A Study of Sweetpotato Postharvest Handling and Marketing in Chiweshe (Mazowe District) in Zimbabwe

A Research Project Submitted to Larenstein University of Applied Sciences in Partial Fulfillment of the Requirements for the Degree of Masters in Agricultural Production Chain Management, specialization Postharvest Technology and Logistics

By

Moudy Mukunyadzi

September 2009

Wageningen
The Netherlands

PERMISSION TO USE

In presenting this research project in partial fulfillment of the requirements for a postgraduate degree, I agree that the library of this University may make it freely available for inspection. I further agree that permission for copying of this research project in any manner, in whole or in part, for scholarly purposes may be granted by Larenstein Director of Research. It is understood that any copying or publication or use of this research project or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University in any scholarly use which may be made of any material in my research project.

Requests for permission to copy or to make other use of material in this research project in whole or part should be addressed to:

Director of Research
Larenstein University of Applied Sciences
Part of Wageningen UR
Director of Research
P.O. Box 411
6708 PG, Wageningen
The Netherlands

ACKNOWLEDGEMENTS

I would like to thank the almighty God for allowing me this opportunity to carry out this study. I would also want to thank Nuffic, without which this study would have been impossible, I am very thankful for the provision of funds.

More thanks to my husband Innocent Shayamano for allowing me to take this course and linking me to the sweetpotato specialist, Sweetpotato specialist Mrs. S Mangena, Sweetpotato researcher Doctor. T. Rukuni, sweetpotato processor Mrs. A. Mutungamiri, Harare municipality market place controllers, sweetpotato traders and Chiweshe farmers for their contribution to the writing of this thesis. I also want to thank my in-laws and my sister Pauline for looking after my son during my absence.

I am very grateful to my Supervisor Mr. Geert Houwers for his commitment in showing me direction in writing this thesis. Without him this report would have not been produced up to this standard. I would also like to extend my sincere thanks to my course coordinator Mr. Robert Baars and all Agriculture Production Chain Management (APCM) staff for the roles they undertake in the whole course.

DEDICATION

This thesis is dedicated to my parents Mr. and Mrs. Mukunyadzi; and my in-laws Mr. and Mrs. Shayamano who always support me in my studies. I am also dedicating this thesis to my loving and caring husband, Innocent Shayamano, for his care and support during my study period, to all my sisters and brother for I wish them to further their studies as I did. Finally I am dedicating my thesis to my lovely son Tanyaradzwanashe Isaka Shayamano whom I deprived of motherly care at his tender age by staying away from him during my study period.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AGRITEX….Agricultural Technical and Extension Services
CIP…….International Potato Centre
DTC-UZ……Development Technology Centre – University of Zimbabwe
FAO……..Food and Agricultural Organisation
NAADS…….National Agriculture Advisory Services (Uganda)
PSC……..Public Service Commission (Zimbabwe)
SARRNET…Southern African Root Crops Research Network
SOSPPA…..Soroti Sweetpotato Producers and Processors Association
USAID……..United States Agency for International Development
UZ…….University of Zimbabwe
ZFU……..Zimbabwe Farmers Union

ABSTRACT

In this thesis research, which was focused on sweetpotato postharvest handling and marketing, it was found that main actors in sweetpotato chain in Chiweshe were farmers, retailers at the market places and vendors who sell in the residential areas. Sweetpotato processing was still at research stage at the time this research was conducted. There were no shops trading in sweetpotatoes. Farmers were selling their sweetpotato at the market places in Mbare and Machipisa in Harare. Sweetpotato marketing still follows a traditional or ad hoc marketing system. Farmers and processor incurs high costs of production as compared to the retailers and vendors. High costs for the processor was attributed to the phase of the products in the product life cycle of marketing. None of the interviewed farmers had knowledge on sweetpotato storage or processing highlighting need for training. Value share analysis indicates that farmers were getting the highest value but the cost and gross margin analysis showed that farmers were also incurring high cost of production, transport and marketing which reduces their gross income. The costs incurred by farmers would be better if Harare municipality reduces its charges of $US6 per day to an amount that is affordable by farmers.

Sweetpotato production levels for irrigation and dryland farmers on equal piece of land were significantly different as proven by the independent variable t-test. The average yield was 10 tonnes per hectare for irrigation farmers and 6 tonnes per hectare for dryland farmers. Differences in yield were attributed to availability of irrigation water which affects storage of planting material and sweetpotato production in the dryland farming system. Farmers in Chiweshe were harvesting their sweetpotato manually by the use of hoes and curing, which provides an opportunity for increased storage life was not practiced in this area. Storage facilities were not available therefore farmers could not store large quantities of sweetpotato. Those who store only store for home consumption. The main reason for not storing was lack of storage facilities, lack of knowledge on storing and staggered harvesting.

Handling procedures for irrigation farmers and dryland farmers differ in the transport systems. Irrigation farmers arrange with their transporters and agree on harvesting date, quantity to be transported and destination market before they harvest their sweetpotato. This arrangement is done to reduce time spend on road. Dryland farmers harvest, package and wait by the road with their bags for any form of transport that comes along.

Dryland farmers take more days (3-7) on road to the market as compared to irrigation farmers who take only one day. Both irrigation and dryland farmers were using plastic woven bags. Irrigation farmers preferred 50kg bags dryland farmers, 90kg bags.

More irrigation farmers prefer selling at Mbare wholesale market. Mbare market place is central to many residential areas therefore more retailers, vendors and consumers buy at Mbare. High number of dryland farmers prefers selling at Machipisa retail market where they will be selling at retail price. There is less congestion of sellers and buyers at Machipisa. Major problems at market place were poor accommodation for farmers, opening and closing time of the market place, congestion of sellers and buyers (for Mbare market) and high municipality fees.

Key words
Sweetpotato, Irrigation, Dryland, Handling and Marketing

Chapter 1: INTRODUCTION

1.1 Sweetpotato

Sweetpotato (*Ipomoea batatas*) is a warm season tropical tuber crop which is globally the second most economically important tuber crop after the potato and is an important food crop in the sub-Saharan Africa (Stathers, Nemanda, Mwaga, Khisa and Kapinga 2005). It has the third greatest production level after cassava and yams and is amongst the widely grown tuber crops in sub-Saharan Africa. Sweetpotato's adaptation to marginal environments, contribution to household's food security, and flexibility in mixed farming systems make it an important livelihood strategy for the small holder farmers (Stathers et al 2005). Sweetpotato takes only a short period to maturity making it possible to produce food in areas with short rainfall seasons.

Sweetpotato has gained popularity in Zimbabwe since the late 1990s. It is widely grown by 85% of small holder farmers (Mutungamiri, Zingoni and Rukuni 2001). Sweetpotato provides a source for food security to both urban and rural population in Zimbabwe. It is consumed as a snack or substitute for bread at breakfast and lunch meals in most urban households. Sweetpotato is consumed either boiled or roasted and in few instances raw (Chivhinge, Rukuni and Mutungamiri 2000).

Farmers face handling and marketing problems of fresh tubers largely due to its bulkiness and high transport costs. Increased marketing is currently limited by lack of alternative uses and processing techniques. Mutungamiri et al (2001) indicated that village or home level processing of sweetpotato is relatively uncommon in Zimbabwe.

Sweetpotato tuber continues to grow until harvesting. Harvesting is done when the tubers have reached desirable marketing size. Most farmers find it very easy to produce sweetpotato although they face difficulties in postharvest handling and marketing. In Zimbabwe, the development of postharvest technologies of sweetpotato is slow. Underground pits and trenches are used to store the sweetpotatoes by most small holder farmers but excessive moisture in the soil may greatly damage tuber quality by aiding decay-producing organisms to enter the tubers. Handling of the sweetpotatoes determines how well they can be marketed. Good handling practices of the sweetpotato will enhance quality and therefore allows the farmers to get a better price at the market. The quality in sweetpotatoes is defined as free from soil, 90% skin intact, no harvest wounds, no soft rot or surface moulds and no insect marks.

In Zimbabwe sweetpotato is still marketed in a spot marketing system. There is some research which is going on at the Development Technology Centre-Univerity of Zimbabwe (DTC-UZ), on sweetpotato processing. The products that are produced by the research include sweetpotato chips, sweetpotato juice, jams, flour and confectionary products.

1.2 Problem

According to the research carried out by International Potato Centre (CIP) on sweetpotato productivity in developing countries, it was found that new food products, small enterprise development and improvements in marketing systems were more important postharvest needs (Fuglie 2007). In Zimbabwe, the department of Agricultural Technical and Extension services (AGRITEX) in the Ministry of Agriculture faces

problems with poor sweetpotato postharvest technology development. This includes poor handling of sweetpotato tubers by the chain actors, poor processing technologies and slow development of the marketing system. Also sweetpotato value addition is lagging behind, the utilization of tubers is still mainly fresh consumption. Postharvest handling of the fresh sweetpotato is a major challenge to sweetpotato farmers in Zimbabwe. Mutandwa and Gadzirai (2006) cited lack of suitable storage facilities and poor handling as major problems that continue to expose small holder farmers to early food shortages and poor market prices. Most farmers still rely on traditional methods of storing sweetpotato (the use of ash, sand, or grass). They only store a small portion and the rest is sold to the retailers or vendors at defined market places. If the farmers store large quantities the sweetpotato end up losing the quality due to poor storage. According to AGRITEX the marketing system of sweetpotato in Chiweshe is not well developed. The marketing system is more traditional as compared to the value chain approach. This means actors in the sweetpotato chain have not yet developed a relationship that strengthens their chain. Measuring, grading and packaging sweetpotato for marketing is still a major challenge to these farmers. The careless postharvest handling, which is common in Zimbabwe often leads to both quantitative and qualitative losses of sweetpotato in Chiweshe.

1.3 Problem statement

Poor sweetpotato postharvest handling and marketing systems for small holder farmers in Chiweshe in Zimbabwe leading to poor quality product and low income is raising concern to AGRITEX.

1.4 Justification

Prior to independence in 1980, in Zimbabwe, sweetpotato was regarded as a women crop and was normally planted at the periphery of the field after maize, tobacco and cotton which were more important. Sweetpotato was only grown as a supplementary crop by women farmers in rural areas. Farmers were mainly relying on maize, tobacco and cotton which were main crops. However due to unstable tobacco prices in Zimbabwe, coupled with anti-smoking campaigns worldwide (FAO 2008), the tobacco industry can not adequately sustain small holder farmers. In addition maize, tobacco, and cotton requires a lot of inputs like fertilizers and chemicals which the farmers can no longer afford considering the unstable economic environment prevailing in the country. These crops also require a lot of water for a better harvest, but with the climatic change, the rainfall has become more unreliable for such crops. Due to these factors, most small holder farmers became very vulnerable to poverty and hunger. These farmers were providing maize for the populations in cities together with the large scale farmers whose production was negatively affected by the land reform program in 2000. Also the large scale farmers were producing wheat for bread which was mainly used for breakfast especially by the urban population.

Faced with this situation the small holder farmers in Chiweshe are shifting their focus to sweetpotato which is less labor requiring and is able to thrive in low rainfall conditions. Sweetpotato has an average yield of 15tonnes/hectare with minimal use of fertilizers (Mutungamiri et al 2001) and does not require expensive herbicides and pesticides that are used for maize, tobacco and cotton. It has become an important crop for food security in Zimbabwe. In both urban and rural populations sweetpotato is used to

substitute wheat bread and maize meal which are scarce due to low production. Considering these facts and problems cited in section 1.2, it has become more important for the researcher to carry out a research on sweetpotato postharvest handling and marketing in Chiweshe in Mazowe district in Zimbabwe.

