch better prices. Moreover, low prices were being caused by farmers supplying the same product simultaneously leading to market gluts. This was more pronounced in the three districts of Seke, Goromonzi and Murehwa because they were supplying conventional leafy vegetables.

Thieves were also causing a menace to farmers by stealing their produce. This was mentioned as a major cause for concern by the following percentages of respondents in Mutoko (32%), Seke (16%) and Murehwa (13%) respectively. This was exacerbated by poor market infrastructure at Mbare Musika and other informal markets where farmers sell their produce in unprotected places. Furthermore, farmers also cited poor market infrastructure at informal markets as exposing them to harsh weather conditions which also compromised the quality of their produce. Findings from this study tend to suggest that value addition might assist SHFs to access alternative markets which offer higher prices such as restaurants and supermarkets. In addition, there is a need to invest in infrastructure improvement in informal markets such as Mbare Musika as well as providing adequate security.

7.8 Market information

Market information is very important in assisting SHFs' decision-making as discussed earlier in section 2.2.5. Farmers are guided by prices, grades and standards amongst other factors that are required in a specific market. The availability of market information is also very vital in determining market channel choice that farmers use. Table 7.7 below showed the main source of market information used by farmers in the study area.

As shown in Table 7.8 below the majority of farmers in the study area received their market information from fellow farmers (35.2%). Farmers also cited that they received market information from extension officers (30.5%). The media was the least-popular source of market information used by farmers across all the four districts. The trend was almost similar for Seke and Goromonzi districts where fellow farmers were the main source of market information, 41.1% and 50.6% respectively. However, Murehwa and Mutoko exhibited a different trend, as

eco-farmer was the main source of market information in these districts at 37.3% and 56.5% respectively.

Table 7.8: Sources of market information

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Source	N	%	N	%	N	%	N	%	N	%
Fellow farmers	39	41.1	45	50.6	16	21.3	21	24.7	121	35.2
Media	15	15.8	4	4.5	11	14.7	0	0	30	8.7
Eco-farmer[26]	7	7.4	5	5.6	28	37.3	48	56.5	88	25.6
Extension officers	34	35.8	35	39.3	20	26.7	16	18.8	105	30.5
Total	95	100	89	100	75	100	85	100	344	100

Source: Survey Data

This might be attributed to the long distances away from Harare in these two districts. Such farmers find it more efficient to subscribe and receive market information from their mobile devices such as cell-phones concerning prevailing prices at Mbare Musika in Harare. Given the challenges of middlemen it can be claimed that farmers in the study area were having challenges in accessing market information. Obtaining timely and accurate market information is crucial as it enables farmers to supply the market with the vegetables of the right quantity and quality. Moreover, it enables farmers to keep abreast of seasonal market gluts, hence they will also be able to make informed production decisions in advance.

7.9 Access to credit by smallholder vegetable farmers

Table 7.9 below showed access to credit by smallholder farmers. The highest proportion of farmers who had access to credit were those in Mutoko District (62.7%) followed by those in Murehwa (12.6%) and a very small percentage (2%) in both Seke and Goromonzi district. Farmers in Mutoko District were able to access credit because of their high productivity as a result of irrigation schemes. Interviews that were conducted with farmers revealed that the majority of those in Seke, Goromonzi and Murehwa did not access credit because of low productivity. Across all the districts, the main source of credit were money lenders (57.8%) followed by commercial banks (28.1%) while a relatively small proportion of farmers borrowed from other farmers (3.1%).

[26] Ecofarmer is used by Econet wireless (one of Zimbabwe's mobile operating companies) to convey farming information to smallholder farmers regarding places they can sell their produce as well as prevailing prices using mobile technology.

Table 7.9: Access to credit by smallholder vegetable farmers

	District								Overall	
	Seke		Goromonzi		Murehwa		Mutoko			
Access to credit	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Yes	2	2.0	2	1.9	13	12.6	47	62.7	64	16.6
No	100	98.0	103	98.1	90	87.4	28	37.3	321	83.4
Reason for credit										
Buy inputs	2	2.0	2	1.9	14	13.6	46	61.3	46	69.7
Source of credit										
Friends	1	1.0	1	1.0	3	2.9	0	0	2	3.1
Money lenders	1	1.0	1	1.0	2	1.9	34	45.3	37	57.8
Commercial bank	0	0	0	0	6	5.8	11	14.7	17	28.1

Source: Survey Data

The main reason that farmers were borrowing across all the four districts was for buying inputs (69.7%). Furthermore, smallholder vegetable farmers were accessing the bulk of their credit from moneylenders and the majority of them were those in Mutoko District. Results of the survey further revealed that on average, farmers particularly those in Mutoko District were borrowing about US$500 from moneylenders. The amount was supposed to be repaid over a period of three months. Based on these findings, it can be inferred that farmers were limited in engaging in post-harvest handling practices because of lack of credit as well as low volume of produce.

7.10 Chapter summary

Smallholder farmers' preferred post-harvest handling practices for value addition were discussed in this chapter. The findings from this study revealed that packaging was the most preferred practice followed by sun-drying. Farmers in the study area were also clamouring for the establishment of processing industries. It is envisaged that this might assist in reducing post-harvest losses as well as create backward and forward linkages in the vegetable supply chain.

Factors that farmers considered in their selecting of post-harvest practices were also analysed. It was shown that the type of market where farmers intended to sell their produce was the most

important deciding factor. Similarly, the need to get higher prices was revealed to be the main reason directing farmers to engage in post-harvest practices for value addition. Moreover, lack of capital was cited by the majority of farmers (22.6%) as the major constraint for them to properly engage in practices of their desired choice. Findings suggest that obtaining credit might assist them in engaging in their desired practices.

Post-harvest losses caused by pests and diseases were noted as the major challenges hindering smallholder vegetable farmers' productivity and ultimately erode their market returns. Hence, the need to invest in training of farmers about identification and control of pests and diseases as well as proper crop rotation methods. On the other hand, transaction costs such as high transport costs were found to discourage farmers from selling their produce in distant markets. The majority of farmers preferred to produce and market their output individually rather than as a group. The only exception was those in Mutoko because of their proximity to irrigation schemes. Nonetheless, even farmers in these schemes were marketing their produce individually rather than as a group. Equally important, farmers cited exploitation by middlemen during marketing of their produce as a major constraint. It is visualised that adding value to their produce through processing might assist farmers to access alternative higher rewarding markets.

The following chapter offers empirical results on factors influencing the number of post-harvest practices adopted by smallholder vegetable farmers based on the objectives that were discussed in the introductory chapter.

CHAPTER 8

FACTORS INFLUENCING NUMBER OF POST-HARVEST PRACTICES ADOPTED BY SMALLHOLDER VEGETABLE FARMERS IN MASHONALAND EAST PROVINCE[27]

8.0 Introduction

Smallholder vegetable production is very vital in the generation of household income in the Mashonaland East Province of Zimbabwe in particular as well as the entire country in general. The pivotal role that smallholder vegetable production plays in improving livelihoods in the province cannot be overemphasised. This is because Mashonaland East Province is regarded as the hub of SHFs' vegetable production and they supply Mbare Musika in the capital city of Harare as explained earlier in Chapters 4 and 5. Despite this, smallholder vegetable farmers suffer huge post-harvest losses which erode their market returns as explained earlier in the literature review chapters. This chapter analyses factors influencing the number of post-harvest practices adopted by smallholder vegetable farmers in the study area for value addition. The survey was conducted on a sample of 385 smallholder vegetable producers in four (4) districts of Mashonaland East Province. Data was entered into STATA 12 and the Poisson count regression model (PCRM) was used to identify the most likely factors for adoption of post-harvest practices for value addition. This chapter presents the research findings based on three major vegetables (rape, covo and tomatoes) which are predominantly grown in the study area as discussed previously in Chapter 6. The following sections discuss the results of the PCRM. Finally, a chapter summary is offered.

8.1 Adoption of post-harvest practices by vegetable farmers

Post-harvest technology is defined as the "*handling, sorting, storage, transportation, marketing, and management of biological products from the moment of harvest until final consumption"* (Studman, 2001 page 109). Adoption of post-harvest practices by smallholder vegetable farmers provides adequate opportunities for farmers to increase their profitability

[27] This chapter has been published in the following Journal:
Mukarumbwa, P., Mushunje, A., Taruvinga, A., Akinyemi, B. and Ngarava, S. (2017), "Factors influencing number of post-harvest practices adopted by smallholder vegetable farmers in Mashonaland East Province of Zimbabwe", *International Journal of Development and Sustainability*, Vol. 6 No. 11, pp. 1774-1790

through raising local value-added products, increasing bargaining power, enhancing market access and promoting greater competition among middlemen (Khatana et al., 1997; Mittal, 2007). The results of this research (Table 8.1) revealed that most smallholder vegetable farmers who were producing rape reported adopting some basic post-harvest practices. Table 8.1 showed that the most prevalent post-harvest technique which was practised by the majority of rape producers was sun-drying which was adopted by 33% of farmers. In the same way, grading/sorting was the second-highest post-harvest technique which was being adopted by 21.9% of farmers. The third most frequently adopted post-harvest technique was washing (cleaning) which was being practised by approximately 16.1% of rape growers. The pattern followed that of covo production with 42.2% of farmers being involved in sun-drying of covo. In the same way, grading was the second-highest post-harvest technique for covo which was adopted by 24.7% of farmers. The third most frequently adopted post-harvest technique was washing (cleaning) which was being practised by about 15.6% of covo growers. Furthermore, packaging was being used by approximately 11.7% of covo producers.

Table 8.1: Adoption of post-harvest practices by vegetable farmers

	Rape		**Covo**		**Tomatoes**	
Post-harvest technique	**N**	**Percentage (%)**	**N**	**Percentage (%)**	**N**	**Percentage (%)**
Washing	45	16.1	24	15.6	12	10.8
Grading	61	21.9	38	24.7	54	48.6
Labelling	5	1.8	0	0	0	0
Sorting	40	14.2	0	0	0	0
Cooling	1	0.4	1	0.6	0	0
Storage	1	0.4	0	0	4	3.6
Packaging	18	6.5	18	11.7	30	27.0
Slicing	16	5.7	8	5.2	0	0
Sun-drying	92	33	65	42.2	11	10
Total	**279**	**100**	**154**	**100**	**111**	**100**

Source: Survey Data

On the other hand, the least common post-harvest techniques were cooling and storage which were both being adopted at equal rates by a negligible 0.4% of farmers for rape production. Similarly, for covo production the least common post-harvest technique was cooling which was being practised by a meagre 0.6% of farmers. These results are in line with the findings of Ali, (2012) who established that smallholder vegetable farmers tend to adopt post-harvest

techniques which are undertaken manually and do not require the use of modern technologies. This is because in most cases, SHFs operate in resource-constrained environments with minimal or non-existent financial investments. There tends to be a decline in use as post-harvest practices become more sophisticated (Ali, 2012).

On the other hand, for tomato production, grading was the most adopted practice with about 48.6% of farmers making use of it. In the same way, packaging was the second-highest post-harvest technique which was being adopted by 27% of tomato farmers. The third most frequently adopted post-harvest technique was washing (cleaning) which was being practised by approximately 10.8% of tomato growers. On the other hand, the least common post-harvest techniques were storage and sun-drying which were adopted by 3.6% and 10% of farmers respectively. These results tend to suggest the high post-harvest losses that smallholder tomato farmers encounter since they lack storage facilities. Furthermore, sun-drying of tomatoes comes across like a measure of last resort to preserve the crop.