1.5 Research Objective

To investigate the possibilities of improving sweetpotato postharvest handling and marketing in the small holder production system in Chiweshe in Zimbabwe

1.6 Research Issue

Main Question 1
How is the sweetpotato value chain organized in Chiweshe in Zimbabwe?

Sub questions

1. Who are the chain actors and their roles in sweetpotato value chain?
2. Who are the chain supporters and influencers in sweetpotato value chain?
3. What are the political, economic, social and technological factors affecting sweetpotato chain?
4. What are the value shares for actors in the sweetpotato value chain?
5. How can the sweetpotato chain be improved

Main Question 2
What are the existing ways of postharvest handling and marketing sweetpotato by smallholder farmers?

Sub questions

1. What possible options are available to farmers for handling and marketing sweetpotato?
2. How are the farmers handling their sweetpotato from field to market?
3. What is the farmers' knowledge in sweetpotato storage and processing?
4. What are the quality practices followed by farmers and traders?
5. What causes sweetpotato losses and where are the most losses found?
6. Where and how do the farmers sell their sweetpotato?

1.7. Outline of Thesis

This report is organized into six chapters. Chapter 1 covers an introduction of sweetpotato and its importance in Zimbabwe. Research objective, research problem and two main research questions which are further narrowed to sub questions has been elaborated in this chapter. Chapter 2 covers the background of Zimbabwe and its agricultural sector in relation to food security. Sweetpotato postharvest handling and the concept of value chain was discussed. The chapter ends by indicating the background of AGRITEX in relation to the sweetpotato chain. Chapter 3 deals with the research methodology elaborating the research area, methods of data collection, tools used and the data analysis procedure. Chapter 4 consists of the empirical findings of the research and Chapter 5 covers the discussion of these findings. The report ends with Chapter 6 that formulates the conclusion and recommendations of the study.

Chapter 2: LITERATURE REVIEW

2.1 Zimbabwe and background of its Agriculture.

Zimbabwe is a landlocked country in southern Africa bordered by South Africa to the south, Mozambique to the east, Zambia to the north and Botswana and Namibia to the west. The country has a total area of 390 757 square kilometers and a total population of 12300million people according to 2002 statistics.

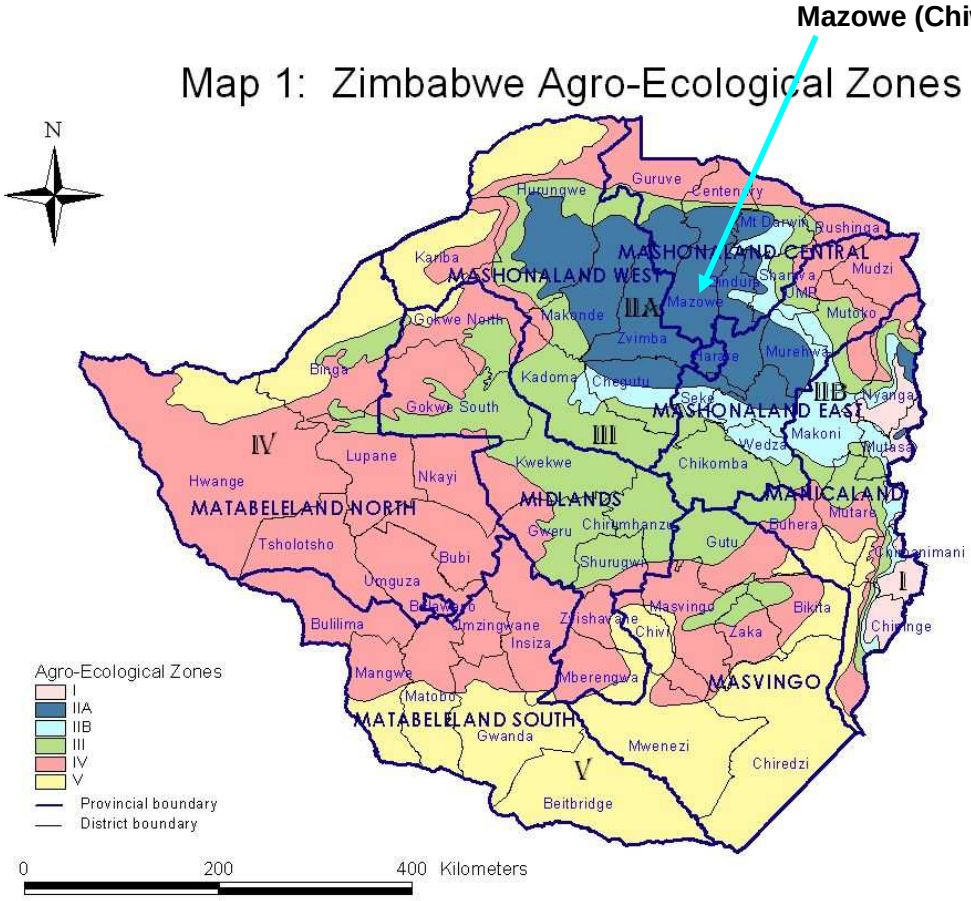

Figure 1: The five natural farming regions of Zimbabwe

Source: FAO report, 2009.

Zimbabwe has been divided into five broad Natural farming Regions (NR) according to climate and soil types with rainfall as the major partitioning factor as shown in Figure 1 and Table 1. Agricultural production patterns depend on these natural regions. The main food crops of the country are maize and wheat. The country produces other cash crops which include tobacco, cotton, soybeans and many other horticultural crops. On the total land area of the country, 8.2 million hectares are under agriculture.

Table 1: Rainfall characteristics in the five Natural Farming Regions of Zimbabwe

Natural Farming Region	Soil type	Area (km^{-2})	Total area (%)	Rainfall ($mm\ yr^{-1}$)	Number of growing days
I	Red clay	7 000	2	>1 050	170-200
II	Sandy loams	58 600	15	700 – 1 050	120-170
III	Sandy, acidic	72 900	18	500 - 700	60-120
IV	Sandy, acidic	147 800	38	450 - 600	60-120
V	Sandy, infertile	104 400	27	<450	50-100

Source: Moyo, 2000

2.1.1 Zimbabwe agriculture and food security

Agricultural sector in Zimbabwe accounts for 15-20% of Gross Domestic Product (GDP). The sector employs 66% of the country's total population with the large number being the smallholder farmers. It generates a large proportion of foreign exchange earnings, but the share of agricultural exports in the country's total exports has come down from 39 percent in 2000 to 13 percent in 2007 (FAO 2009).

Table 2: Crop production (tonnes) trend in Zimbabwe 2000-2007

Year	Maize	Wheat	Sweetpotato	Tobacco	Cotton
2000	2,108,110	250,000	1,600	227,726	327,000
2001	1,466,750	325,000	1,600	195,905	330,000
2002	498,540	160,000	1,600	178,408	200,417
2003	929,619	120,000	1,700	102,683	228,106
2004	1,686,151	122,000	1,700	78,312	364,266
2005	915,366	134,000	1,700	83,230	196,300
2006	1,484,839	144,000	1,700	44,451	207,912
2007	952,600	128,000	1,800	79,000	235,000

Source: FAOSTAT

In 2000, Zimbabwe ranked second on the world tobacco exporters but dropped from second position to fifth position in 2007 (FAO 2008). Cotton, maize and wheat production also dropped from year 2000 as indicated on Table 2 (FAOSTAT). Mashonaland Central (in which Chiweshe is found) and Mashonaland West were the two main tobacco and cotton producing provinces of the country. The drop in main cash and food crop production negatively affected the livelihoods and food security of these provinces as well as the country as a whole. This left many small holder farmers in Mashonaland central choosing to grow sweetpotato which is less labor and input requiring and has the potential to solve the food security problems. From Table 2, the production trend of sweetpotato has been slowly increasing since year 2000. Sweetpotato figures shown in Table 2 are estimates from FAO but the actual production levels might be higher basing on the consumer survey carried out by Mupanda (2002) which showed that in 100 households interviewed, 35 were consuming sweetpotato everyday at the level of 200g/person per day. The average household has six people and the population of Harare and Chitungwiza towns is approximately four million.

2.2 Sweetpotato production in Zimbabwe

Sweetpotato is produced throughout the year. Most varieties grown in Zimbabwe are harvested at 120 days of maturity. According to Mutungamiri et al (2001), varieties grown in Zimbabwe include Brondal (red skinned), Chingovha (Light Khaki skinned), Magutse (Khaki skinned), Cordiner (bronze skin color), and Mozambican white (red skinned). Sweetpotato has an average yield of 15 tonnes per hectare (Mutungamiri et al 2001). According to Chipangura and Jackson (1993) sweetpotato has a yield potential of 60 tonnes per hectare if supplied with correct amounts of fertilizer and irrigation water. High yield is achieved with the use of 1250kg of compound S fertilizer per hectare with all other factors having been considered. The varieties grown in Zimbabwe are shown in Figure 2.

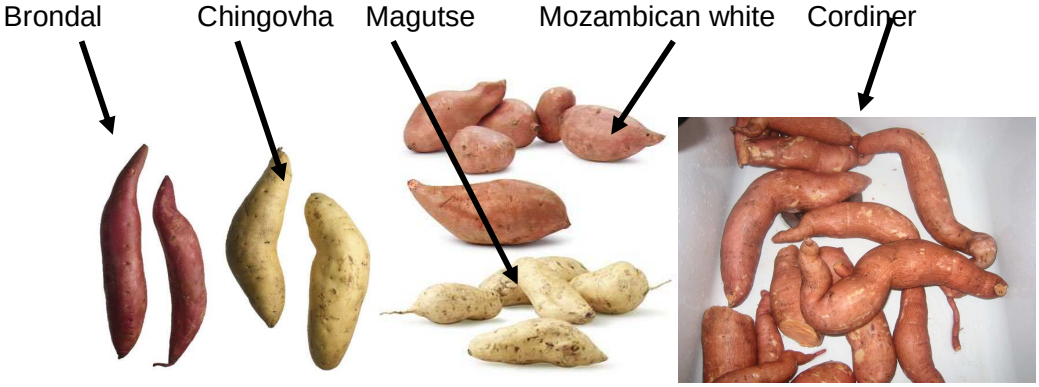

Figure 2: Sweetpotato varieties showing different skin colors

2.2.1 Sweetpotato production areas in Zimbabwe

Sweetpotato production is distributed throughout the country with main production areas found in Mashonaland Central, Mashonaland East, Mashonaland West, Manicaland, Masvingo, and Midlands provinces (Mutandwa and Gadzirai 2006). Major parts of these provinces where sweetpotato is grown fall under Natural Farming Region I, II and III as shown in Figure 1. The rainfall patterns in these places, as described by Manzungu, Senzanje and Van Der Zaag (1999) are shown on Table 1. Sweetpotatoes generally do well in loamy soils and light clays that allow for easy growth of the tubers. Ideal temperatures for production range from 18-27C.

Natural Farming Region I is characterized by rainfall of roughly 1050 mm per annum and relatively low temperatures of 16-24^{o}C. It has the rich fertile red clay soils. Natural Farming Region I covers most parts of Manicaland province, and areas in this agro-ecological zone include Mutare and Chipinge.

Natural Farming Region II receives 700mm-1050mm of rain per annum, mainly confined to summer (from November to April). It is further divided into two sub regions known as IIA and IIB according to the reliability of rainfall. IIA is colored dark blue on the map (Figure 1) whereas IIB is colored light blue. Soils found in Natural Farming Region II are sandy loams which are more suitable for farming. Temperatures range between 18^{o}C-27^{o}C. This Natural Farming Region covers part of Mashonaland Central, Mashonaland East, Mashonaland West, and Manicaland Provinces. Areas such as Mazowe (where Chiweshe is found - area of study), Bindura, Marondera, Chinhoyi, Chegutu, and Rusape are part of Natural Region II.

Natural Farming Region III has rainfall of 500mm-700mm per annum. This Natural Farming Region has sand and acidic soils which require more liming to neutralize the pH for crop production. This Natural Farming Region has very cold winters and hot summers. Temperatures range from 10^{o}C-27^{o}C. Natural Farming Region III generally spans across the Midlands province.

Natural Farming Region IV has rainfall amount and soil characteristics that are nearly similar to Natural Farming Region III (450mm-600mm and acidic sand soils). The main difference is that rainfall in Natural Farming Region IV is more erratic and less reliable as compared to that of Natural Farming Region III. This Natural farming region covers mostly Matebeleland provinces and some part of Mashonaland central.

Region Framing Region V is the driest and hottest Natural Farming Region in Zimbabwe, with a maximum Temperature of 40^{o}C. It is less suitable for farming.

2.3 Sweetpotato postharvest handling

Sweetpotato postharvest handling involves several steps to maintain the quality good. Handling sweetpotato involves some Critical Control Points (Lunning, Marcelis and Jongen 2006), that need to be watched carefully to avoid unnecessary losses. According to Dhliwayo-Chiunzi (2004) these Critical Control Points include harvesting, curing, washing, environmental control in storage and transportation.

2.3.1 Pre – Harvest conditions of sweetpotato

Sweetpotato tubers develop to marketable size in 90 to 150 days after transplanting (Stathers et al 2005). Sampling can be done by digging up a few representative plants and determine size grades (Figure 3). Maturity can also be assessed by cutting tubers in the field and observing the color of the latex exudation which turns black in immature tubers and remain creamy-white in mature tubers (Mutandwa and Gadzirai 2006).

Figure 3: Sampling sweetpotato size for marketing

Normally, harvest begins when most of the tubers have reached the desirable size to maximize on the market prices. Figure 3 shows the different market sizes. Market grade differs with the market supplied; with most consumers preferring the medium (3-5cm diameter) grade as shown on two large heaps in the middle on the picture showing white sweetpotatoes. The red sweetpotato shows three different grades that are large (5-9cm

diameter) on the left, small (less than 3cm diameter) in the middle and medium on the right side of the picture.

In harvest systems where the vines would be used for other purposes like animal feed or where the vines could disturb the harvesting process, the vines are cut immediately before harvest. Vine killing in hot, wet weather and/or in poorly drained soils may result in anaerobic conditions and subsequent souring of tubers either in the ground or in storage (Edmunds, Boyette, Clark, Ferin, Smith and Holmes 2003); therefore tubers should not be left in the ground for long periods after the vines are killed.

In very dry soil, the tuber periderm or outer layer of skin becomes more fragile and easily abraded or 'skinned' on the hard soil clods during harvest. Sweetpotatoes do not have a thick protective outer layer of cells such as that on Irish potato tubers. Any abrasion can lead to rots in storage. Skinning injury in dry soil can be avoided either by waiting for rain or by irrigating the field before harvest.

Skinned areas can become dark and sunken and surrounded by a narrow brown border. These scars offer opportunities for storage rot pathogens such as Fusarium to enter the tuber (Brooke, Michael, Christopher, Donald, Tara and Gerald 2003) Curing tubers (section 2.3.4) after harvest allows the periderm to reform, reducing subsequent storage damage. Skinning also takes place in packing and shipping to markets so packing lines should be designed to reduce injury.

2.3.2 Harvesting

According to Brooke et al (2003) sweetpotatoes can be harvested either manually or mechanically. Mechanical harvesting may result in high levels of mechanical damage, the level of which depends on the depth of the digger, the speed of the tractor and the soil conditions. Whether harvested mechanically or by hand, transport from the field to the packing facility is best carried out using field crates, as sacks result in rubbing of the surface skin and build-up of disease organisms. To harvest sweetpotato; the field is usually ploughed with a modified disk or moldboard plough with a spiral attachment. Tubers are then hand picked and graded in the field. Sweetpotatoes can also be dug by a chain digger or a riding harvester which conveys the tubers to a sorting crew using a harvest aide. Potato harvesters are sometimes used to harvest sweetpotatoes but damage is usually unacceptably high. Mechanical harvesting is mainly practiced in developed countries and is different for developing countries including Zimbabwe where the harvesting of sweetpotato is done by digging using hoes or ox-drawn plough. Regardless of the method used to dig sweetpotato, after digging the tubers are hand picked and graded in the field to remove damaged tubers.

Mechanical damage during harvest can become a serious problem, as injuries predispose produce to decay, increased water loss and increased respiratory and ethylene production rates leading to quick deterioration (Katinoja and Kader 2004). In general, harvesting by machine will cause more damage than harvesting by hand, although some careless digging can cause alarming damage to the tubers.

At harvesting extra care is taken to minimize tuber injuries as these will provide potential entrance for infection especially when washing the tubers. The sweetpotato skin is very delicate and can be bruised by soil clogs if harvesting is done when the soil is very dry. Before curing, sweetpotato should be handled as little as possible to prevent cutting, skinning, and bruising. When loading into the harvesting or storage bins, they should not

be overfilled otherwise the sweetpotato will be exposed to compression which will damage tubers and they can decay in a few days in storage. The containers used for collecting the tubers after digging should be clean, have smooth inside surfaces and be free of rough edges. The tubers must also not be exposed to the sun for more than an hour or so after digging because of sunscald damage. Scalded areas turn purplish-brown and are more susceptible to storage rots. If the field is big and there is no enough man power to quickly transport the sweetpotato to the storage house before it is affected by sun, it is recommended to put them under shed in the field. To prevent infection by disease-producing organisms, the tubers should be brought to storage immediately after harvesting and cured.

2.3.3 Picking

During picking sorting is done to separate injured tubers from the good ones to avoid damaged tubers entering into storage. The damaged tubers are more susceptible to pest and disease attack especially the soft rot fungal disease therefore, if left unsorted; the damaged tubers can be a source of infection to the adjacent undamaged tubers in storage. Tubers showing the signs of soft rot disease are screened out so that they do not enter into storage (Dhliwayo-Chiunze 2004). During picking the bins should not be overloaded as this will expose the tubers to compression stress and injuries when the bins are loaded into the transport vehicles.

2.3.4 Curing

According to Brooke et al (2003), curing sweetpotatoes, by allowing the external layers of tissue to dry out, prior to handling and storage helps to protect the sweetpotatoes from decay and further water loss. The idea of curing was supported by Katinoja and Kader (2004) who argued that curing root crops such as sweetpotatoes is an important practice if these crops are to be stored for any length of time. Curing allows the periderm to thicken and to reform (wound healing).

Curing is done to increase storage life thereby enhancing proper and profitable marketing. It should be done soon after harvesting before the disease organisms finds their way into the tubers. Curing should be done before washing because cured tubers are less injured at washing. Curing also converts some starches to sugars thus enhancing flavor. If the curing temperature and relative humidity are lower than recommended, healing is slower and less effective in preventing subsequent decay in storage or marketing. Sweetpotatoes for curing should be exposed to temperature of 30-32^{o}C and Relative Humidity of 90-95% for 4 to 7 days after harvesting (Katinoja and Kader 2004). Curing after harvest is mostly important especially for sweetpotatoes that are harvested during or after a period of cold weather. Enough ventilation should be provided during curing to prevent accumulation of carbon dioxide, depletion of oxygen, or condensation of moisture.

In developed countries curing of sweetpotatoes is done in warehouses where temperatures and relative humidity can be easily controlled. In most developing countries where sweetpotato is produced by small holder farmers, curing is done in the open field due to lack of well developed warehouses and electricity to operate the warehouses. According to Katinoja and Kader (2004), sweetpotato, and other tropical tuber crops can be cured outdoors if piled in a partially shaded area. The curing process can be accomplished by the use of cut grasses or straw which is used as insulating material against the excess heat from the sun. The pile should be covered with jute

sacks or woven grass mats (Figure 4). This covering will trap self-generated heat and moisture to create required temperature and relative humidity for curing. The pile should be left covered for four to seven days as is done when curing is done in a warehouse.

After curing, the temperature should be reduced to storage temperature (Kader 2002), usually by ventilating the storage with outside air. Temperatures for piled sweetpotatoes can be reduced by taking the tubers to a storage structure which can be underground pit or other storage structures shaded with grass thatching and provided with enough ventilation. The relative humidity should remain at 85% to 90% during storage. Most cured cultivars will keep satisfactorily for 4 to 7 months under these conditions. Storage at relative humidity above 90% is not recommended because of the possible development of surface discoloration and surface mold on the tubers (Poincelot 2004).

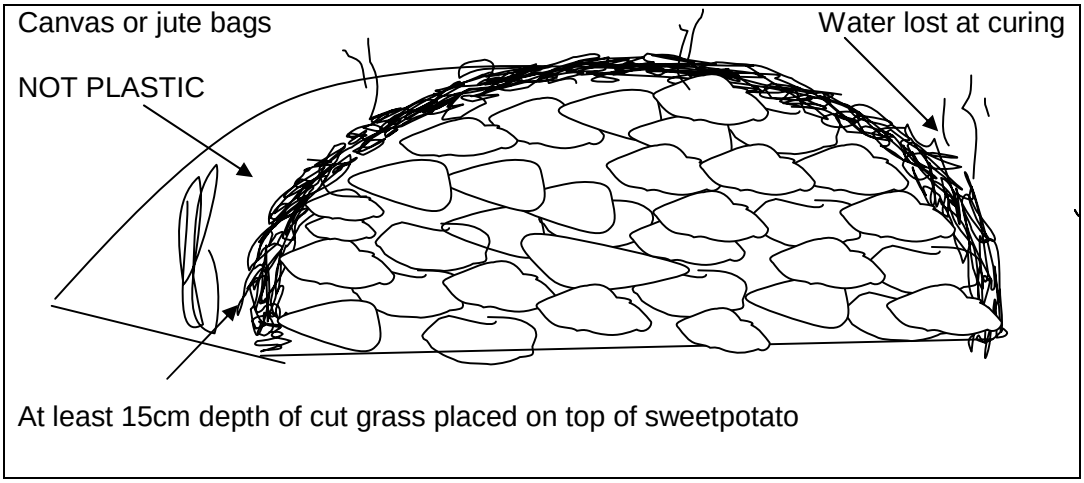

Figure 4: Cut-away view of sweetpotato curing

Source: Modified from; Katinoja and Kader, 2004

2.3.5 Storage

In Sub-Saharan Africa, many sweetpotato farmers do not routinely store fresh sweetpotato tubers, but leave them in the ground, until they are required, (Stathers et al 2005). The tubers become more prone to attack by insect pests, diseases and rodents as they stay long in the field. However, it is very possible to store fresh tubers successfully in specially constructed pits or mounds. Losses can be kept low in these storage structures by the use of pit liners like grass, sand and ashes (Mutatndwa and Gadzirai 2006). According to Mutandwa (2008), sweetpotato can remain relatively fresh in these storage structures for three to six months. Storing sweetpotato has many benefits to the farmers. The farmers can harvest the tubers as soon as they mature for intensive land use. Storing the tubers enables the farmers' family to eat fresh sweetpotato for a longer period after harvesting. Another advantage is that the stored sweetpotato can be sold at high price when the supply is low on the market.