8.2 Number of post-harvest techniques adopted by vegetable farmers

Table 8.2 presents the proportion of vegetable farmers adopting a certain number of post-harvest techniques in Mashonaland East Province. The survey offered evidence that about 20.6% of farmers had adopted at least one post-harvest technique for rape production during the 2016 agricultural season. Furthermore, findings of the survey also revealed that 306 (79.48%) of sampled rape farmers in Mashonaland East Province had not adopted any of these post-harvest techniques.

Table 8.2: Proportion of vegetable farmers using identified post-harvest techniques

	Rape		**Covo**		**Tomatoes**	
Number of techniques used	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
0	306	79.48	315	81.82	326	84.68
1	8	2.08	27	7.01	22	5.71
2	15	3.90	16	4.16	27	7.01
3	27	7.01	14	3.64	8	2.08
4	8	2.08	12	3.12	2	0.52
5	7	1.82	1	0.26	0	0
6	6	1.56	0	0	0	0
7	7	1.82	0	0	0	0
8	1	0.26	0	0	0	0
Total	**385**	**100**	**385**	**100**	**385**	**100**

Source: Survey Data

While the majority of rape farmers (92.4%) had adopted at least three or less post-harvest techniques, only 7.6% of these farmers had used four or more post-harvest techniques. Furthermore, three post-harvest techniques was the highest number adopted by 7% of rape farmers. Conversely, only a paltry 0.26% had adopted all eight post-harvest techniques. For covo production about 18.18% of farmers had adopted at least one post-harvest technique while 315 (81.82%) of sampled covo farmers in the study area had not adopted any of these post-harvest techniques.

For tomato production the results of the survey indicate that about 15% of farmers had adopted at least one post-harvest technique during the 2016 agricultural season. On the other hand, 326 (84.68%) of sampled tomato farmers in Mashonaland East Province had not adopted any of these post-harvest techniques. Conversely, only a paltry 0.52% had adopted all four post-harvest techniques for tomato production. These findings imply a meagre adoption rate of these low-cost post-harvest techniques by smallholder vegetable farmers in Mashonaland East Province. Against this background, in the next section the study estimates factors affecting adoption of post-harvest techniques by rape, covo and tomato farmers.

8.3 Factors affecting adoption of post-harvest techniques by vegetable farmers

Analysis of factors influencing number of post-harvest techniques adopted by smallholder vegetable farmers was done using the Poisson count regression model (PCRM) and the Negative binomial model (NBM) as explained in section 5.7. The results of the Poisson count regression model (PCRM) for rape, covo and tomatoes are shown in Table 8.3 below. One assumption of the Poisson count regression model is that the mean and variance of the dependent variable are equal. Therefore, this gives rise to the need for a hypothesis test for over-dispersion using the NBM to determine the most appropriate model to use (Mariano et al., 2012). However, in this instance, both the PCRM and the NBM had the same likelihood ratio, hence the hypothesis that alpha is equal to zero was not rejected. Thus, the estimated coefficients of the PCRM and the NBM are the same. Hence, only the results of the PCRM are discussed since it suits the data best. Furthermore, the likelihood ratio value showed that the model, as a whole, was highly significant (1% level). For rape production 7 out of 12 variables were statistically significant, at least at the 10% level. For covo production, 5 out of 12 variables were statistically significant, and lastly for tomato, only 2 out of 12 variables were statistically significant, at least at the 10% level.

The results of the PCRM revealed that the following variables were significant in influencing the number of post-harvest practices adopted by smallholder rape growers: gender, household size, age, market information, group membership, credit and hired labour. However, with the exception of hired labour and credit the significant variables had very small marginal effects on the number of post-harvest techniques adopted by farmers. Similarly, the significant variables influencing number of post-harvest practices adopted by smallholder covo growers were: gender, education, household size, farming experience and credit. In the same way, the two variables that influenced the number of post-harvest practices adopted by smallholder tomato farmers were: gender and distance to market.

Gender of household head was found to significantly influence number of post-harvest practices adopted by farmers across all three vegetables mainly grown in the study area. It was positive and statistically significant at 10% level for both rape and covo production, while it was positive and significant at 5% level for tomato production. The marginal effect results suggest that female-headed households will adopt one unit more post-harvest practices than their male counterparts. The probable explanation for this is that post-harvest practices mainly adopted in the study area such as washing, drying and grading are associated with female's day to day household activities. For example, drying entails slicing, washing, boiling of the vegetables and eventually drying them on an open surface. Gender roles in the study area dictate that such kinds of activity are mainly undertaken by women. For that reason, males were more likely to refrain from participating in such kinds of basic post-harvest activities. Thus, females adopted these low-cost and uncomplicated post-harvest practices such as grading, washing, drying, etc. in Mashonaland East Province. Similar comparable findings were established by Abdul-Hanan et al. (2014) that there tends to be a positive relationship between gender and adoption of techniques. Females tend to embrace adoption of uncomplicated techniques whilst their male counterparts prefer adoption of more complicated techniques.

Table 8.3: Factors influencing number of post-harvest techniques adopted by smallholder vegetable farmers

	Rape						Covo						Tomatoes					
	Poisson estimates			Marginal effects			Poisson estimates			Marginal effects			Poisson estimates			Marginal effects		
Variables	Coef.	Std. Err.	P>|z|	dy/dx	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|	dy/dx	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|	dy/dx	Std. Err.	P>|z|
Gender	0.7978	0.4772	0.095*	0.0674	0.0442	0.127	1.1765	0.7093	0.097*	0.0514	0.0361	0.154	1.3942	0.5977	0.020**	0.0120	1.8932	0.995
Education	0.0087	0.5690	0.988	0.0007	0.0481	0.988	1.6770	0.8228	0.042**	0.0733	0.0416	0.078*	0.0410	0.6542	0.950	0.0003	0.0560	0.995
Household size	0.4066	0.1295	0.002***	0.0344	0.0134	0.010**	0.2486	0.1432	0.083*	0.0108	0.0085	0.201	-0.0610	0.1382	0.659	-0.0005	0.0828	0.995
Age	0.0588	0.0299	0.049**	0.0049	0.0025	0.050*	-0.0081	0.0304	0.790	-0.0003	0.0013	0.786	-0.0138	0.0276	0.616	-0.0001	0.0188	0.995
Farming experience	-0.0263	0.0233	0.259	-0.0022	0.0020	0.266	0.0672	0.0310	0.030**	0.0029	0.0018	0.109	0.0102	0.0222	0.645	0.0001	0.0139	0.995
Land size	-0.1148	0.2061	0.578	-0.0096	0.0156	0.536	-0.0785	0.2225	0.724	-0.0034	0.0092	0.711	-0.0534	0.0626	0.394	-0.0004	0.0725	0.995
Distance to market	0.0054	0.0096	0.579	0.0004	0.0008	0.592	-0.0074	0.0098	0.454	-0.0003	0.0004	0.446	-0.0277	0.0119	0.020**	-0.0002	0.0377	0.995
Market information	1.6904	0.8112	0.037**	0.1428	0.0711	0.045**	-0.1909	0.7489	0.799	-0.0083	0.0330	0.800	-16.9971	2090.38	0.994	-0.1462	5.0893	0.977
Group membership	-0.4452	0.2227	0.046**	-0.0376	0.0216	0.082*	-0.1728	0.2558	0.499	-0.0075	0.0125	0.547	0.0451	0.2509	0.857	0.0004	0.0613	0.995
Credit	-1.4136	0.7849	0.072*	-0.1194	0.0681	0.080*	-2.1481	1.2261	0.080*	-0.0940	0.0483	0.052*	1.8630	1.1802	0.114	0.0160	2.5297	0.995
Hired labour	-2.4236	0.6712	0.000***	-0.2048	0.0884	0.021**	-1.0492	0.7845	0.181	-0.0459	0.0416	0.270	-0.2047	0.4805	0.6700	-0.0017	0.2779	0.995
Training	0.4379	0.5568	0.431	0.0370	0.0453	0.415	-1.0946	0.8067	0.175	-0.0479	0.0411	0.245	-1.0844	0.8983	0.227	-0.0093	1.4724	0.995
Constant	2.0057	3.2194	0.533				3.2681	3.7367	0.382				17.3837	2090.384	0.993			
N	106						106						106					
LR chi2(12)	48.32						43.32						46.27					
Prob > chi2	0.0000						0.0009						0.0000					
Pseudo R-squared	0.5264						0.5098						0.4896					
Log likelihood	-60.1935						-37.1241						-34.5465					

;;*** denotes significant at 10%, 5% and 1% probability levels respectively*

Source: Survey Data

Educational level proved to be one of the factors that positively influences adoption of post-harvest techniques by smallholder covo farmers. The estimated marginal effect of education shows that the probability of engaging in post-harvest practices for value addition increases by 0.073 in covo production for a 1-year increase in formal schooling. Hence, as expected, farmers with high literacy levels had better information about post-harvest practices in the study area compared to those who were less educated. The implied message is that as education level increases farmers are likely to embrace the importance of engaging in post-harvest practices for value addition. It is envisaged that engaging in these practices is likely to increase income of covo in the output market. In most cases it was old farmers who had attained minimal basic primary education who would rely mainly on their traditional knowledge of post-harvest management and marketing of their vegetables. Such farmers were likely to find it very difficult to deal with unscrupulous middlemen in the output market as well as having proper strategies to deal with post-harvest losses. Similar comparable studies reached the same findings that smallholder vegetable farmers with high education levels have better post-harvest management strategies and interpret market information better (Ali, 2012; Musasa et al., 2015). Further, the results concur with several studies which argue that more-educated farmers have greater probability of adopting techniques compared to their less-educated counterparts (Doss & Morris, 2001; Foltz, 2003).

As expected **household size** increased the number of post-harvest practices adopted by vegetable farmers. Household size coefficient was positive and statistically significant at 1% and at 5% level for rape and covo production respectively. This is because for the majority of SHFs in Mashonaland East Province family labour was the major source of labour since they lacked resources to employ hired labour. Large family sizes in the area therefore made it possible to use labour for post-harvest value-adding practices such as grading, washing and packaging. Furthermore, large household sizes were also able to offer additional labour to farmers during times when there was high competition for labour with other farming activities such as planting, weeding and harvesting of other crops in the study area. This is because the dominant post-harvest practices adopted in the study area such as washing, grading and drying were labour intensive. These findings are consistent with several previous studies which suggest that household size plays a significant role in production and marketing of vegetables by smallholder farmers (Ali, 2012; Bindu & Chigusiwa, 2013; Sebatta et al., 2015). Large

household size minimises costs that might be incurred through hiring labour for undertaking rigorous value-adding activities.

Results of the survey show that **age** was positively associated with adoption of post-harvest practices at 5% significance level for rape production. The rationale is that as the farmer gains more experience with increasing age, they may become more aware of the importance of adopting post-harvest practices in rape production. While on the other hand, young farmers might be lacking experience and appreciation of the importance of the primary post-harvest techniques in rape production. Previous findings by Ramirez and Shultz, (2000) confirm the same finding that age and experience have a positive influence on adoption of technologies. In their study they found that a 53-year-old farmer with 21 years of farming experience was three times more likely to adopt integrated pest-management technologies in Central America in comparison to a 38-year-old farmer with only 10 years of farming experience. These results contradict conventional wisdom where young farmers are expected to be more educated and have better awareness of good post-harvest management techniques specifically and farming practices in general. Nonetheless, in the context of the study area these results are not surprising as shown earlier in section 6.1 that the majority of farmers were old (mean age 50). The youth tend to migrate to urban areas in search of better work opportunities.

The coefficient of **farming experience** was positive and statistically significant at the 5% level for covo production. The positive coefficient for covo production imply that as farmers gain more experience they are more likely to adopt post-harvest practices for value addition. Experienced farmers appreciated the importance of engaging in post-harvest practices for value addition in the output market compared with farmers with less experience. These results are consistent with the findings of Gido et al., (2015) that farming experience positively influences farmers' decision-making. This is based on acquired knowledge from extension services over the years as well as their own personal experiences. It could also be that experienced farmers might have acquired more resources over time. Hence, they might have a higher output of vegetables compared with less-experienced farmers which will eventually compel them to engage in post-harvest practices for value addition. Furthermore, similar comparable results were found by Mutayoba and Ngaruko, (2015) that farmers experience increased quality and quantity of vegetables produced. Additionally, experience gives farmers bargaining power as well as improving their marketing networks. Again, a similar study conducted by Al-Shadiadeh

et al., (2012) showed that farming experience had a positive and statistically significant effect on influencing farmers' decisions to adopt post-harvest practices in vegetable production. Results of this survey may provide evidence for the need to train farmers on post-harvest handling techniques as well as the production of higher-value horticultural crops. To this end, trainings and extension advice can be designed targeting less-experienced farmers for them to adopt post-harvest techniques which can improve their vegetable production and marketing strategies. A detailed explanation of the effect of farming experience on smallholder vegetable farmers' post-harvest management was offered in section 2.2.7.

Distance to the market negatively and significantly influences the adoption of post-harvest techniques by smallholder tomato farmers at the 5% significance level. This means that as distance to the market increases, adoption of post-harvest techniques by smallholder tomato farmers' decreases. The rationale of these findings is that smallholder tomato farmers in the study area get discouraged from adopting post-harvest techniques as market distance increases. This is mainly because when farmers produce low volumes they tend to resort to local markets where grades and standards are not a major requisite as explained earlier in section 7.6. These findings are consistent with comparable earlier studies which suggest that longer distances negatively influence SHFs' participation in formal markets which are mainly located in urban areas and subsequently adoption of techniques (Jari & Fraser, 2009; Siziba et al., 2011; Mariano et al., 2012). Results of this present study tend to suggest that reducing distance to market might improve vegetable production as well as adoption of post-harvest techniques in the study area.

As expected **market information** was positive and statistically significant at the 5% level for rape production. The *a priori* expectation of the variable was measured as explained earlier in section 5.7.1 in the methodology chapter. The result suggests that an increase in access to market information by rape farmers leads to increasing engagement in post-harvest practices for value addition. A probable explanation in this present study is that access to market information may be revealing that basic post-harvesting practices increase farmers' profit for rape in their current marketing channels. Thus, the implied message from these findings is that selling partially value-added rape offers significant profit returns in Mashonaland East Province, hence it is worth venturing into such basic post-harvest techniques. These results are also aligned with findings of the descriptive results as explained earlier in section 7.8. Moreover, these findings are in line with a comparable study by Ali, (2012) which established

that acquiring market information plays a significant role in influencing smallholder vegetable farmers' adoption of post-harvest techniques.

In this study, the coefficient of **group membership** was negative and statistically significant at the 5% level. This implies that group membership had a negative influence on adoption of post-harvest practices for rape farmers compared with those farmers who were working individually. These findings are contrary to those of Abdul-Hanan et al., (2014) who argue that there is a positive influence on technology adoption by farmers who belong to farmer groups compared with those who do not. Similar sentiments are echoed by conventional wisdom in literature that farmers who are group members are more likely to be involved in value-adding practices compared to their individual counterparts (Berem et al., 2010; Orinda, 2013). This is because groups may have better access to credit, equipment, training, technical advice and benefit from collective marketing which individual farmers lack, hence promoting 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 SHFs by introducing innovations to existing value chains or creating entry ways into new markets. Nonetheless, the negative coefficient found in this study is not surprising given the history of failure of farmer groups in Zimbabwe as stated by various scholars (Stringfellow et al., 1997; Masakure & Henson, 2005; Zivenge & Karavina, 2012). Moreover, social cohesion and networking may have revealed to them that value addition to rape is unprofitable compared to those farmers who work individually and use conventional wisdom in thinking that value addition is always profitable. Furthermore, low volumes and ultimate target markets that farmers are able to access impact negatively on them to be able to participate in marketing groups as confirmed earlier by the descriptive results in section 7.6.

Access to credit was significant at the 10% level of significance, for both rape and covo production. It showed a negative influence on the adoption of post-harvest techniques. This is inconsistent with the findings of Mariano et al., (2012) and Abdul-Hanan et al., (2014) who maintain that access to credit is an important factor in the adoption of techniques by SHFs. However, this result is not surprising because only a very small proportion of farmers in the study area had access to credit. Moreover, the majority of them were located in Mutoko District mainly in the irrigation schemes. Besides, the majority of these SHFs in irrigation schemes were producing vegetables such as carrots, butternuts and cucumbers which experience minimal post-harvest losses. Hence, the results tend to suggest that there is an inclination to

move away from conventional leafy vegetables such as covo and rape and switch towards high-value crops with increasing access to credit. Pursuing this further, because credit comes at a cost in the form of interest rates, farmers may have realised that acquiring credit for post-harvest practices of rape and covo may be unprofitable. Therefore, they would rather acquire credit for high-value field crops such as tobacco.

Hired labour had a negative coefficient and was statistically significant at the 1% level of probability for rape production. The negative coefficient of hired labour implies that SHFs find it unprofitable to hire additional labour to engage in post-harvest practices of rape. They just utilise available family labour as confirmed by a positive and statistically significant coefficient of household size. The marginal effects show that as hired labour increases the possibility of adopting post-harvest practices decreases by 0.20. A possible explanation could be that hired labour is channelled to other competing agricultural enterprises rather than post-harvest practices for rape. These findings are also consistent with those of Sebatta et al., (2015) that bigger household sizes supply the required labour for value-adding activities, thus reducing the need for hired labour to undertake post-harvest practices. Furthermore, the low volumes produced do not warrant the use of hired labour as explained earlier in section 6.8.

8.4 Chapter summary

The most frequently adopted post-harvest techniques for rape and covo vegetables was sun-drying. For tomato production, grading (sorting) was the most commonly adopted post-harvest technique for value addition. Findings from the study showed that the majority of SHFs in the study area were not engaged in these basic post-harvest practices for value addition across all three vegetables which were predominantly produced in the study area. For rape production gender, household size, age and market information encouraged adoption of post-harvest practices. On the other hand, market information, group membership, access to credit and hired labour variables were suggesting that it is not worth investing in rape post-harvest value addition possibly as a result of financial gains likely to be realised from their local environment. In the same way, for covo production, gender, education, household size and farming experience encouraged the adoption of post-harvest practices. Nonetheless, the non-availability of credit tends to suggest that engaging in post-harvest practices was not viable. Lastly, for

tomato production only two variables (gender and distance to market) significantly influenced the adoption of post-harvest practices for value addition.

CHAPTER 9

SELECTION OF POST-HARVEST PRACTICES FOR VALUE ADDITION AND MARKET CHANNEL CHOICE OF SMALLHOLDER VEGETABLE FARMERS IN MASHONALAND EAST PROVINCE[28]

9.0 Introduction

This chapter presents the results of objectives 4 and 5 as introduced in Chapter 1 and explained further in Chapter 5 by category of dependent variable. Data which was collected from 385 smallholder vegetable farmers in four (4) districts of Mashonaland East Province was entered into SPSS version 23. The binary logit model was employed to analyse factors that influence smallholder vegetable farmers' decision to select a specific post-harvest practice for value addition. This was based on the three major post-harvest practices which were mainly being adopted by smallholder vegetable farmers' in the study area which were drying, grading and washing for rape, covo and tomato production. Results of factors that influence market channel choice of smallholder vegetable farmers are presented. The multinomial logistic regression model was used to analyse this objective. The results from the multinomial logistic regression model revealed that gender, distance to market, market information, group membership, producer price, value addition, road infrastructure, quantity produced and market infrastructure, influence farmers' participation in lucrative formal markets. Policies that promote group participation of smallholder vegetable farmers (production and marketing) might enable them to access lucrative formal markets.

9.1 Factors that influence farmers' decision to select post-harvest practices

In this study, farmer respondents were asked if they had selected a specific post-harvest practice for value addition or not. The observed yes/no decision in selecting a post-harvest practice for value addition was regarded as a binary choice model outcome as explained earlier in section 5.7 of Chapter 5. The results of the binary logit model are summarised in Table 9.1 below. According to Nour, (2011), R^2 cannot be exactly computed for Logistic Regression, hence a pseudo R^2 was therefore computed. In this study the *Nagelkerke* R^2 was computed as a proxy

[28] This chapter has been published in the following Journal:
Mukarumbwa, P., Mushunje, A., Taruvinga, A., Akinyemi, B. and Ngarava, S. (2017), "Analysis of Factors that Influence Market Channel Choice of Smallholder Vegetable Farmers in Mashonaland East Province of Zimbabwe", *International Journal of Development and Sustainability*, Vol.7 No.2, pp. 734-754.

estimate to R^2 in OLS regression to measure proportion of the variation in the response that is explained by the model (Norusis, 2004). In this study, the *Nagelkerke* R^2 of 0.609, 0.446 and 0.413 was obtained for drying, grading and washing of vegetables respectively. This indicates that more of the variation was explained by the model with an overall prediction percentage of 61, 45 and 41 as shown in Table 9.1 below.

Of the fifteen predictor variables that were fitted into the model, nine (9) had a significant impact on influencing smallholder vegetable farmers' selection choices of post-harvest practices for value addition. The nine (9) variables that were significant were: gender, land size, distance to market, market information, family labour, training, target market, quantity produced and storage facilities. Six (6) variables were not significant: these were education, household size, age, farming experience, credit and group membership.

The variables with negative signs, implied that an increase in either of these variables may lead to a decrease in farmers' selection choice of post-harvest practice (s) for value addition. On the other hand, variables with positive signs mean that an increase in either of these variables may be accompanied with an increase in the farmers' selection choice of post-harvest practice(s) for value addition, as shown in Table 9.1 below.

Drying

The factors that were significant for selection of drying as a post-harvest technique are explained in the section below:

Table 9.1: Factors that influence farmers' decision to select post-harvest practice

	Drying			Grading			Washing		
Variable	B	Sig	Exp (B)	B	Sig	Exp (B)	B	Sig	Exp (B)
Gender	2.220	.019**	9.203	-.300	.476	.741	-.247	.608	.781
Education	-0.642	.367	.526	-.873	.129	.418	-.333	.449	.716
Household size	-1.004	.212	.367	-.387	.318	.679	.080	.856	1.083
Age	-1.004	.289	.366	-.677	.165	.508	-.105	.847	.900
Farming experience	-1.099	.228	.333	-.476	.278	.621	-.949	.047	.387
Land size	1.786	.030**	.168	.627	.096*	.534	1.325	.002***	.266
Distance to market	-2.443	.017**	.087	1.197	.018**	3.309	.844	.110	2.325
Market information	0.815	.321	2.259	.736	.089*	2.087	.825	.094*	2.283
Credit	-17.875	.996	.000	-.049	.947	.952	-.297	.742	.743
Group membership	.095	.931	1.100	.105	.853	1.110	.023	.973	1.023
Family labour	2.427	.027**	11.325	1.700	.000***	5.475	1.811	.002***	6.118
Training	-.467	.528	.627	.631	.031**	.532	.526	.232	1.692
Target Market	1.531	.006***	4.621	1.946	.000***	7.001	1.651	.000***	5.211
Quantity Produced	1.701	.031**	5.477	1.357	.001***	3.886	.481	.295	1.618
Storage facilities	.909	.405	2.483	.969	.087*	2.636	.035	.952	1.035
Constant	-21.981	.997	.000	-4.241	.000***	.014	-3.289	.005***	.037
No. observations	369			369			369		
-2 Log likelihood	74.454			215.400			180.686		
Nagelkerke R^2	0.609			0.446			0.413		
Chi-Square (df = 15)	92.277			112.242			88.987		
Accuracy of prediction; Overall (%)	95			87.5			90.2		

Exp (B) shows the predicted change in odds for a unit increase in the predictor

P< 0.1; p< 0.05 **; p< 0.01****

Source: Survey Data

Gender of household head was found to significantly influence selection of drying as a post-harvest practice for value addition. Results showed that gender positively influenced selection of drying as a post-harvest practice for value addition by smallholder vegetable farmers at the 5% level. Per every unit increase in female-headed households, the results suggested a 9.203 increase in the log odds of engaging in drying of vegetables as a post-harvest practice holding all other independent variables constant. The probable explanation for this is that drying entails processes such as washing, slicing, boiling of the vegetables and eventually drying them on an open surface. Gender roles in the study area dictate that such kinds of activities are mainly undertaken by women. For that reason, males were more likely to refrain from engaging in drying as a post-harvest practice. Furthermore, the stringent hygiene standards which need to be maintained during drying entails that women might find it relatively easier to engage in this process compared with their male counterparts.