On the other hand, according to Stathers et al (2005), there are some problems associated with storing sweetpotato. The problems include the fact that the sweetpotato tubers are tender and lose quality after harvest due to water and weight loss during storage. This will affect the texture and taste of the sweetpotato. Some loses can occur due to pest and disease attack as well as the development of off-flavors in storage.

Another problem is that sweetpotato tubers are bulky therefore require relatively large storage structures and this might not be economic.

In contrast to Stathers et al (2005)'s point of storage structures being not economic, Soroti farmers proved that sweetpotato warehousing can be useful. Soroti farmers through Soroti Sweetpotato Producers and Processors Association (SOSPPA) in Soroti district in Uganda managed to develop a warehouse where farmers can store and process their sweetpotato. SOSPPA is a farmers association which was formed with the help of National Agriculture Adivisory Servises (NAADS). The warehouse is used to store and process sweetpotato thus reducing cost of transporting the bulky sweetpotato to the market in towns. Through this warehouse system, Soroti farmers are able to access bank loans from Stanbic and Centenary banks (Zeblon 2007).

2.3.5 Washing sweetpotatoes

One reason why farmers often receive low prices for sweetpotatoes is that they have used improper methods of growing, handling, and marketing (Mupanda 2002). Careful grading, cleaning, and packing the product and putting it on the market when there is a good demand means better prices. When sweetpotatoes are to be marketed they must be carefully washed and graded. Washing is a very critical stage with the potential of contaminating the tubers if care is not taken. This might lead to health hazards due to decay and food spoilage. Prior to marketing, the sweetpotato tubers from the storage should be washed to remove soil on the surface of the tubers and increase attractiveness to consumers. Care should be taken not to make fresh wounds such as broken ends because of the danger soft rot infection. Prolonged washing may induce water soaked appearance; and moisture penetration may aid pathogen access through wounds and tuber ends (Edmunds et al 2003). Effectiveness of washing depends on water quality that is acidity, hardness, mineral content temperature and microbial count (Edmunds et al 2003). It also depends on the amount of water used, force applied, whether brushing or rubbing is used, and the time taken to replace dirty water.

2.3.6 Packaging sweetpotatoes for marketing

Throughout the entire handling system, packaging can be both an aid and a hindrance to obtaining maximum storage life and quality. Packages need to be vented yet be sturdy enough to prevent collapse. If sweetpotato is packed for ease of handling, waxed cartons, wooden crates or rigid plastic containers are preferable to bags or open baskets, since bags and open baskets provide no protection to the produce when stacked (Katinoja and Kader 2004). Sometimes locally constructed containers can be strengthened or lined to provide added protection to the sweetpotato tubers. Waxed cartons, wooden crates and plastic containers, while more expensive, are cost effective when used for the domestic market.

The containers mentioned in the above paragraph are reusable and can stand up well to the high relative humidity found in the storage environment. Adding a simple cardboard liner to a crate will make it less likely to cause abrasion to produce. Containers should not be filled either too loosely too tightly for best results. Loose products may vibrate against others and cause bruising, while over-packing results in compression bruising.

Sacks are often used to package sweetpotato in developing countries, since they tend to be inexpensive and readily available (Stathers et al 2005). None of the types of sacks available are good for protecting fresh sweetpotato, and they should be avoided

whenever possible. Sacks only help to easy handling especially when transporting sweetpotato from the field to the storage place or when transporting to the market.

Sweetpotato packages should be labeled with necessary information as this helps handlers to keep track of the produce as it moves through the postharvest system. Important information that should be shown on the labels of sweetpotato packages include common name of the product, net weight, place of origin, name and address of the packer or shipper. Quality attributes like size and grade should also appear on the label.

2.4 Marketing

There are two main marketing systems that are used by farmers to get their products to their consumers. These are Traditional Marketing Systems and Value Chain Approach.

2.4.1 Traditional Marketing Systems

In the Traditional Marketing system (Figure 5), farmers produce commodities that are "pushed" into the market (Research Into Use 2007). Farmers are usually isolated from the consumers of their products. KIT and IRRI (2008) described this marketing system as an ad hoc system or a spot market where farmers produce without knowing the consumers of their products. They usually have little or no control over input costs and prices of their produce. This definition excludes instances where farmers sell their produce at their local markets where there is a direct link from farmer to consumer.

Products may often be sold into a crowded market where competition is high. The farmers are largely isolated from the consumer, and from the demands and preferences of consumers. Research and Development normally focus on production and on reducing costs of production, and may not take account of other steps, links, or dependencies in the chain (e.g. environmental or social costs).

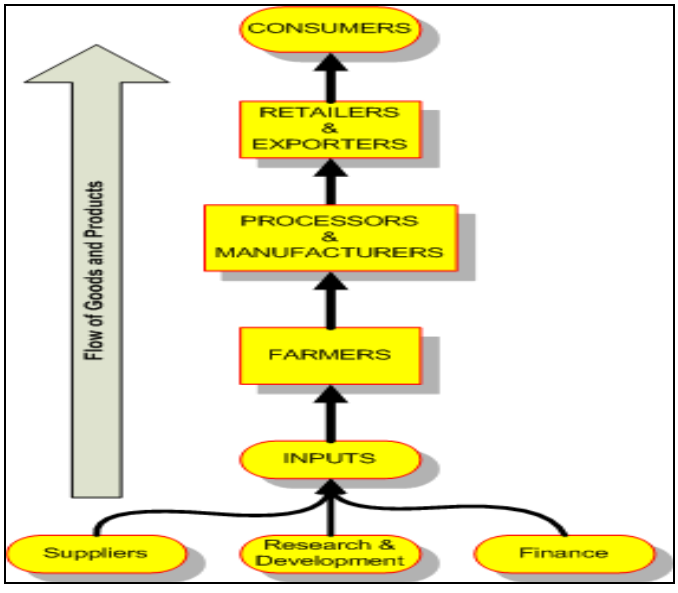

Figure 5: Traditional Marketing Systems

Source: http://www.researchintouse.com/nrk/RIUinfo/valuechain/valuechain.htm

2.4.2 Value Chain Approach

According to KIT, Faida MaLi and IIRR (2006), a value chain is a specific supply chain where actors actively seek to support each other so that they can increase their efficiency and competitiveness. They invest time, effort and money and build relationships with other actors to reach a common goal of satisfying consumers' needs. A value chain consist input suppliers, producers, processors, traders, wholesalers, exporters, retailers and consumers of the product or service. Value chain also includes Research and Development. The farmer/producer combines the resources from research and development; and input suppliers with land, labor and capital to produce commodities.

The value chain perspective has become a central focus of many recent international agricultural development strategies (Vermeulen, Woodhill, Proctor and Delnoye 2008). Will (2008) described value chain development as a business-oriented approach that aims to capture the best value at all stages. A value chain is therefore characterized by a sequence of functions and linkages and coordination between the various actors and supporters (Figure 6). Value chain exist where operators share common vision and goals for managing the chain processes, thus allowing for mutual decision-making on how to link production with markets while sharing risks and benefits. The better all value chain partners cooperate, the greater will be the value generated for the individual operator at every stage of the chain (Will 2008).

According to USAID (2009), taking a value chain approach requires understanding a market system in its totality. This includes all chain actors, supporters and the business environment in which the industry operates. USAID (2009) further argued that, within many staple food value chains in Africa, relationships between actors at different levels of the value chain are weak, disconnected or even adversarial. Information flows are often asymmetrical. In addition, there is a widespread lack of objective standards and grades. Consequently, transaction costs and risks and costs are high, and lack of transparency means that value chain actors enter into negotiations with mistrust.

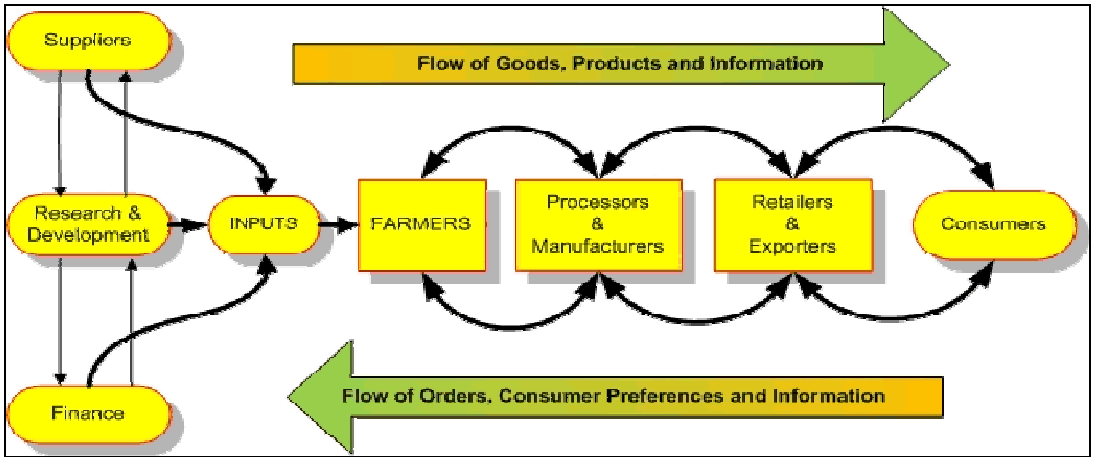

Figure 6: Value Chain Approach

Source: http://www.researchintouse.com/nrk/RIUinfo/valuechain/valuechain.htm

2.4.3 Sweetpotato marketing

According to Stathers et al (2005), marketing involves determining what your customers wants, developing that product, delivering that product to the place where the customers can purchase it, determining a price for the product that is profitable and attractive to the customers and then informing the customer about your product. This definition describes the marketing mix known as Product, Price, Place and Promotion of the product. These are four factors that help farmers to decide on what sweetpotato varieties to grow and where to sell them and at what prices. The four parts of the marketing mix rarely work in isolation but in relation to each other, for example, one has to decide upon the sweetpotato variety to grow by determining if it will sell for a price that is profitable. In relation to this the farmer has to decide on which place to distribute the sweetpotato. The traders and processor apply the same principle of marketing mix when deciding on ordering their sweetpotato or when processing sweetpotato into various products. According to Visser and Van Goor (2006), pricing decision should take into consideration the product phase in the product lifecycle.

Marketing Mix operates in an environment of 3Cs that is Customers, Competition and Controls or government regulations (Stathers et al 2005). Knowing the customers, the competition and the government regulations build a solid environment with which farmers, traders and sweetpotato processors apply the four Ps. If any one actor does not know who are the customers, the existing competition or the government regulations, he or she may make wrong decisions on product, price place and promotion.

In Zimbabwe the sweetpotato marketing is covered in general regulations for vegetable marketing. Farmers are not supposed to sell their vegetables on any place they want but they have to sell at the established and well recognized market places (AGRITEX 2008). This regulation controls street vending, at the same time allowing the consumers to buy the vegetable products at a central point. There are no regulations on residual pesticides and fertilizers and quality standards governing sweetpotato marketing in Zimbabwe. The competition for sweetpotato marketing is strong in the months of June, July and August (Chivhinge et al 2000), where the supply is very high on the market.