Land size

With regards to land size, the results revealed a positive and significant influence on selection of drying as a post-harvest practice. Per every unit increase in land size devoted to vegetable production, the results suggested a 0.168 increase in the log odds of engaging in drying as post-harvest practices holding all other independent variables constant. The possible explanation for this scenario is that farmers with more land would be expected to produce large quantities of vegetables which may not be absorbed by local markets, hence they might end up drying them as a preservation measure for future consumption. This is because drying was regarded as a preservation measure of last resort to curb post-harvest losses since farmers cited that not many buyers were interested in dried vegetables. Thus, the absence of local markets may force farmers to consider drying these large volumes so as to curb spoilage, given the perishable nature of vegetables.

Distance to market

The coefficient of distance to formal market was negative and statistically significant at 5% level for drying of vegetables. This suggested that as distance to market increased farmers were less likely to dry their vegetable to sell in these distant markets mainly because of the low price

associated with dried vegetables against high transport costs to formal markets which are usually located far away in urban areas or towns.

Family labour

With respect to family labour the results revealed a positive and significant influence on farmers' decision to engage in drying as a post-harvest practice for vegetable farming. The results are significant at 5% level. The results indicate that per every unit increase in family labour, there is an increase of 11.325 in the log odds of engaging in drying of vegetables as post-harvest practice holding all other independent variables constant. Family labour is normally treated as "free labour" by most smallholder farmers in Africa. Thus availability of "free labour" promotes smallholder farmers to engage in drying as a post-harvest practice if there is excess volume produced.

Target market

This variable was measured as explained earlier in section 5.7.2. The coefficient of target market was positive and statistically significant at the 1% level in influencing farmers' decision to engage in drying of vegetable as a post-harvest practice. The results of the study reveals that a small proportion of dried vegetables was more likely to be sold in formal markets which were located in urban markets in comparison to local informal markets. This was because in local informal markets most households will have produced and dried their own vegetables hence in most instances there might be no need to buy them.

Quantity produced

Quantity produced was positive and statistically significant at the 5% level for drying as a post-harvest technique. The results indicated that per every unit increase in quantity produced, there was an increase of 5.477 in the log odds of engaging in drying of vegetables as post-harvest practices holding all other independent variables constant. The quantity produced determines available surplus for sale in the output market after meeting household consumption needs for smallholder farmers. Huge volumes force farmers to look for formal markets since household

consumption and local informal markets will have failed to absorb these large quantities. In the case of drying, it could have been that farmers dried excess surplus vegetable to avoid spoilage so that they will consume this at a later time during lean periods when water is scarce for producing fresh vegetables.

Grading

The factors that were significant for selection of grading as a post-harvest technique are explained in the section below.

Land size

With regards to land size, the results revealed a positive significant influence on selection of grading as a post-harvest practice. Per every unit increase in land size devoted to vegetable production, the results suggest a 0.534 increase in the log odds of engaging in grading as a post-harvest practice holding all other independent variables constant. The possible explanation for this scenario is that farmers with more land would be expected to produce large quantities of vegetables which may not be absorbed locally, forcing them to sell some in formal markets which are usually located in urban areas where the issue of grades and standards are a prerequisite. Hence, high volumes as a result of increased scale of production may trigger smallholder vegetable farmers to consider value-adding initiatives dictated by formal markets such as grading in order to obtain a better premium due to stiff completion in these formal markets. However, the results are contrary to those of Ali, (2012) who established a negative relationship between operational farm size and farmers' decision to participate in vegetable post-harvest practices. Ali, (2012) suggested that this may be explained by vegetable farmers with small landholdings being more conscious of engaging in basic post-harvest techniques to enhance their productivity and profitability compared with their counterparts with large land holdings.

Distance to market

The coefficient of distance to market was positive and statistically significant at the 5% level for selection of grading as a post-harvest practice for value addition. Per every unit increase in

distance to the formal markets, the results suggest a 3.309 increase in the log odds of engaging in grading of vegetables as a post-harvest practice holding all other independent variables constant. The plausible explanation is that increase in distance to formal markets increases farmers' marketing costs. Thus far, high-value post-harvest practices like grading will be targeted by farmers for them to be able get premium prices in the output markets. This will also enable them to cover their transport costs. Earlier studies suggest that expertise on grades and standards are crucial for SHFs' participation in distant markets (Jari & Fraser, 2009; Panda & Sreekumar, 2012).

Market information

Market information was measured as explained in section 5.7.2. As expected market information was positive and statistically significant at the 10% level for grading of vegetables as post-harvest practices. The result suggests that an increase in access to market information by smallholder vegetable farmers leads to increase in selection of grading as a post-harvest practice for value addition. Access to market information reveals different markets, market entry requirements and premiums associated with various value-adding initiatives to farmers. The observed association between access to market information and selection of grading and washing as value-adding initiatives suggests the role of market information in revealing signals to farmers on the value additions dictated by the markets. These findings are in line with those of Ali, (2012) that use of information and communication technology (ICT) positively influences smallholder vegetable farmers to engage in post-harvest techniques. This is mainly because access to ICT enhances good decision-making of smallholder vegetable farmers in the output market. The source of SHFs' market information in the study area was also outlined in section 7.8 of the descriptive results.

Family labour

With respect to family labour the results revealed a positive significant influence on farmers' decision to engage in grading as a post-harvest practice. The results are significant at the 1% significance level. The results indicate that per every unit increase in family labour, there is an increase of 5.475 in the log odds of engaging in grading of vegetables as post-harvest practice respectively holding all other independent variables constant. Family labour is normally treated as "free labour" by most SHFs in Africa. Since grading can be labour intensive (that may

significantly reduce farmer's profits if hired labour is used); an increase in "free labour" will promote value-adding initiatives as long as the initiatives are associated with entry to formal markets with premium prices. Comparable previous findings were noted by Sebatta et al., (2015) that availability of family labour influences farmers' engagement in vegetable post-harvest techniques for value addition. This is mainly because family labour reduces costs of undertaking arduous value-adding activities if labour were to be hired.

Training

This variable was measured as explained in section 5.7.2 of the methodology chapter. As expected, access to training was found to have a positive and statistically significant influence on selection of grading as a post-harvest practice with a *p value* of 0.031. The results indicate that per every unit increase in training, there is an increase of 0.532 in the log odds of engaging in grading of vegetables as a post-harvest practice, holding all other independent variables constant. The results imply that, those farmers who had managed to get training had better appreciation of grading as a post-harvest handling technique. The probable explanation is that farmers who might have received training had better post-harvest management strategies. Hence they upheld the issues of grades and standards highly since it gave them a premium in the output market. These results confirm previous findings which confirm the link between farmers receiving training from horticultural support organisations with increased productivity, better post-harvest management and participation in urban markets in Zimbabwe (Bindu & Chigusiwa, 2013). This was mainly because training provides necessary information which enhances post-harvest management and ultimately the productivity of smallholder vegetable farmers.

Target market

The coefficient of target market was positive and statistically significant at the 1% level in influencing smallholder vegetable farmers' decision to engage in grading as a post-harvest practice. The results of the study reveal that vegetables that have undergone grading were more likely to be produced targeting formal markets rather than local informal markets. This is because in formal markets the issue of grades and standards is very crucial compared with local

informal markets. These results are consistent with previous studies which suggest a positive relationship between the type of post-harvest management that farmers engage in and the type of market they are producing for in Zimbabwe (Bindu & Chigusiwa, 2013; Musasa et al., 2015). Additionally, Slamet et al., (2017) also noted that target market influences the type of post-harvest activities that smallholder vegetable farmers choose. Their study amongst smallholder vegetable farmers in Indonesia revealed that farmers who were producing for supermarkets conducted more post-harvest activities compared with those who were producing for traditional marketing channels.

Quantity produced

Quantity produced was positive and statistically significant at the 1% level for grading of vegetables. The results indicate that per every unit increase in quantity produced, there is an increase of 3.886 in the log odds of engaging in grading of vegetables respectively as post-harvest practices holding all other independent variables constant. The quantity produced determines available surplus for sale in the output market after meeting household consumption needs for SHFs. Huge volumes force farmers to look for formal markets since household consumption and local markets will have failed to absorb these large quantities. These findings are in line with previous studies which indicated that quantity produced for vegetables necessitate SHFs to engage in post-harvest management techniques (Musasa et al., 2015; Sebatta et al., 2015). Hence supporting farmers to produce huge volumes can enable them to engage in post-harvest practices and ultimately access lucrative markets.

Storage facilities

This variable was measured as explained in section 5.7.2 of the methodology chapter. Storage facilities were significant (*p-value:* 0.087) and positively influenced participation in grading of vegetables. The results suggest that, for every unit increase in storage facilities there is a 2.636 increase in the log odds of participation in grading of vegetables by households, holding all other independent variables constant. This is because availability of storage facilities improves the shelf life of vegetables. This encourages farmers to search for lucrative markets and possibly also wait for strategic marketing opportunities when there is a shortage on the formal market when prices are high. They act as an incentive for farmers to engage in strategic post-harvest value-adding techniques that offer premium prices. These results are consistent with

previous conclusions which reported a positive association between availability of storage facilities and participation in post-harvest techniques (Kader, 2005; Affognon et al., 2015; Mvumi et al., 2016). This was mainly because the availability of such kinds of infrastructure improves the handling of vegetables given their perishable nature.

Washing

The factors that were significant for selection of washing as a post-harvest technique are explained in the section below:

Land size

With regards to land size, the results revealed a positive and significant influence on washing as a post-harvest practice. Per every unit increase in land size devoted to vegetable production, the results suggest a 0.266 increase in the log odds of engaging in washing of vegetables as a post-harvest practice holding all other independent variables constant. The possible explanation for this scenario was explained earlier in the above section on grading.

Market information

As expected, market information was positive and statistically significant at the 10% level for washing of vegetables as a post-harvest practice. The result suggests that an increase in access to market information by smallholder vegetable farmers leads to an increase in the selection of washing as a post-harvest practice for value addition. Access to market information reveals different markets, market entry requirements and premiums associated with various value-adding initiatives to farmers. The possible explanation was offered in the above section and is also aligned with descriptive results in section 7.1.

Family labour

With respect to family labour the results revealed a positive significant influence on farmers' decision to engage in washing as a post-harvest practice in vegetable farming. The results are significant at the 1% level and indicate that per every unit increase in family labour, there is an increase of 6.118 in the log odds of engaging in washing of vegetables as post-harvest practice

holding all other independent variables constant. The possible explanation in the study area was offered in the above section on grading.

Target market

The coefficient of target market was positive and statistically significant at the 1% level in influencing farmers' decision to engage in washing as a post-harvest practice in vegetable farming. The possible explanation for this outcome was offered in the above section on grading.

9.2 Results of factors that influence market channel choice

This section presents the econometric results of factors that influence market channel choice of smallholder vegetable farmers in the Mashonaland East Province of Zimbabwe. The practical applicability of the multinomial logistic regression model used is summarised in Table 9.2. The results of the statistics imply that, of the cases used to create the model, 159 of the 185 respondents who chose non-market participation were correctly classified (85.9%). Seventy-eight (78) of the 136 respondents who chose the informal markets were correctly classified (60%). Again, 39 of the 53 respondents who chose the formal markets were correctly classified (73.6%). Finally, the classification table suggests that, on average, 75 % of the cases were correctly classified.

Table 9.2: Classification table for factors that influence market channel choice

Classification				
Observed	**Predicted**			
	Non- market participation	**Informal markets**	**Formal markets**	**Percent Correct**
Non-market participation	159	23	3	85.9%
Informal markets	42	78	10	60.0%
Formal markets	10	4	39	73.6%
Overall Percentage	**57.3%**	**28.5%**	**14.1%**	**75.0%**

Source: Survey Data

The multinomial logistic regression results for factors that influence market channel choice of smallholder vegetable farmers are shown in Table 9.3. The dependent variable in the multinomial logistic regression was ordered as follows: 0 = non-market participation; 1 =

households participating in informal markets; 2 = households participating in formal markets[29]. Findings from literature revealed that the redundant category should be used as the reference category (Gujarati, 1992). Hence, non-market participation was used as the reference category in this model. The variables that were discussed in section 5.7.3 were used in the model and their significance was tested. Table 9.3 shows the estimated coefficients (β values) standard error, significance values, and odds ratio of independent variables in the model. The direction of influence of the variable on the logit is shown by the sign of the coefficient. A positive sign of the coefficient implies an increase in the likelihood of a farmer participating in either informal markets or formal markets. Conversely, a negative value of the coefficient shows that a farmer is less likely to consider that alternative.

With regards to the proportion of variance in the dependent variable a Pseudo-R^2 (Nagelkerke's Pseudo-R^2) of 0.683 was obtained in the model as shown in Table 9.3. This implies that more of the variation was explained by the model. The chi-square (χ^2) value was significant at $p< 0.01$ suggesting that the model was a good fit. Hence, the null hypothesis (0 independent variables) is rejected. Thus, the independent variables combined influence marketing channel choice of smallholder vegetable farmers in Mashonaland East Province.

The results, shown in Table 9.3 suggest that distance to market, group membership, adding value, road infrastructure and quantity produced, influence participation in informal markets. On the other hand, gender, distance to market, market information, group membership, producer price, adding value, road infrastructure, quantity produced and market infrastructure influence farmers' participation in formal markets. Hence, of the 16 independent variables used in the model, five (5) variables are statistically significant in informal markets and nine (9) in formal market choices. Table 9.3 shows that the significance of the independent variables differs across categories for all marketing channel choices. The results of the estimated equations of the final multinomial logistic regression model were discussed in terms of the significance and signs on the parameters.

[29] Smallholder vegetable farmers generally use more than one marketing channel choice. See section 3.2 in Chapter 3 as well as descriptive results in Chapter 7. However, in this study there was a negligible number of farmers who were participating in both informal and formal markets hence they were excluded from this analysis.

Table 9.3: Factors that influence market channel choice: MNL results

	Informal markets				Formal markets			
Variable	Coefficient	SE	Significance	Odds Ratio	Coefficient	SE	Significance	Odds Ratio
Gender	0.425	0.361	0.240	1.529	-1.491	0.707	0.035**	0.225
Education	-0.424	0.341	0.215	0.655	-0.395	0.544	0.468	0.674
Household size	0.041	0.320	0.899	1.042	-0.709	0.575	0.218	0.492
Age	-0.328	0.396	0.407	0.720	-0.490	0.658	0.456	0.612
Farming experience	-0.253	0.354	0.475	0.777	-0.731	0.659	0.267	0.481
Distance to market	-0.897	0.390	0.021**	0.408	3.428	0.744	0.000***	30.810
Market information	-0506	0.610	0.407	0.603	0.998	0.345	0.004***	2.714
Credit	0.501	0.570	0.380	1.650	0.234	0881	0.791	1.264
Group membership	1.021	0.435	0.019**	2.775	2.920	0.906	0.001***	18.535
Producer Price	0.041	0.569	0.942	1.042	0.772	0.388	0.047**	0.462
Extension	0.299	0.545	0.584	1.348	-1.859	1.433	0.195	0.156
Family labour	-0.546	0.335	0.103	0.579	0.352	0.552	0.524	1.421
Add Value	-3.035	0.592	0.000***	0.048	3.835	0.779	0.000***	0.022
Road infrastructure	0.784	0.375	0.037**	0.456	1.815	0.674	0.007***	0.163
Quantity produced	2.123	0.456	0.000***	0.120	2.864	.592	0.000***	0.057
Marketing stalls	-1.475	1.124	0.190	0.229	1.476	0.748	0.049**	0.229
Intercept	4.966	1.223	0.000	–	2.630	1.736	0.130	–
a) Base Category	= Non market participation							
b) No. of Observations	= 368							
c) LR chi-square (32)	= 327.588***							
d) Overall Classification %	= 75							
e) Pseudo R -Squared	= 68.3							

Significant at *** 1 percent, ** 5 per cent, * 10 percent

Source: Survey Data

Gender

Model results confirm a negative association between household-head gender and selection of formal market channels. It could mean that in comparison to non-market participation, male-headed households are more likely to choose formal market channels instead of informal markets. This implies that female-headed horticultural households are less likely to select formal market channels in relation to non-market participation compared to their male counterparts. The observed negative relationship between gender and participation in formal markets (-1.491: 0.035) may be explained by the differences in resource endowments critical for formal market access. Male farmers in the study area tend to have a higher probability of having better access to productive resources such as membership in irrigation schemes and ownership of transport which enable them to produce and transport large volumes as well as to meet quality requirements normally a prerequisite for formal markets participation. Therefore, ultimately, they end up having a wide option of marketing channel choices compared with their female counterparts. On the other hand, women may prefer to sell their produce in local markets (neighbouring rural households, local shops and at the farm gate) where there are no transport costs, volumes are low and quality issues are not a prerequisite. This is because they may be constrained to participate in distant formal markets which are usually located in urban areas, due to high transaction costs. Gender of the household head plays a very vital role in determining market access in the study area. Similar findings on how gender differences impact on market access were established by Sikwela(2013) arguing that females are risk averse and are likely to sell their produce at the farm gate. Conversely, males are likely to sell their produce in distant markets which pay better.

Distance to market

Distance to market had a negative sign for informal markets and was statistically significant at the 5% level. These findings are surprising and they tend to suggest that an increase in distance to market reduces the probability of the non-participant group engaging in informal markets and rather opting for formal markets. The results are inconsistent with a *priori* expectations. On the other hand, formal market choice had a positive coefficient and was statistically significant at the 1% level. This result is surprising also given the large value in odds ratios (30.810) showing that farmers are likely to increase their participation in formal markets with

increasing market distance. The results are contrary to findings of previous studies which establishes that distance negatively influences SHFs' participation in markets (Siziba et al., 2011; Alene et al., 2008; Makhura et al., 2002). All these studies have consistently highlighted that as distance to the market increases it discourages SHFs from participating because of resource constraints. Nevertheless, a possible explanation for this scenario is that farmers in villages that had irrigation schemes specifically those in Mutoko were producing high volumes. These could not be absorbed by local markets because they offer low prices in comparison with Mbare Musika in Harare which lies about 160 km from the study area. The premium price that farmers got from distant urban markets such as Mbare Musika would offset transport costs. This was in the face of flooded local markets. This is in line with the findings of the descriptive results as explained in section 7.6. Consequently, SHFs would profit from price differentials between local markets and prevailing prices in distant markets such as Mbare Musika. These findings are however consistent with those of Zamasiya et al., (2014) that SHFs tend to opt for distant markets if local markets are not offering lucrative returns. Thus, the findings of this study emphasise the need for availing vegetable farmers with easy access to markets.

Market information

Access to market information had a positive sign for formal market choices, which is consistent with the *a priori* expectations. The coefficient for market information was significant at the 1% level for formal market choice. This suggests that availability of market information improves participation in formal markets. The odds ratio value of more than one (2.714) explains that farmers are likely to participate in formal markets if information is available to them. Farmers were mainly relying on other farmers to convey market information in the study area as explained in section 7.8. Hence, it is most likely that through word of mouth farmers were communicating to each other pertaining to lucrative urban market channels. Market information enables smallholder vegetable farmers to align their production as well as their marketing systems in tandem with the demands of various formal market channels. Therefore, this reinforces the notion that acquiring of market information enhances SHFs' productivity. These results support previous empirical studies that availability of market information plays an important role in market channel choice of smallholder farmers (Jari & Fraser, 2009; Panda & Sreekumar, 2012; Bindu & Chigusiwa, 2013; Mmbando et al., 2016).

Group membership

With reference to group membership it had a positive sign for both informal and formal market choices, which was in line with the hypothesis. The significance values of 0.019 for the informal market choice and 0.001 for the formal market choice imply that group membership increases participation in these markets. The value of the odds ratio in both informal and formal markets (2.775 and 18.535 respectively) supports the higher probability of the variable influence on both the informal and formal market choice. Therefore, group participation enables SHFs to gain access to markets which they might find difficulty in penetrating individually. The results of the model therefore emphasise the need to upscale group participation of SHFs for them to access markets. These findings are consistent with numerous studies which emphasise the importance of SHFs working collectively to access markets (Markelova et al., 2009; Abdul-Hanan et al., 2014). However, these findings contradict findings of Zivenge and Karavina, (2012) which suggest that smallholder vegetable farmers in groups were less likely to participate in formal markets. The reason for this is that in most cases farmers prefer to market their produce individually rather than as a group given the history of mistrust and lack of cooperation within smallholder farmer groups in Zimbabwe. Nonetheless, this present study challenges that conventional wisdom and recommends group participation of farmers so that they can benefit from economies of scale as well as reduce transaction costs associated with individual participation in markets.

Producer Price

Regarding producer price, the coefficient was positive and significant at the 5% level in formal market channel choice. The significant value (0.047) implies that farmers tend to be guided by producer price for them to participate in formal markets. Farmers tend to receive higher prices in formal markets which are located in urban areas than in informal markets which are mainly found in their nearby surroundings. The value of the odds ratio (0.462) reinforces this observation that producer price influences formal market choice. If SHFs are assured of a good producer price they are willing to travel long distances to access formal markets in urban areas, rather than settling for informal local markets. During the study the respondents cited that local markets may offer very low prices and they might also not be able to absorb the huge volumes that they produced. This was mainly emanating from parts of Mutoko and Goromonzi. Though this may be so, farmers had to possess good negotiation skills for them to be able to get a good

producer price in urban markets. This was due to the issue of middlemen trying to undercut farmers' prices as explained earlier in section 7.6 of the descriptive results. A similar positive relationship between producer price and smallholder vegetable farmers' market channel choice was noted by (Zivenge & Karavina, 2012) attributing the association to lucrative producer prices which are offered in formal markets.