Consumption of sweetpotato is mainly in the cities. The market for farmers in Chiweshe is Harare because it is their nearest city and is an easy route for those who use public transport to carry their sweetpotato to the market. Another determining factor on making decisions on sweetpotato marketing is the consumer preferences. According to consumer survey done in Harare and Chitungwiza by Mupanda (2002), consumer preference of sweetpotato is determined by texture when cooked, cooking time, sweetness and skin and flesh color.

2.5 Postharvest losses of sweetpotato

Despite decades of educational efforts, the most common causes of postharvest losses in developing countries continue to be rough handling and inadequate cooling and temperature maintenance (Ray and Ravi, 2005). The lack of sorting to eliminate defects before storage and the use of inadequate packaging materials further add to the problem. In general, minimizing rough handling, sorting to remove damaged and diseased produce and effective temperature management will help considerably toward maintaining a quality product and reducing storage losses. The principal causes of sweetpotato loss and poor quality in the order of importance and percentage loss is shown in the Table 3.

Table 3 Percentage loses of sweetpotato

Causes of postharvest loss (in order of importance)	Percentage loss
Mechanical injuries	30
Improper curing	20
Sprouting and rooting	18
Water loss (shriveling)	17
Decay	10
Chilling injury	5

Source: Ray and Ravi, 2005

2.6 Background of AGRITEX

AGRITEX is a department of Ministry of Agriculture which provides technical and extension services to the Zimbabwean farmers and the agriculture industry.

2.6.1 Mission

The mission of AGRITEX is to promote development of an efficient, competitive and sustainable agricultural sector which assures food security and increased income. This mission thrives to contribute to the overall goal of poverty reduction (AGRITEX 2008).

2.6.2 Objectives

- Assure national and household food security
- Ensure that the agricultural resource base is maintained and improved.
- Generate income and employment to maximum feasible levels

2.6.3 Functions of AGRITEX

- Diagnose problems of the agricultural industry for purposes of finding solutions for them.
- Generate information on agricultural production; analyse, process and disseminate agricultural information to farmers, policy makers and other stakeholders
- Develop and disseminate appropriate Agricultural Technologies.
- Train farmers in appropriate and sustainable farming methods.
- Provide farmers and the public with agricultural knowledge and information.
- Contribute to sustainable industrial development through the provision of home grown agricultural raw materials
- To provide Agricultural professional services including extension, farmer training, regulatory, advisory and, technical services:
- Establish and maintaining strategic alliances, linkages, partnerships and networks with stakeholders and; with regional and international agricultural research and development agencies.
- Advise policy makers on matters related to research, extension and rural development.
- Facilitate/mobilize agricultural resources/inputs for the farming community.

2.6.4 AGRITEX and the sweetpotato chain

AGRITEX is responsible for all the research work that involves sweetpotato and other tuber and root crops in Zimbabwe. AGRITEX coordinates with the researchers at the University of Zimbabwe and passes the research information to the farmers through the extension officers in the local areas. The research findings from the researchers at

university of Zimbabwe are simplified and reproduced in languages that can be understood by farmers. This coordination makes the research useful to farmers. AGRITEX also carries out farmer trainings on root and tuber crops that include sweetpotato. AGRITEX extension officers and sweetpotato specialist carries out farmer field days, on farm demonstrations; and the main important responsibility are of linking the sweetpotato farmers to different stakeholders in the chain. AGRITEX helped DTC-UZ to mobilize some women groups from Seke district to undergo value addition training at DTC-UZ.

Chapter 3: RESEARCH METHODOLOGY

3.1 Area of Study

This study was conducted in Chiweshe communal area in Mazowe district in Zimbabwe. Chiweshe is 80km away from the capital city Harare. Negomo irrigation scheme is located iChiweshe, 90km away from Harare. The irrigation scheme was fully developed in 1995 with many companies and government entities including AGRITEX involved in the designing of the irrigation scheme and the construction of the dam. The irrigation scheme has a total land area of 300hectares and uses water from a 3.6 million m^3 dam constructed in Ruya river. The irrigation land is divided and allocated to 270 households.

The irrigation scheme is bisected into two by a tarred highway from the capital Harare in the South to the small town of Centenary in the North. This makes the irrigation scheme one of the most opportune irrigation schemes in the country in terms of road links to markets. The scheme is easily accessible by many wishing to buy agricultural produce from all corners of the province. There are also many urban markets in the vicinity: Glendale (22 km South), Concession (32 km South West), Mazowe (40 km South), Bindura (52 km South East), Mvurwi (25 km West) and Centenary (42 km North). Chiweshe communal area itself also provides a major market for the scheme. Thus Negomo is a privileged smallholder irrigation scheme when compared to many in the country. Negomo irrigation farmers were selected mainly from five villages (Nyakudya, Masawi, Mahonde, Kanhukamwe and Muroiwa), whose arable land was engulfed by the development of the scheme.

3.1.1 Irrigation farming system

Irrigation farmers are responsible for the operation and maintenance costs of the irrigation infrastructure though a levy system which is at the moment fixed at $US14. The farmers in the irrigation scheme were allocated 0.4 hectares of land for food crops and 0.7 hectares of land for citrus production. These farmers grow vegetable crops that include sweetpotato, carrots, sweet corn, peas, and a variety of leafy and root vegetables. They also grow oranges which they supply to horticultural companies like Interfresh. These farmers also keep some livestock in their farming system. The irrigation farmers also grows crops in their home areas (dry land) where they have an average plot size of 5hectares just like all other dryland farmers

3.1.2 Dryland farming system

Dryland farmers in Chiweshe have an average plot area of 5hactares which rely solely on rainfall for crop production. They grow cotton, tobacco as major cash crops and maize as a staple food. Thy also grow root crops which include sweetpotatoes in the rain season. Dryland farmers also rear cattle in their farming system. Dryland farmers also have small vegetable gardens located close to the streams which they irrigate with the use of watering cans and buckets.

3.2 Data Collection

Data collection was done through a literature study, survey, a case study and market observation. These data collection methods and sources of information are summarized in Table 4 and further explained in sections 3.3 to 3.8.

Table 4: Data Collection Methods and Sources of Information

Data Collection Method	Source
Literature study	Internet, DTC-UZ , Ministry of agriculture library , Wageningen library
Survey	15 Irrigation farmers in Mazowe District
	15 Dryland farmers in Mazowe district
Case study	8 Respondents
Market Observation	3 market places (Mbare wholesale, Mbare retail, and Machipisa retail)

3.3 Literature Study

Literature study was done using the internet because many sources with the information on sweetpotato handling and marketing could be found. DTC-UZ carries a lot of research on sweetpotato therefore it was selected strategically as an important source of material that includes publications and reports. Ministry of Agriculture library provided the source of information on the sweetpotato production in Zimbabwe. Wageningen University library helped to access many books and previous thesis from the previous students to see how they did the thesis write-up.

3.4 Survey

A survey was carried out on sweetpotato farmers from Negomo irrigation in Chiweshe communal area in Mazowe district and dry land farmers who are 15Km away from the irrigation scheme. Farmers were selected systematically and interviewed with the use of questionnaires. Fifteen (15) farmers were selected from the irrigation scheme whilst the other fifteen (15) was selected from the dry land farming system.

The irrigation scheme was chosen as area of interest to the researcher because of the organisation of the fathers. These farmers are producing their crops concentrated on one area and they exchange information on production and marketing as compared to the dryland farmers who are widely spaced therefore information exchange is difficult.

Farmers from the dryland farming system were sampled from an area which if 15km away from the irrigation scheme. This was done to avoid farmers who might have access to rent land in the irrigation scheme, as this could upset the clustering criteria. Another reason was that the researcher's rural home is in this dryland area which is 15km away from the irrigation scheme. The researcher was using public transport to reach the irrigation farmers therefore to reduce transport costs the research had to stay in the area were dryland farmers were sampled.

In order to reach the farmers in the irrigation scheme the chairman of the scheme was visited first and appointments were made on the days to meet the farmers. The chairman took part in introducing the researcher to the farmers so that they would freely give out the required information. Farmers in the irrigation scheme were interviewed in their fields so that their activities were not very much disturbed and the researcher could have a clear picture of the cropping systems, irrigation type and the general organisation of the scheme. In the dryland farming system, the village head and the agricultural extension officer in the area were first visited. The agricultural extension officer introduced the researcher to the farmers for them to be comfortable in giving out the required information.

The survey was done in six days from 31 July 2009 to 4 August 2009, where five farmers were interviewed each day. The clustering was done on the basis of organisation of farmers. The aim of comparing these two clusters was to see which cluster could be easily managed for chain development.

The survey was done using questionnaires (Annex 8). The questionnaires were well structured and focused on three groups of information that is; production costs, postharvest handling and marketing questions. Data collected from farmers was analyzed with the use of descriptive statistics and independent variable t-test to compare results from two clusters and presented using tables and graphs.

3.5 Case study

A case study was carried out to clearly see how the sweetpotato chain is organized and all the stakeholders involved. The actors and supporters listed below have been interviewed with the aid of a checklist (Annex 9).

1. Sweetpotato specialist in the department of Agricultural Technical and Extension (AGRITEX) in the ministry of Agriculture
2. Sweetpotato researcher at Development Technology Centre- University of Zimbabwe (DTC-UZ)
3. Sweetpotato processor at DTC-UZ to have a clear picture of the chain and be able to calculate the value shares
4. Three market place controllers to compliment the personal observation on the organisation of the market place; and sweetpotato handling and marketing.
5. Sweetpotato retailer at Mbare retail market to get information on sweetpotato handling and be able to calculate the value share.
6. Sweetpotato retailer at Machipisa retail market to get information on sweetpotato handling and be able to calculate the value share.
7. Sweetpotato vendor to get information on sweetpotato handling and be able to calculate the value share. The sweetpotato vendor was strategically selected to be able to get information on cost and benefits of vendors buying at Mbare wholesale and Machipisa retail

During the first week of data collection the sweetpotato specialist (Mrs. S. Mangena) at AGRITEX was visited after the appointments were made through telephone and the checklist had been sent to her though e-mail so that she could prepare for the discussion. On the first visit the sweetpotato specialist had some urgent tasks to perform at work so the appointment had to be postponed. On the second visit which was on the 14th of July 2009, discussions were made on sweetpotato production trends in Zimbabwe and the stakeholders involved. The interview with the sweetpotato specialist enabled the mapping of the sweetpotato chain. From the specialist, the contact details of the relevant stakeholders were obtained and appointments were booked for the next interviews.

The second interviewee was the sweetpotato researcher (Doctor T. Rukuni) at DTC-UZ on the 16th of July 2009. Discussions were done about general handling and processing of sweetpotato. After the discussions books and reports on sweetpotato processing were borrowed from Doctor Rukuni. The books also include his publications on sweetpotato postharvest handling and consumers surveys for Harare and Chitungwiza cities.

The third interview was done with three market place controllers at Mbare wholesale market Mbare retail market and Machipisa retail market concerning how they control inflow and outflow of sellers and buyers into and out of the market place. This interview also took care of the municipality payments and farmers' accommodation at the market place.

The forth interviewee was with the sweetpotato processor at DTC–UZ (Mrs. A. Mutungamiri). An appointment was booked by telephone and the checklist forwarded to her by e-mail before the day of the interview. This interview was done on the 10th of August 2009 and focused on sweetpotato processing, products and costs and profits that are made.
During this whole research period the researcher looked around for vegetable shops and supermarkets selling sweetpotato to interview them but unfortunately not even a single shop was found selling sweetpotato.