Adding Value

This variable was measured as explained in section 5.7.3 of Chapter 5. Different value-adding practices to the produce by farmers was significant for both informal and formal market choice with a significant value of 0.000 for both. Nonetheless, the coefficient was negative (-3.035) for informal markets and positive (3.835) for formal market choice. A negative sign on its coefficient implies that an improvement in expertise on grades and standards might not result in an increase in informal markets participation. This is consistent with the findings of Poisson count regression model (PCRM) that value-adding of vegetables has minimum relevance in informal markets. Conversely, a positive sign on its coefficient suggests that an improvement in value-adding practices results in an increase in formal market participation choice by smallholder vegetable farmers. The odds ratio value also explains that it is more likely that smallholder vegetable farmers will change from non-market participation to formal market participation with an increase in value-adding practices on their produce. The plausible explanation is that in formal markets there is high emphasis on grades and standards due to stiff competition. Moreover, there was also quality standards competition from imported vegetables coming from South Africa particularly at Mbare Musika which made the issue of grades and standards of paramount importance. Similar comparable findings were also inferred by Jari and Fraser, (2009) and Panda and Sreekumar, (2012) with reference to the effect of value addition by SHFs on market channel choice. Both studies noted that the ability of farmers to add value by different means increases participation in formal markets.

Road infrastructure

This variable was measured as explained in section 5.7.3 of Chapter 5. Road infrastructure had a positive and significant coefficient for both informal markets and formal markets as expected. Both informal and formal markets had significant values of 0.037 and 0.007 respectively. A

positive relationship between the variables confirms the hypothesis that good road conditions have a positive influence on market participation by smallholder vegetable farmers. Smallholder vegetable farmers could consider hiring transport to sell their vegetables to local business centres. The condition of the road would affect their decision to participate in these informal markets which were far off. Likewise, SHFs were prepared to travel long distances for example from Mutoko to urban markets in Harare if roads were in good condition. However, the majority of farmers in the study area were bemoaning the need for feeder roads that link them to nearby local business centres as well as major highways that connect to urban areas to be maintained. They stated that this will minimise spoilage of their vegetables during transportation as well as reduce their effort in accessing marketing centres. Good roads will not only reduce time required to reach the market centres but also vegetables will be delivered fresh and undamaged. Hence, in good condition, vegetables might fetch higher prices on the output market. These results confirm earlier findings by Panda and Sreekumar, (2012) that goad road infrastructure enhances smallholder vegetable farmers' participation in markets. They argued that roads in good condition minimise the transaction costs of smallholder vegetable farmers.

Quantity produced

The coefficient of quantity produced is statistically significant (0.000) and positive for both informal and formal market choice. The positive sign as well as the odd ratio emphasise the importance of quantity produced in determining market participation of farmers in both informal and formal markets. This is because SHFs in the study area, like everywhere else in the country, firstly need to satisfy household consumption requirements before engaging in the decision to participate in markets. Thus, the decision to participate in markets is conditional on surplus quantity being produced. This is consistent with the findings of descriptive analyses as explained earlier in section 7.6. This is where farmers in Mutoko district which is situated about 160 km away from Harare were willing to transport their produce to Mbare Musika because of large quantities produced which could not be absorbed by the local market. These observations support the claims that smallholder vegetable farmers will be willing to travel long distances to business centres or distant urban markets depending on the amount that they have produced.

Marketing stalls

Finally, the results suggest a positive likelihood of choosing urban markets with respect to improvement in market infrastructure like marketing stalls. This variable was measured as explained in section 5.7.3 of Chapter 5. The positive and significant coefficient (0.047) supports the observation that improvements in marketing facilities encourage participation in formal markets. As expected, market infrastructure in good condition positively influences non-participants to choose formal markets. Thus, condition of the market infrastructure where SHFs sell their produce has an effect on their market participation. Similar comparable results were inferred from previous studies that availability of good market infrastructure positively influences SHFs' participation in markets (Jari & Fraser, 2009; Panda & Sreekumar, 2012). Strategies aimed at improving market infrastructure like marketing stalls may therefore positively influence SHFs' participation in these markets.

9.3 Chapter summary

Several messages are suggested from the above results. First, drying of vegetables as a post-harvest practice for value addition may be promoted, mainly targeting women in the study area. This was because women were the ones mainly engaged in this practice in the study area. Generally, vegetable production is deemed a "women crop" in the study area as well as the entire country. Nonetheless, drying of vegetables as a post-harvest technique was found to be less lucrative as distance to the market increases. Despite this, there are opportunities to increase marketing of dried vegetables. This can be done through targeting urban markets. Additionally, introducing solar driers might improve the hygienic conditions under which drying of vegetables is conducted as well as speeding up the drying process.

Secondly, grading of vegetables as a basic post-harvest technique may be enhanced through training of smallholder vegetable farmers. Thus, farmers will be equipped with the necessary skills to manage their post-harvest losses and have more bargaining power with buyers in the output market. However, lack of storage facilities as well as low volume of produce may inhibit the adoption of this technique for post-harvest management. Therefore, the study recommends strategies which are geared towards increasing the volume of produce as well as using innovative low-cost storage facilities for vegetables.

In the same way, washing of vegetables as a post-harvest technique may be enhanced through improving market information as well as targeting lucrative urban markets. Nonetheless, shortage of labour as well as small land sizes might hinder the practice. Therefore, the results of this present study recommend dissemination of information to SHFs about the importance of these basic post-harvest management practices.

The type of market where the farmer intends to sell their produce was found to have a positive effect towards farmers' selection of post-harvest practices. This suggests that once lucrative markets are set as a target market it triggers farmers to engage in post-harvest practices. The implied message is that SHFs should be educated to regard farming as a business. Training in post-harvest management strategies is very critical for smallholder vegetable farmers. This will enable them to minimise post-harvest losses, given the highly perishable nature of horticultural products. Again, such kind of training will enable farmers to improve their grades and standards of the product and ultimately obtain a higher premium in the output market. Training smallholder vegetable farmers in basic record-keeping is also vital. It will enable them to track their productivity and profitability along the vegetable marketing channels. This might be attained through the use of extension information from government, non-governmental organisations and private companies. Forging of private public partnerships to attain this goal might also be very helpful. The results of this present study also tend to suggest that the area cultivated by SHFs influences their decision to engage in post-harvest practices. This is because area operated to a greater extent affects quantity produced. Therefore, for farmers to gain economies of scale they can be encouraged to increase their land area devoted to vegetable production. However, it is worth noting that land size must be complemented by provision of other factors such as irrigation and proper storage facilities. This will enable SHFs to increase their output and also properly engage in post-harvest practices for value addition. Thus, these findings relay a message to government, NGOs as well as to private partners to improve facilities such as storage and irrigation. Moreover, they need to provide training to smallholder vegetable farmers.

The study also analysed factors that influence market channel choice of smallholder vegetable farmers in the Mashonaland East Province of Zimbabwe. Results from the multinomial logistic regression model suggest that distance and value addition negatively influence participation in informal markets. Again, group membership (participation), road infrastructure and quantity produced positively influence SHFs' participation in informal markets. On the other hand,

distance to markets, market information, group membership, producer price, adding value, road infrastructure, quantity produced and condition of marketing facilities positively influence participation in formal markets. Finally, despite horticulture production being deemed a "women crop" the study revealed that males were more likely to participate in lucrative formal markets mainly located in urban areas than their female counterparts. The study therefore recommends the need to empower women with productive resources so that they can also supply markets in urban areas.

Furthermore, the study suggests that an adjustment in each of the significant variables can improve market participation of smallholder vegetable farmers in the study area. It is given that smallholder vegetable farmers cannot compete individually with large-scale producers in the output markets. However, group participation and cooperatives in production and marketing might be beneficial innovations for them. Granted that cooperatives and smallholder farmer groups have had their own challenges in the past, these can be circumvented by coming up with mechanisms that foster trust, commitment and collaboration amongst SHFs. Public Private Partnerships (PPP) can also improve the productive resources of smallholder vegetable farmers particularly water supply through drilling of boreholes. Again, extension can encourage smallholder vegetable farmers to diversify crop production to high-value horticultural crops such as baby marrow, squash and lettuce, rather than focusing solely on conventional leafy vegetables like covo and rape. Thus, findings from this study tend to suggest that concerted efforts from government and NGOs to convey information to farmers about new market opportunities and vegetables is required. In addition, government can support smallholder vegetable farmers by investing in improving road infrastructure. This is urgent particularly with reference to feeder roads that link farmers to major highways. In the same way PPPs geared towards providing irrigation facilities such as the drilling of boreholes are very beneficial. This can assist farmers to produce the large volumes required for them to venture into lucrative markets. Pursuing this further, provision of these productive resources will enable farmers to diversify towards production of vegetables which offer higher premiums in the output market. Formation of an association by farmers in the study area is also recommended as it will enable them to deal with unscrupulous middlemen in the output market.

The following chapter concludes the study by presenting the research summary and conclusions. Furthermore, policy recommendations are also offered based on the study findings that were discussed from preceding chapters, as well as opportunities for future research.

CHAPTER 10

RESEARCH SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

10.0 Introduction

This chapter offers a summary of the main findings of the study. The outline of the chapter is as follows, first the research summary is presented and the main conclusions drawn from the study are discussed. The discussion is centred on the main objectives of the study which were presented in the introductory chapter of this study. This will lead to policy recommendations. Finally, areas of further study in attempting to bridge the gap that currently exists in literature are offered.

10.1 Research summary

The broad objective of this study was to assess smallholder vegetable farmers` preferred post-harvest practices for value addition as well as factors that condition their selection choices, adoption and product market access. The study was conducted in four districts (Seke, Goromonzi, Murehwa and Mutoko) of the Mashonaland East Province in Zimbabwe. Mashonaland East Province was chosen because it is the hub of the country where SHFs produce a wide variety of vegetables for both informal and formal marketing. A total of 385 smallholder vegetable farmers were interviewed across all four districts in the Province. The distribution of respondents was as follows: 102 farmers were sampled from Seke district, 105 from Goromonzi district, 103 from Murehwa district and finally, 75 were drawn from Mutoko district.

Descriptive statistics were employed to analyse the socio-economic and demographic characteristics of households that were sampled in Mashonaland East Province. Age of household head, gender, educational level, household size, farming experience, main sources of income, land ownership, main vegetables produced and main causes of post-harvest losses were some of the statistics that were analysed.

The average age of the farmers varied significantly across districts and it was generally high (average of 50 years). Furthermore, the average household size was about 6 individuals, which

is an indication of a high dependency ratio. The results from this study also showed that the majority of households in the study area were headed by males (68.1%) who had attained some primary education. However, none of the respondents had attained tertiary education. Crop farming, particularly vegetable growing was ranked as the main source of livelihood for the majority of respondents in all the four districts. Average annual income from crop farming was highest in Mutoko district (US$3 208.79). This might be attributed to the presence of irrigation facilities in areas such as Chitora compared with other districts. Hence the need to support SHFs with irrigation facilities to improve their livelihoods in vegetable production cannot be overemphasised. Additionally, findings from the survey revealed that rape, covo and tomatoes were the predominantly grown vegetables in Seke, Goromonzi and Murehwa districts. Conversely, Mutoko district specialised in production of crops which fetch higher prices on the output market such as carrots, cucumbers and butternuts.

The study also revealed that tomato production experiences the highest volumes of post-harvest losses compared with other vegetables. Pursuing this further, the major causes of post-harvest losses across all major vegetables predominantly cultivated in the study area was pests and diseases, followed by decay. However, most of the underlying causes of huge post-harvest losses in the study area were within the control of the farmer.