3.6 Market Observation

Market observations for Mbare wholesale and retail markets as well as Machipisa retail market places were done between 18 and 23 July 2009. Of the three market places Mbare wholesale and retail were the first to be visited. These two market places were visited on the same day. The researcher moved around the market place observing sweetpotato grades, quality, measurements and price negotiations between the farmers and their customers. When leaving the market place the researcher asked for an interview with the market place controllers and fortunately they agreed. The same approach was done at Machipisa retail market.

3.7 Data analysis

- Chain Mapping and PESTE - institutional analysis of the chain
- SWOT analysis was done on AGRITEX
- Gross Margin Analysis and Value Share analysis was used to calculate the value shares of the chain actors. Value share calculations have been done basing on results of gross margin analysis. Gross margin analysis for irrigation farmers and dryland farmers have been done separately to show different costs of production and encountered by these two clusters. This has been done because these two clusters have different production levels that are 10 tonnes per hectare for irrigation farmers and 6 tonnes per hectare for dryland farmers.
- Independent variable t-test was used to compare the different handling practices between the two clusters. Independent variable t-test was chosen because it can be used to analyze more than one variable at the same time and performs well when the sample size is small as compared to other tests like the chi-square test.

The results from the survey and case study was analyzed and compared with the literature.

3.8 Challenges met during data collection

On the initial plan the researcher had planned to interview supermarkets selling sweetpotato but this was not possible because there were no any shop selling sweetpotato. Another challenge was of the postponement of appointments. Also for the survey the researcher had planned to meet the Agricultural extension officer in the irrigation scheme before the irrigation scheme chairman but the extension officer was on leave and was not available at the time of the survey therefore the researcher had to introduce herself to the chairman of the irrigation scheme. This was a difficult task

because the researcher and the chairman did not know each other and it took much time for the chairman to appreciate that this research was only for the purpose of learning. The researcher had to show the chairman her identification and proof of studentship before the survey could proceed.

Due to the economic hardships, the bakery was not operating and could not be interviewed therefore the operating costs of the bakery was taken from the information obtained from the DTC-UZ since they were working together.

Chapter 4: RESULTS

This chapter shows the results obtained from the study. In Table 5, average area, yield and selling period of sweetpotato has been indicated. The results include chain mapping, institutional environment of sweetpotato chain, costs and revenues and value share analysis. Sweetpotato handling and marketing was also presented in this chapter with the aid of figures and tables. Organisational environment of AGRITEX in relation to the sweetpotato chain was done and presented at the end of this chapter.

Table 5: Average area, yield and selling period for irrigation and dryland farmers

Farming system	Area (Hectares)	Yield (Tonnes/ha)	Selling period (months)
Irrigation	0.4571	10	6.86
Dryland	0.4786	6	3

From the survey the average land size allocated for sweetpotato is big in the dryland farming system as compared to the irrigation farming system as shown by the figures in the table above. Farmers in dryland farming system have an average yield of 6 tonnes per hectare which is less than 10 tonnes per hectare from the irrigation system. Irrigation farmers have a longer selling period than dryland farmers.

4.1 Chain Mapping

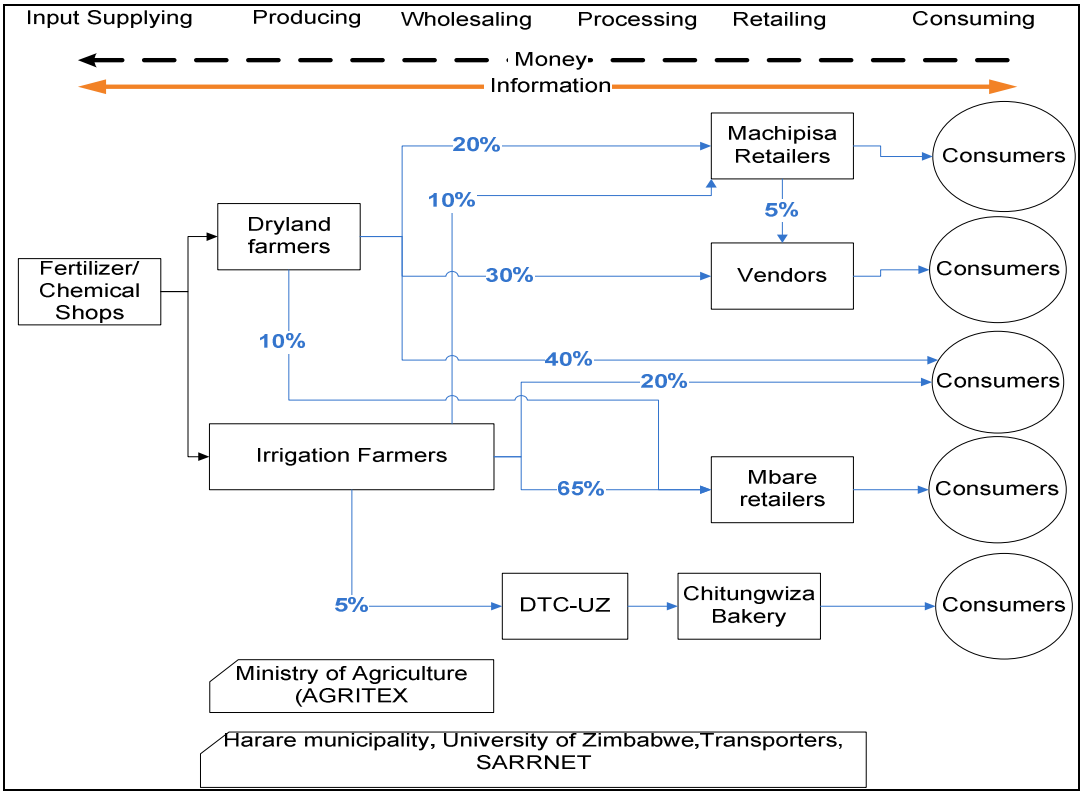

Figure 7: Sweetpotato chain map for Chiweshe Farmers

The chain map in Figure 7 is showing all the stakeholders involved in sweetpotato chain in Chiweshe district. The product flow is shown with blue arrows, information flow with

double pointed brown arrow and money flow is shown with black dotted arrow on the chain map. The chain actors and supporter; and their roles are shown in Table 6 and 7.

Table 6: Sweetpotato chain actors and their roles

Chain Actor	Role
Irrigation farmers	Producing sweetpotato and selling at wholesale market in Mbare and retail market in Machipisa
Dryland farmers	Producing sweetpotato and selling at wholesale market in Mbare and retail market in Machipisa
DTC–UZ	Buy sweetpotato from the wholesale market, Process sweetpotato into flour, chips, drinks, jams and confectionary products. Supply the UZ community with chips and confectionary products. Supply Chitungwiza bakery with sweetpotato flour
Retailers	Buy at least five bags of sweetpotato from wholesale market repackage and sale to consumers in small packages in the retail market at Mbare and Machipisa market place
Vendors	Buy at most one bag of sweetpotato from the wholesale market in Mbare and retail market in Machipisa and sell to consumers in small heaps

Table 7: Sweetpotato chain supporters and their roles

Chain supporter	Role
AGRITEX	Provide research and extension services to the farmers.
Harare Municipality	Provides the market place services, controls the market place activities and provide security services to the market place
DTC-UZ Researchers	Carry out research on sweetpotato processing as well as development of virus free vines for planting
Southern African Root Crops Research Network (SARRNET)	Provides funding for sweetpotato research through the DTC-UZ and Ministry of agriculture
Transporters	Transport farmers with their sweetpotato to the market
Input shops	Selling fertilizers and pesticides to the farmers

4.2 Institutional environment of sweetpotato chain

This is the general environment of the sweetpotato chain that involves the influence of political, economic, technological, social and ecological factors. These factors are summarized below.

Political factors

— No policy for sweetpotato production and processing, there are no subsidies for inputs or regulations that facilitate farmers' access to bank loans.

- Less priority of sweetpotato when budgets are allocated to crops of importance to the country. According to the sweetpotato specialist, sweetpotato is not given a large budget for research and extension.
- Too much bias to tobacco, maize and wheat programmes by the government in input distribution in relation to other crop production programmes.

Economical factors

- Traditional marketing system for sweetpotato
- Price fluctuations and high municipality fees affects sweetpotato pricing.
- High inflation before the introduction of multicurrency. DTC-UZ sweetpotato processor had managed to link with a food processing company, Cairns Foods Limited for mass production of sweetpotato chips but all the efforts have been wasted by high inflation rate which swept away the budget for mass production. At the time of research there was no mass production of chips going on.
- High cost of fertilizers
- High cost of bread increases the demand for sweetpotato
- Sweetpotato is regarded as a less economic crop therefore farmers can not apply for bank loans
- Provision of research fund from SARRNET steering sweetpotato processing research at DTC-UZ

Social Factors

- Sweetpotato is associated with the poor
- Non-governmental Organizations (Africare) promoting sweetpotato production to the poor households. Rich families who have the capacity to produce tend to distance themselves from sweetpotato production, saying it's a crop for the poor since these organizations are promoting its production by the poor households
- No decent accommodation for farmers at the market place demotivates the farmers.
- Acceptance of sweetpotato products on the market has not yet fully developed

Technical factors

- The extension officers constantly change (high staff turnover) thus affecting the quality of services provided to farmers. There should be three extension officers at the irrigation scheme but there was one at the time of study.
- Shortage of good quality planting material. All the farmers interviewed were using retained sweetpotato planting material.
- Measuring sweetpotato hectarage and yield is difficult as some farmers intercrop sweetpotato with other crops and harvest what is only needed for market or home consumption
- Slow development of processing technology. At DTC-UZ where sweetpotato processing is done, most work like washing, peeling and slicing is chipping is done manually. This raises the cost of production too high there for reducing the gross margin per kg of sweetpotato as shown on Annex 5.
- Limited processing and other value addition knowledge for the farmers. All farmers that were interviewed do not know other value addition methods besides boiling or roasting for home consumption.
- Inadequate and inappropriate transport to market
- Bulkiness of sweetpotato and relatively poor marketing skills.

— Difficulties in storing planting material by farmers also discourages the production of sweetpotato in Zimbabwe especially in dryland farming system where farmers have to store their planting material in small vegetable gardens.
— Pests problems combined with poor extension services reduce the farmers' yield. Storage pests and lack of storage facilities discourages high production of sweetpotato by farmers as they fear loses due to poor storage and pest attack.

Ecological factors

— Chiweshe lies in Natural Farming Region IIA (Figure 1)
— Climatic change is affecting mostly the dryland farmers who solely rely on rainfall.
— Long dry spells (mid season droughts) occurring during the rain season reduce farmers' yield.

4.3 Costs and Revenues

Gross margin for all actors in the sweetpotato chain has been calculated and presented in Annex 1 to Annex 7. The calculations are based on a kilogram of sweetpotato. All calculations for gross margin are based on an interest rate of 5% and miscellaneous costs at 2%. The sweetpotato chain has five main routes as shown on the chain map on Figure 5. These routes include selling sweetpotato through the retailer, processor, vendors at Mbare wholesale market and vendors at Machipisa retail market. Farmers can also sell direct to consumers or to vendors at Machipisa retail market. Following the gross margin analysis done at different levels in the sweetpotato chain, the costs and revenues of the chain actors selling through different routes have been presented on Figure 8.The gross margin analysis also led to the calculation of the value shares in the sweetpotato chain (section 4.4).