Smallholder farmers' preferred post-harvest handling practices for value addition were also identified. Findings from this study revealed that packaging was the most preferred practice followed by sun-drying. Other post-harvest practices farmers were engaged in were grading and washing. Farmers in the study area were also clamouring for the establishment of processing industries. It is envisaged that this might assist in reducing post-harvest losses as well as create backward and forward linkages in the vegetable supply chain. Pests and diseases as well as lack of markets were cited as some of the major challenges affecting smallholder vegetable farmers. Equally important, farmers cited exploitation by middlemen (33.6%) during marketing of their produce as a major constraint.

The Poisson count regression model (PCRM) was used to analyse factors influencing number of post-harvest techniques adopted by smallholder vegetable farmers in the study area. The results of the PCRM revealed that the following variables were significant in influencing the number of post-harvest practices adopted by smallholder rape growers: gender, household size, age, market information, group membership, credit and hired labour. Similarly, the significant

variables influencing the number of post-harvest practices adopted by smallholder covo growers were: gender, education, household size, farming experience and credit. Similarly, the two variables that were influencing the number of post-harvest practices adopted by smallholder tomato farmers were found to be: gender and distance to market.

To analyse factors that influence smallholder vegetable farmers' decision to select a specific post-harvest practice for value addition, the binary logit model was employed. This was based on the three major post-harvest practices which were mainly being adopted by smallholder vegetable farmers in the study area which were drying, grading and washing. The results of the binary model showed that nine (9) variables were significant in influencing smallholder vegetable farmers' decision to select post-harvest practices for value addition. These were: gender, land size, distance to market, market information, family labour, training, target market, quantity produced and storage facilities.

The multinomial logit model was used in the study to analyse factors that influence market channel choice of smallholder vegetable farmers in the study area. There were three dependent variables in the model while, the independent variables consisted of different household socio-economic factors, institutional as well as technical factors. The results from the multinomial logistic regression model revealed that distance to market, group membership, adding value, road infrastructure and quantity produced influence participation in informal markets. On the other hand, gender, distance to market, market information, group membership, producer price, adding value, road infrastructure, quantity produced and market infrastructure influence farmers' participation in formal markets.

10.2 Conclusions

Smallholder farmers in the study area still concentrate on production of conventional vegetables such as rape, covo and tomatoes. With the exception of tomatoes, rape and covo do not fetch higher prices on the output market. In view of that, there is a need for farmers to diversify their production to other high-value vegetables which fetch higher prices on the output market. Pests and diseases were identified as the major cause of post-harvest losses in the study area followed by decay. Hence, the study concludes that there is a need to invest in the training of farmers about identification and control of pests and diseases as well as proper

crop rotation methods. Adoption of simple and uncomplicated post-harvest techniques such as drying, washing and grading might also help SHFs to curb post-harvest losses and obtain a higher premium in the output market. Additionally, farmers face a number of challenges when marketing their vegetables such as exploitation by middlemen and market flooding which lead to low producer prices. These challenges need to be addressed if smallholder vegetable production is to become a lucrative business venture. Furthermore, smallholder vegetable farmers are still constrained by several factors for them to participate both in informal markets as well as formal markets.

10.3 Policy recommendations

Pests and diseases, followed by decay were identified as the main causes of post-harvest losses across all major vegetables predominantly cultivated in the study area. Largely most of the underlying causes of huge post-harvest losses are within the control of the farmer. Thus, strategies which enhance post-harvest management can result in a substantial reduction in losses which can increase farmers' income without necessarily expanding land under cultivation. Hence, it is recommended that government and NGOs invest in the training of farmers about identification and control of pests and diseases as well as proper crop rotation methods and other post-harvest management strategies. This might improve awareness of SHFs' causes of post-harvest losses as well as possible ways of mitigating them.

The majority of smallholder vegetable farmers in the study area were concentrating on the production of conventional vegetables such as rape and covo. However, these crops generally fetch very low prices on the output market and have a high risk of frequent seasonal market gluts. There is thus a need for government, working closely with other implementing partners such as NGOs, to support and convey information on diversification of vegetable production and new market opportunities.

Empirical evidence from this study has shown that factors such as land size and quantity produced influence SHFs to select post-harvest practices such as drying, grading and washing. Policymakers and other stakeholders need to provide productive resources such as inputs to improve productivity and ultimately selection of these basic post-harvest management techniques along the vegetable supply chain. Furthermore, establishment of more irrigation

schemes by government and NGOs can go a long way in boosting smallholder vegetable farmers' productivity.

Training of smallholder vegetable farmers on the importance of grading as a basic post-harvest management strategy is encouraged. Such training workshops should be done targeting women, as the results of this study revealed that women are more likely to engage in these activities compared to their male counterparts. Moreover, such trainings should encourage farmers to target lucrative markets. Technical information that emphasises the importance attached by formal markets to grades and standards needs to be communicated. Additionally, policies that disseminate market information on grading and other post-harvest activities are encouraged. This can be attained through the media, extension officers as well as encouraging farmers to register for platforms such as the eco-farmer were they can receive vital farming information.

Concerted efforts through public private partnerships (PPPs) to provide active extension about post-harvest education is required. This will promote adoption of simple, uncomplicated and innovate low-cost technologies particularly by women. Such training should be complemented by providing market information on crops such as rape, covo and tomatoes. Furthermore, agribusiness companies should assist in designing post-harvest technologies that mirror adoption patterns of SHFs. In other words, they have to suit local conditions. Overall such policies will go a long way in reducing smallholder vegetable farmers' post-harvest losses.

Policies aimed at providing resources for improved productivity of vegetable farmers should be gender sensitive. This is because the study findings revealed that despite horticulture production being deemed a "women crop", males were more likely to participate in lucrative markets than their female counterparts. Hence, policies must be implemented directed towards empowering women with productive resources so that they can also supply lucrative markets. This can be attained through the establishment of irrigation schemes as well as offering credit. In that way, quantities of vegetables produced will increase and farmers will diversify to other high-value horticulture crops which fetch more on the output market. Production of huge volumes was found to be one of the prerequisites for SHFs to be able to participate in lucrative markets. In the same way, the need for policies that support SHFs with irrigation facilities cannot be overemphasised also given the changes in climatic conditions.

Group membership was found to have a positive effect on the participation of farmers in both informal and formal markets. Thus, there is need for crafting of appropriate policies and programmes which foster collective action amongst smallholder vegetable farmers. This can be attained through PPPs from various stakeholders such as government and NGOs. They can assist in offering institutional support so that SHFs can participate in lucrative markets. It is recommended that farmers should form partnerships for them to be able to supply alternative markets which are organised such as hospitals, boarding schools and fast food outlets. Such partnerships will also enable them to supply the required volumes and guarantee consistency. Therefore, group participation and cooperatives in production and marketing might be beneficial innovations for smallholder vegetable farmers. Granted that cooperatives and smallholder farmer groups have had their own challenges in the past, these can be circumvented by coming up with mechanisms that foster trust, commitment and collaboration amongst SHFs.

Closely related to the issue of farmer groups, is the need to establish an association of smallholder vegetable farmers. Such associations will be able to prevent exploitation by middlemen during marketing of their produce particularly in urban markets such as Mbare Musika.

Government can also work closely with agro-processing companies to establish rural factories that can process some of the vegetables such as tomatoes into purees and paste. Such initiatives will also go a long way towards strengthening the country's policy of Zim-Asset through value addition and beneficiation.

Finally, there is an urgent need for government to invest in improving road infrastructure, especially feeder roads that link farmers to major highways. This can minimise the transaction costs of smallholder vegetable farmers and they will be able to access distant urban markets more easily.

10.4 Areas for further study

The broad objective of this study was to assess smallholder vegetable farmers` preferred post-harvest practices for value addition as well as factors that condition their selection choices, adoption and product market access in Mashonaland East Province. However, other scholars can also expand the research and investigate post-harvest losses along the marketing value

chain of fruits in other parts of the country such as Manicaland Province. Studies that focus on ways of resuscitating horticulture production for export amongst Zimbabwe's smallholder resettled farmers are vital. This is because prior to the fast track land reform programme the horticulture sector used to contribute an estimated 4.5% to GDP (see Heri, 2006). However, massive negative transformations were encountered after the fast track land reform programme causing the sector to become dysfunctional. Thus, future studies that explore potential ways in which the country's horticulture sector can be resuscitated to produce for export markets are important. Additionally, there is a need for studies that focus on methods that accurately estimate post-harvest losses of SHFs in the country. Currently such studies are limited (Affognon et al., 2015). Studies of that nature will enable policymakers to accurately estimate economic losses encountered by SHFs. Therefore, policies will be crafted which are informed by empirical evidence on ways of curbing SHFs post-harvest losses.

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Appendix 1: Household questionnaire

All information provided will be treated as STRICTLY CONFIDENTIAL and will be used for research purposes only

Questionnaire number…… Ward number……..
Enumerator name…… District name……...
Name of farmer…… Village name ……
Date……..

A. Household Demographic Information				
Household head				
A.1 Sex	Male	1		
	Female	2		
A.2 Marital status	Married	Single	Divorced	Widowed
	1	2	3	4
A.3 Age of household head				
A.4 What is your highest level of education?	1.Primary	2.Secondary	3.Tertiary	4.Other (specify)
A.5 What is your household size?	**Total number**			
A.6 Indicate number of males and females in each age range		Male	Female	Total
	0-15			
	16-45			
	46-65			
	65+			
A.7 How long have you been a fruit and vegetable farmer?				
A.8 What are your sources of income (Rank 1 as the most important and 5 least important)				
	Source	Amount raised per year		Rank
	Crops			
	Livestock			
	Salary/Wages			
	Pension			
	Other (Specify)			

B. Land Ownership and Agricultural Productivity					
B1. How much land do you own (ha)?					
B2. How much land is arable (ha)?					
B3. How much arable did you use last season (ha)?					
B4. Which field crops did you grow last season?					
Crop	Area (ha)	Total produced (kgs)	Consumed (kgs)	Sold (kgs)	Amount (U$)
Maize					
Roundnuts					

Groundnuts					
Sorghum					
Tobacco					
Cotton					
Soya beans					
Millet					
Other (Specify)					

B5. How many of the following livestock species do you own?

Cattle	Goats	Donkeys	Sheep	Chicken	Other (specify)

C. Fruit and Vegetable Production

C1. Which of the following fruits and vegetables do you produce per month?

	Area (ha)	Total produced (kg)	Consumed (kg)	Sold (Kg)	Amount (US$/month)
1.Rape					
2.Tomato					
3.Cabbage					
4.Potatoes					
5.Onions					
6.Mangoes					
7.Bananas					
8.Covo					
9.Carrots					
10.Butternut					
11.Sweet potato					
12.Cucumber					
13.Oranges					
14.Apples					
15.Other (specify)					

C.2 Do you produce any of the above crops under contract? If so specify crop and type of contract

C.3 What is the cause of postharvest losses on fruits and vegetables that you produce?

	Wilting	Mechanical	Over/Under maturity	Pest and diseases	Decay	Rough handling	Delayed marketing	Other (specify)	Estimated Amount Lost (kg)	Estimated Amount Lost (US$)
1.Rape										
2.Tomato										
3.Cabbage										
4.Potatoes										
5.Onions										
8.Covo										
9.Carrots										
10.Butternut										
11.Sweet potato										
12.Cucumber										
13Oranges										
14.Apples										
15.Other (specify)										

C.4 Do you practice any of the following postharvest practices for value addition to your vegetables and fruits?	1.Yes	2. No
C.5 If yes specify postharvest practices and vegetable/fruit type	Type of vegetable/fruit	Quantity of fruit and vegetables
1.Washing		
2.Grading		
3.Labelling		
4. Dehydration		
5.Sorting		
6.Cooling		
7.Storage		
8.Packaging		
9.Slicing		
10.Sun-drying		
11.Juice extraction		
12.Other (Specify)		

C.6 What factors do you consider when selecting postharvest practices for value addition?
1. Cost of activity
2. Target market
3. Fruit/vegetable type
4. Quantity produced
5. Available labour
6. Available equipment
7. Knowledge of value addition practice
8. Availability of storage infrastructure
9. Other (specify)

C.7 What are your reasons for adding value? Mention fruit/vegetable and specify reason				
Fruit/vegetable	Improve shelf life	Get higher prices	Demand from buyers	Other (specify)

C.8 What factors constrain you from adding value to your fruits and vegetables?					
Lack value addition equipment	Knowledge of value addition	Lack of capital	Absence of ready market	Low volume of produce	Others (specify)
C.9 What other challenges do you face in fruit and vegetable production?					
	Water	Pests and disease	Lack of markets	Inputs	Other (Specify)

C.10 What are your preferred value addition initiatives? (State all mentioned)					
1.					
2.					
3.					