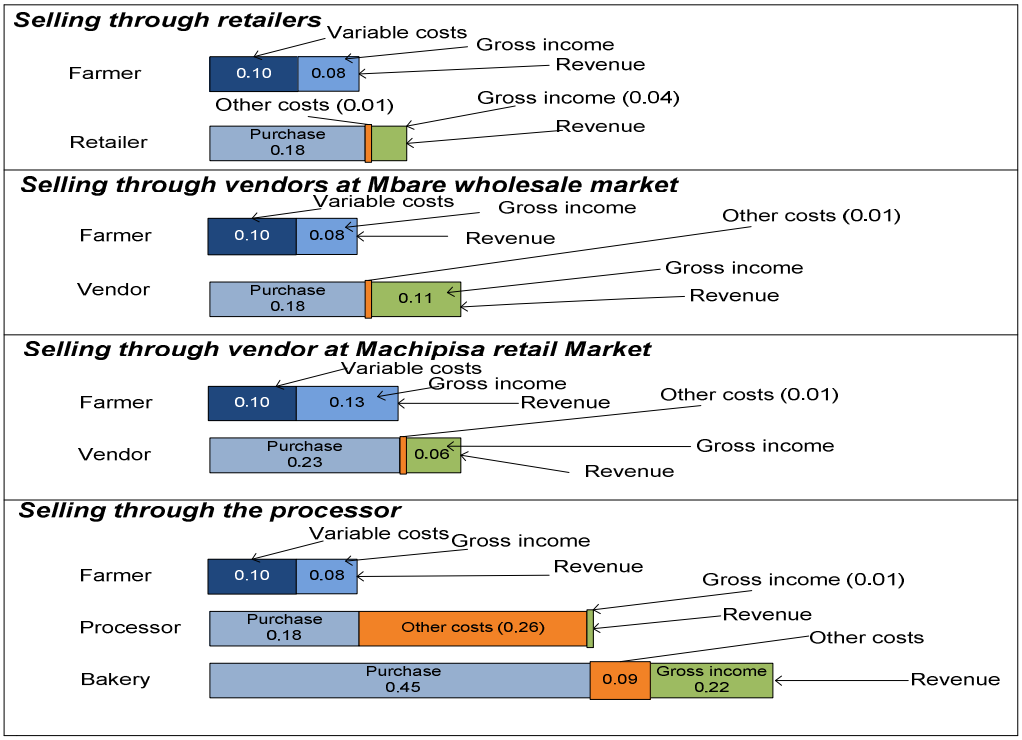

Figure 8: Costs and Revenues of actors in the sweetpotato chain ($US/kg)

Retailers and vendors incur low costs besides the purchasing costs as compared to the processor and bakery as shown in orange color in Figure 8. The processor has the least gross income in the chain. The costs are calculated per kilogram of sweetpotato

4.4 Value Share Analysis

Basing on the gross margin analysis in Annex 1 to Annex 7 and costs and revenues in section 4.3 and Figure 8, the value shares for all the chain actors in the sweetpotato chain has been calculated. The calculation is indicated in Table 8 and visually presented with the use of pie charts in Figure 9.

Table 8: Value share for sweetpotato chain actors (Share/kg sweetpotato)

Chain Actor	**Variable costs**	**Revenue** *Selling price*	**Gross income** *Revenue-costs*	**Added value** *Revenue-previous actor's revenue*	**Gross margin** *Gross income * 100 /Revenue*	**Value share** *Added value * 100 /Retail price*
Farmer selling to consumers at Machipisa retail market						
Irrigation Farmer	0.10	0.23	0.13	0.23	56.5%	100%
Dryland farmer	0.13	0.23	0.10	0.23	43.5%	100%
Selling through Retailers						
Farmer	0.10	0.18	0.08	0.18	44.4%	78.3%
Retailer	0.19	0.23	0.04	0.05	17.4%	21.7%
Selling through Vendors at Mbare wholesale market						
Farmer	0.10	0.18	0.08	0.18	44.4%	60%
Vendor	0.19	0.30	0.11	0.12	36.7%	40%
Selling through vendors at Machipisa retail market						
Farmer	0.10	0.23	0.13	0.23	56.5%	76.6%
Vendor	0.24	0.30	0.06	0.07	23.3%	23.3%
Selling through Processor						
Farmer	0.10	0.18	0.08	0.18	44.4%	26.9%
Processor	0.44	0.45	0.01	0.27	2.2%	40.3%
Bakery	0.87	0.67	0.13	0.22	13%	32.8%

The value share of irrigation farmers and dryland farmers only differ if they supply different markets (Machipisa retail and Mbare wholesale). The wholesale price is the same for all farmers therefore, even though their variable costs differ, the share they will get from a kg of sweetpotato is the same as long as they supply the same market. Those farmers who sell their sweetpotato at the retail market in Machipisa, play the same role as the retailer therefore if they sell direct to consumers, they get 100% value share of their sweetpotato as shown in the first two rows of Table 8. Figure 9 below show the different value share for selling sweetpotato though different routes in the chain.

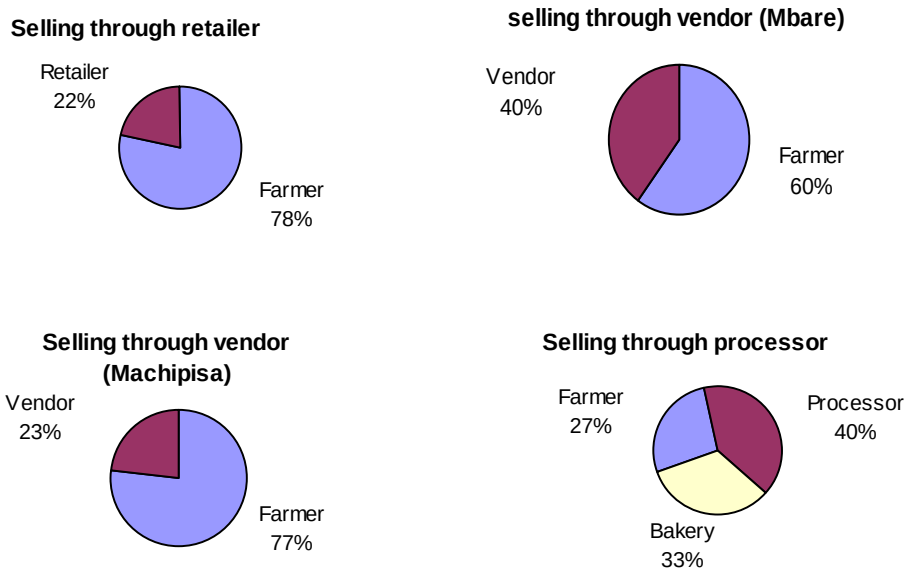

Figure 9: Value shares for sweetpotato chain actor

4.5 Sweetpotato handling

Sweetpotato handling at different stages in the chain has been indicated on Table 9 Farmers are not storing large quantities of sweetpotato. Those who store normally use the underground pits and only store for home consumption. For farmers in irrigation system, they do not store as they produce throughout the year. All the farmers interviewed do not have the processing skills besides boiling and roasting the tubers for home consumption

Quality practices that are followed by farmers and traders include careful harvesting, grading and packaging; repackaging into small quantities of different quality grades. None of the farmers and traders are washing or curing their sweetpotato. Only the processor is washing the sweetpotato prior to processing.

Table 9: Sweetpotato handling activities and risks associated

Activity	**Explanation**	**Risk Associated**
Harvesting	Done by digging with hoes, irrigation farmers use both hired labor and family labor whilst most dryland farmers rely on family labor.	Careless digging creates injuries which can be entrance for infection
Picking	done in conjunction with sorting	Contamination if injured tubers are not removed
Grading	Irrigation farmers do grading in the field and the dryland farmers carry their sweetpotato to do grading at their homes. Three quality grades are made according to size. Grading is also done according to skin and flesh color.	Grading in field may expose the sweetpotato to too much sun light causing sunburn.
Packaging	Both irrigation and dryland farmers use plastic woven bags (50Kg and 90Kg).	Sweetpotatoes are less protected from damage
Labeling	The bags are labeled with the farmers name and grade	Lost bags are difficult to trace if they are not labeled
Transporting	-Irrigation farmers arrange with their transporters before harvesting so that they do not spend more time on road -Dryland farmers harvest and wait on the road for any transport that comes along. They normally take two to seven days on road waiting for transport.	Spending more days on road exposes sweetpotato to high temperatures and heat that will cause sunburn and weight loss
Marketing	In the wholesale market farmers sell the full bags without repackaging and in retail market the sweetpotato is repackaged with buckets being used for measuring.	Careless handling reduces marketable quantity, causing low income
Trader / processor	**Handling activity**	
Retailer	Transporting the sweetpotato using own or hired trolley. Repackaging into small quantities according to quality grades and sell to the consumers	Careless handling reduces marketable quantity
Vendor	Carefully heap their sweetpotato at their homes or roadside to sell to their consumers. Heap size is determined by the number of tubers is a heap. For medium size tubers, vendors get 20 heaps from 20kg.	Selling in unclean environments can cause contamination of sweetpotato with disease causing organisms that can be harmful to consumers
Processor	Wash the sweetpotato, peel it and process it into chips, drinks or jams. Also process peeled or unpeeled sweetpotato into flour	Soft rot can spread by washing and use of dirty equipment.

4.6 Sweetpotato marketing

Irrigation and dryland famers use different sizes of packaging material and supply different markets. Table 10 below shows sizes of bags used for packaging by the two farming systems. Out of the 30 farmers interviewed, 10 irrigation farmers use 50kg bags and the other 5 farmers use 90kg bags 9 irrigation farmers were using 90kg bags and the other 6 were using 50kg bags.

Table 10: Packaging material preferences for irrigation and dryland farmers

		What type and size of bags do you use to package for marketing?		
		90kg plastic	50kg plastic	Total
How do you grow your sweetpotato?	irrigation	5	10	15
	dryland	9	6	15
Total				30

The farmers were slowly changing from using 90kg bags to 50kg bags with irrigation farmers leading the change. All farmers were using plastic woven bags.

4.7 Market places

According to the market observation and interviews done with the market place controllers and farmers, Mbare wholesale market accommodates many farmers who sale at wholesale price. These farmers sell to retailers for Mbare and Machipisa retail markets or to vendors who sell in the residential areas. The retail market at Mbare is not accessible to farmers and is only meant for retailers who can buy permanent tables that run for a minimum of six months. The retail market is well organized as compared to the wholesale market. Machipisa retail market is divided into two sections; one for farmers and the other one for permanent sellers with tables. Farmers sell their sweetpotato at retail price of $US0.23 per kilogram (Table 8). The preferences for market places by farmers are highlighted on Table 11 below. At Mbare wholesale market and Machipisa retail market, farmers pay $US6.00 per day which is very high compared to the permanent sellers in Mbare and Machipisa retail markets who pay $US10.00 per month to the municipality. The market places opens at 04:30am and closes at 11:30am

Table 11: Market place preferences for irrigation and dryland farmers

		Where do you sell your sweetpotato?		
		Mbare	Machipisa	Total
How do you grow your sweetpotato?	irrigation	11	4	15
	dryland	6	9	15
Total		17	13	30

Overally more farmers prefer selling at Mbare wholesale market because the market place is central to many residential areas and is the biggest vegetable market place for Harare city. More irrigation farmers prefer selling their sweetpotato at Mbare wholesale market as compared to dryland farmers who prefer selling at Machipisa retail market.

4.8 Time taken to reach the market

The time which farmers spent on road trying to get their produce to the market varies. This has been shown on Figure 10 where high number of irrigation farmers (11 out of 15) takes 0-1 days on the road. 8 out of 15 farmers from the irrigation scheme take between 3 and 7 days on the road to the market.