D. Awareness and Perceptions towards Postharvest value addition initiatives

In your own opinion rate the following statements on a scale of 1-5 (1= Strongly Disagree, 2= Disagree, 3= Undecided; 4= Agree; 5 = Strongly Agree)	
Value addition practices	
D.1 Washing of fruits and vegetables does not increase income	
D.2 Grading of fruits and vegetables increase income	
D.3 Labelling of fruits and vegetables does not increase income	
D.4 Dehydration of fruits and vegetables increase income	
D.5 Sorting of fruits and vegetables does not increase income	
D.6 Cooling of fruits and vegetables increase income	
D.7 Slicing of fruits and vegetables does not increase income	
D.8 Sun-drying of fruits and vegetables increase income	
D.9 Packaging is not very important for value added fruits and vegetables	
Technological Issues	
D.10 Processing and storage of fruits and vegetables assist in preventing distress sale	
D.11 Poor on-farm storage and infrastructure handling facilities affects the quality of crops	
D.12 Value addition assist in improving shelf life of horticultural crops	
D.13 Possessing necessary value addition skills influence adoption of value addition practices	
D.14 Adopting value addition technologies is not beneficial to my fruit/vegetable business venture	
Economic Issues	
D.15 Value added horticultural produce fetch better and get sold quickly on the market	
D.16 Reducing packaging cost can assist improving processing of produce	
D.17 Postharvest technologies do not enhance profits of farmers or wholesalers	
D.18 Diversity of value added horticulture products improve income	
D.19 Advances in postharvest technologies for preservation and processing enable product availability throughout the year	
D.20 Value addition is a way to solve postharvest losses of fruits and vegetables	
D.21 Self-help groups are important in creating awareness of postharvest value addition initiatives	
D.22 Trainings are not necessary for adoption of postharvest value addition initiatives	

E. Marketing of fruits and vegetables

E.1 Where do you sell your produce?		
	Tick	Specify commodity
Neighbours		
Local shops		
Middlemen		
Mbare Musika		
Supermarkets		
Other (Specify)		

E.2 How far is the nearest market for your products?	km

E.3 What is the condition of the road to the market?	1.Good		2. Poor	
E.4 Why do you use these particular marketing channels? (state reasons)				
1.				
2.				
3.				

E.5 What mode of transport do you use to transport your produce to the market?		
1.Own vehicle		
2.Public transport		
3.Hired vehicle		
4.Scotch cart		
5.Wheel barrows		
6.Bicycle		
7.Other (specify)		

E.6 What packaging do you use to pack fruits and vegetables to the market?		
	Sacks	
	Crates	
	Boxes	
	Plastic bags	
	Other (specify)	

E.7 Do you store some of your harvested fruits and vegetables before marketing them?	Yes		No	

E.8 If yes specify	Crop	Storage method	Storage period

E.9 Do you belong to any farmer group/cooperative?					
	Yes (Specify group)		No		
E.10 Do you market your produce as a group?		Yes		No	
E.11 What are the other functions of the farmer group? (state all mentioned)					
E.12 Do you encounter any problems when marketing your produce		Yes		No	
E.13 If yes please specify					
E.14 Do you receive information about the market for your products?		Yes		No	
E.15 If yes specify source of information					

F. Agricultural Extension

F.1 Do you receive any extension services for fruit and vegetable production?	Yes		No	

F.2 If yes please specify the provider	AREX Officer	
	NGO (specify)	
	Farmer group	
	Other (specify)	
F.3 How often do extension officers visit per year?		
F.4 How do you rate extension service you receive?		
	Very poor	
	Poor	
	Satisfactory	
	Very good	
	Excellent	

G. Credit

G.1 Have you ever acquired credit for production of fruits and vegetables?	Yes		No	
G.2 If yes what was the reason for borrowing?				
	Buy inputs			
	Pesticides			
	Buy value addition equipment			
	Other specify			
G.3 What was the source of credit?				
	Friends			

	Relatives	
	Commercial Bank	
	Product buyers	
	Money lenders	
	Government	
	Local cooperatives	
	Other (Specify)	

G.4 What was the approximate amount which was borrowed?	U$

G.5 What was the tenure of the loan (period of repayment)?	

H. Labour

H.1 Do you have adequate family labour for fruit and vegetable production?	Yes		No	

H.2 If no to H1 which activities do you experience labour shortages?		
	Land preparation	
	Planting	
	Weeding	
	Harvesting	
	Value addition activities (specify)	

H.3 How do you deal with labour shortages?	Hire	
	Other arrangements (specify)	

H.4 How much do you pay your hired labour	US$

I. Training

I.1 Have you ever attended any fruit and vegetable training?	**Yes**		**No**	

NB If the answer to I.1 is no skip to section J.

I.2 If yes who offered the training?		
	NGO (specify)	
	AREX	
	Other (specify)	

I.3 If yes H1 please specify type of training	
Training	**Tick Appropriate**
1.Postharvest handling	
2.Marketing	
3.Pest and disease control	
4.Organic Farming	
5.Irrigation practices	
6.Soil management	
7.Value addition techniques	

8.Book keeping and accounting	
9.Other (specify)	

J. Asset Ownership

J.1 Asset	**Ownership Status**	
	Yes	**No**
1.Plough		
2.Cultivator		
3.Harrow		
4.Knapsack		
5.Water pump		
6.Scotchcart		
7. Other (Specify)		

Thank you!!!

Appendix 2: List of extension agents consulted

Goromonzi District			
Name	Telephone Number	Position	Area
Mrs Mateta	+263775801033	Assistant District Administrator	Goromonzi
Mrs Susan Mujati	+263717906757	Supervisor Agricultural Extension Officer[30]	Domboshava
Mr Guti	+263774040156	District Agricultural Extension Officer[31]	Goromonzi
Mrs Rufaro Charakupa	+263778969110	Extension Officer	Domboshava
Seke District			
Mrs Matinhira		District Agricultural Extension Officer	Seke
Mr Samunda	+263777541465	Assistant District Administrator	Seke
Mrs Diana Mukucha	+263773103630/+263713007439	Extension Officer Ward 2	Seke
Mr Munemo	+263774053648/+263712513234	Supervisor Agricultural Extension Officer	Seke
Mrs Mutandiwa	+263775145833	Supervisor Agricultural Extension Officer	Seke
Mutoko District			
Mr Makonyere	+263779532814	District Agricultural Extension Officer	Mutoko
Mrs Emilda Chidarikire	+2632874	Assistant District Administrator	Mutoko
Mr Solomon Mukwanhiri	+263772818605	Agricultural Extension Officer Ward 25	Mutoko
Murehwa District			
Mr Tichaona Mamhunze	+263773994752	Horticulture Specialist	Murehwa
Mr Douglas Makuvire	+263733059602	District Agricultural Extension Officer	Murehwa
Mrs Mufori	+263736082101	Agronomist	Murehwa
Mr Trymore Mwedzi	+263773644363	Agricultural Extension Officer	Murehwa
Mrs Sipiwe Chimbwanda	+263737492551	Agricultural Extension Officer	Murehwa
Agritex Head Office-Harare			
Mrs Otilia Mabvongwe	+263773416928		Harare
Hilda Manditsvara			Harare

[30] Supervisor Agricultural Extension Officer will be in charge of 3–4 wards
[31] District Agricultural Extension Officer oversees the entire district

Appendix 3: Average conversion measurement of vegetables

Crop	**Measure**		**Kg -Equivalent**
Tomatoes	Small box		3kg
	Standard box	2.5 small boxes	7 kg
	20 L tin	2 standard boxes	15 kg
		5 standard boxes	35 kg
Cucumber	50 kg bag		60 kg
	5 Cucumbers		1 kg
Carrots	Big bundle		5 kg
	Small bundle		1 kg
Butternuts	50 kg bag		60 kg
Sweet Potatoes	Small pocket		10–15 kg
	Large pocket		30kg
Irish Potatoes	20 litres tin		15 kg
Leaf Vegetables	Big bundle		5 kg
King Onion	Bundle		1kg
	Pocket dried		10–15 kg
Shallots	Bundle		3 kg
Cabbage	Small		1kg
	Medium		2.5 kg
	Large		5kg

Source: Survey Data

Appendix 4: Editing certificate

Anne Erikson
Copy Editor, Technical Writer and Indexer

CERTIFICATE OF EDITING

To whom this may concern

This is to certify that I have copy edited the full thesis of

PETER MUKARUMBWA

"Smallholder vegetable farmers' determinants of participation in post-harvest practices and market access: Evidence from Mashonaland East Province of Zimbabwe"

submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

in Agricultural Economics

in the Department of Agricultural Economics and Extension

Faculty of Science and Agriculture

at the
University of Fort Hare

for spelling and grammatical errors

Date: November 2017

M A Erikson
BA (UKZN), BEd (Wits)
Full Member of Professional Editors' Guild
Member of ASAIB (Association of Southern African Indexers and Bibliographers)

Appendix 5: Publications

Mukarumbwa, P., Mushunje, A., Taruvinga, A., Akinyemi, B. and Ngarava, S. (2017), "Factors influencing number of post-harvest practices adopted by smallholder vegetable farmers in Mashonaland East Province of Zimbabwe", *International Journal of Development and Sustainability*, Vol. 6 No. 11, pp. 1774-1790

Mukarumbwa, P., Mushunje, A., Taruvinga, A., Akinyemi, B. and Ngarava, S. (2017), "Analysis of Factors that Influence Market Channel Choice of Smallholder Vegetable Farmers in Mashonaland East Province of Zimbabwe", *International Journal of Development and Sustainability*, Vol.7 No.2, pp. 734-754

Appendix 6: Ethical clearance

University of Fort Hare
Together in Excellence

ETHICAL CLEARANCE CERTIFICATE
REC-270710-028-RA Level 01

Certificate Reference Number:	MUS241SMUK01
Project title:	Determinants of smallholder vegetable farmers' participation in post-harvest practices and market access: Evidence from Mashonaland East Province of Zimbabwe
Nature of Project	PhD in Agricultural Economics
Principal Researcher:	Peter Mukarumbwa
Supervisor:	Prof A Mushunje
Co-supervisor:	Dr A Taruvinga

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

Special conditions: Research that includes children as per the official regulations of the act must take the following into account:

Note: The UREC is aware of the provisions of s71 of the National Health Act 61 of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2013, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
  - Any unethical principal or practices are revealed or suspected
  - Relevant information has been withheld or misrepresented
  - Regulatory changes of whatsoever nature so require
  - The conditions contained in the Certificate have not been adhered to

- Request access to any information or data at any time during the course or after completion of the project.

- In addition to the need to comply with the highest level of ethical conduct principle investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to the Dean of Research's office

The Ethics Committee wished you well in your research.

Yours sincerely

Professor Wilson Akpan
Acting Dean of Research

19 June 2017