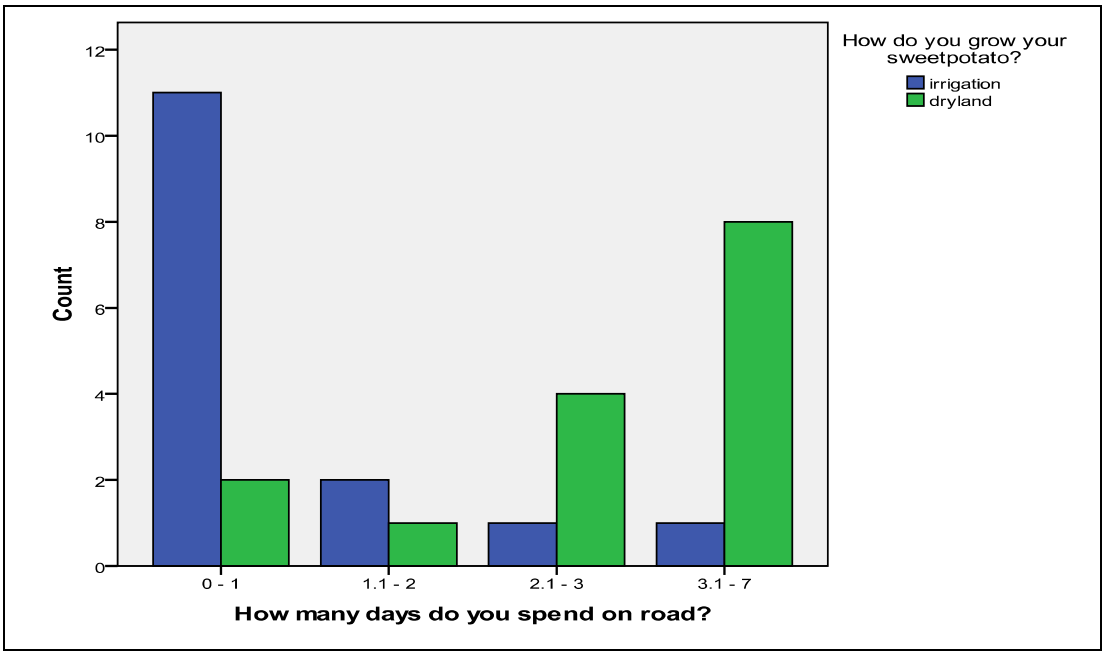

Figure 10: Time taken by farmers on road to market

4.9 Sweetpotato loses

Sweetpotato loses in the sweetpotato chain as was found from the sweetpotato specialist at AGRITEX are shown on Table 12.

Table 12: Causes of sweetpotato loses

Cause	**Stage of Loss in the production chain**	**percentage**
Careless digging	Harvesting	11%
Pest and disease	In field	9%
Pest and disease	in storage	6%
Selling at give away price	At market	8%

4.10 Independent variable t-test

Independent variable t-test was performed at 95% confidence interval to test if there is any significant difference on the plot size, yield per hectare, transport cost, market price, selling period and days spent on road to market between the irrigation and dryland farmers. The independent variables t-test for these variables is shown on Annex 10.

Hypothesis for t-test was:
H_0: There is no significant difference in plot size, production level (yield per hectare), transport cost, market price, selling period and time spent on road to the market between irrigation and dryland farmers.
H_1: There is a significant difference in plot size, production level, transport cost, market price, selling period and time spent on the road to the market between irrigation and dryland farmers.

For plot size, transport cost and market price; Sig. (2-tailed) > 0.05 therefore the conclusion for the t- test is that there is no significant difference in the average plot area, transport cost and market price between irrigation and dryland farmers.

For production level (yield per hectare), selling period and days spent on road to market; Sig. (2-tailed) < 0.05 and the conclusion for the t-test is that there is a significant difference in the average yield per hectare selling period, and days spent on the road to the market between irrigation and dryland farmers.

4.11 Organisational environment – AGRITEX

Organisational environment of AGRITEX in relation to sweetpotato production has been done with the use of SWOT analysis. These are facilitating factors (Strengths and Opportunities) and hindering factors (Weaknesses and Threats) affecting AGRITEX in performing its duties in supporting the sweetpotato chain.

Strengths
- Highly qualified personnel
- Good in-house training programmes that have produced credible staff.
- Extensive grassroots coverage with district and or village level representation
- Collaboration with other departments in the ministry
- Well known by the farmers and other stakeholders

Weaknesses
- Limited financial resources: more than 75 percent of budget goes on salaries; very little left for operational costs.
- Poor logistical support: no transport and equipment.
- Lagging technical knowledge in new enterprises
- Bureaucracy and long channels of communication.
- High staff turnover at grassroots level (one extension officer at irrigation scheme instead of three).

Opportunities
- Availability of research fund from SARRNET for production of virus free planting material.
- Processing research being done by DTC-UZ.

— Existence of irrigation facilities at the irrigation scheme.
— NGO promoting sweetpotato production (providing their beneficiaries with small irrigation kit-Treadle pumps)

Threats
— Inadequate budgets for supporting farmers and to carryout trials.
— Prevailing economic situation: unlikely that government will increase budgetary allocations.
— Unstable macroeconomic and political environment.
— Less seed producers of virus free planting material, resulting in farmers using retained plating material
— Lack of storage facilities for the harvested tubers.
— Slow development of processing technology

Table 13: Suggestions for improvement from respondents

Sweetpotato specialist — There should be more production and multiplication of virus free planting material at large scale so that farmers do not use retained planting material which is infected by virus thus reducing farmers' yields
Processor — Formation of farmer associations that will represent farmers at the market — University of Zimbabwe researchers should collaborate with local engineering companies like Tan Roy Engineering (Local engineering company for processing machinery) to develop sweetpotato processing technology.
Irrigation farmers — Provision of decent accommodation at market — Adjustment of opening and closing time of the market place so that farmers have more time to sell their sweetpotato — Transporters should be paid after farmers have sold their sweetpotato so that the farmers can have enough money to pay for transport. — AGRITEX should provide trainings on pest and disease control.
Dryland farmers — Use of small scale irrigation equipment like (NGO), Africare's beneficiaries are doing. They suggested the use of treadle pumps for watering their sweetpotato
All farmers — Training on sweetpotato postharvest handling especially on storage and how to link with shops or companies to market their sweetpotato — There is need to improve cleaning and maintenance of the market place because dirtiness can cause contamination of the sweetpotato and other vegetable products as well as spread diseases amongst the farmers themselves. — Reduction of municipality fees
Market place controllers — Market fees should be charged in relation to quantity and not per day

Chapter 5: DISCUSSIONS

This chapter compares the research findings with the literature. Also the researcher's opinions on the sweetpotato chain are involved in this discussion. The chapter covers discussions on sweetpotato production, chain and chain governance, handling, marketing, AGRITEX as a chain supporter and sweetpotato processing research.

5.1 Sweetpotato production

Sweetpotato production for irrigation farmers is yielding high, 10 tonnes per hectare as compared to dryland farmers whose yield has an average of 6 tonnes per hectare. From the averages in Table 5 the land size for dryland farmers is slightly bigger that one for the irrigation farmers. However independent variable t-test (section 4.10) has proven that there is no significant difference in land size. The test also proved that there is a significant difference in the sweetpotato yield between dryland and irrigation farmers. Even though the yield from the irrigation scheme is high, it does not reach the 15 tonnes per hectare as was suggested by Mutungamiri et al (2001). Chipangura and Jackson (1993) also mentioned that sweetpotato has a potential yield of 60 tonnes per hectare if supplied with enough inputs. Chivhinge et al (2000) suggested the use of 1250kg of compound S fertilizer (7%Nitrogen, 21% Phosphorus and 7% Potassium) per hectare of sweetpotatoes. The farmers argued that the use of too much fertilizer will increase the fragility of the sweetpotato tubers causing difficulties in handling the tubers. The sweetpotato specialist attributed the low yield to use of retained planting material which is highly prone to virus infection and the use of inadequate and inappropriate fertilizers.

Gross margin analysis on Annex 1 and 2 shows that farmers were using less amount of fertilizer that is 150kg Ammonium Nitrate and 250 compound D. This type of fertilizer they were using is different from compound S suggested by Chivhinge et al (2000). Compound S is not readily available on the market due to the unstable economic environment therefore farmers tend to use whatever is available. Some farmers can not even afford to buy little fertilizer therefore the yield becomes low.

The yield from the dryland farmers is less than that of the irrigation farmers due to a number of factors. The dryland farmers solely rely on rainfall. Due to the climatic change there is prevalence of long mid-season droughts in Zimbabwe. During these mid season drought the irrigation farmers will be irrigating their crop therefore yield high. In the dry season the irrigation farmers keep their planting material under irrigation. At the time of planting when the rain season starts, the dryland farmers use their vines which they store in their vegetable gardens. Due to less availability of water, the dryland farmers can not store enough planting material to plant their plots at once. They plant the first small portion and when the vines grow; they cut the planting material from that field to plant the remaining area until the whole plot is planted. The cutting of the vines will affect the accumulation of dry matter and delay tuber development resulting in low yield. To solve these problem dryland farmers suggested the use of treadle pumps like their colleagues in the project of an NGO (Africare) were doing

5.2 Sweetpotato chain and chain governance

The sweetpotato chain in Chiweshe resembles traditional marketing systems concept as suggested by Research Into Use (2007). The farmers produce their sweetpotato and push it into the market. USAID (2009) argued that, within many staple food value chains in Africa, relationships between actors at different levels of the value chain are weak,

disconnected or even adversarial. Information flows are often asymmetrical and there is a widespread lack of objective standards and grades. Consequently, transaction costs and risks and costs of production are high, and lack of transparency means that value chain actors enter into negotiations with mistrust. The USAID (2009) arguments are true with the sweetpotato chain in Chiweshe. The links in this value chain are disconnected. Farmers produce their sweetpotato for consumers whom they do not know. The actors follow an ad hoc or spot market system. There are no relationships between chain actors therefore mistrust exist in the chain. Some farmers have a tendency of packing small roots at the bottom of the bags or buckets and put the big ones on top when selling thus increasing mistrust in the chain. Also in agreement with the USAID (2009), there are no objective quality standards and grades in the sweetpotato chain as stated in the marketing environment (section 2.4.3).

For farmers to get market information they rely on other farmers who would have sold their sweetpotato in the near dates therefore the farmers will set their prices slightly above what other famers found at the market. This leads into unstable pricing of sweetpotato at market. The information flow in the sweetpotato chain is not smooth as the chain links are disconnected. AGRITEX claims that there are farmer representative organizations that help farmers to market their produce for example the Zimbabwe Farmers Union (ZFU) but farmers do not know that this organisation can help them. They do not even know where to go with the problems they face in marketing their sweetpotato.

AGRITEX as a chain supporter may need to facilitate development of chain relationship so as to strengthen the sweetpotato chain and solve the marketing system development problems. However considering the weaknesses of AGRITEX as indicated on the SWOT analysis, it is difficult to act strongly as a chain supporter especially with high staff turn over at grassroots level. For example at the irrigation scheme there was one extension officer instead of three. This means that there will be some time when there will be no extension officer to help the farmers if they need some information. Another example is when the researcher visited the irrigation scheme, she wanted to meet the extension officer but the officer was on leave.

The sweetpotato chain, due to disconnected links, has no specific coordinator. This leads to farmers, even those in the irrigation scheme to concentrate their production in the same period causing oversupply and low prices at the market in the months of June, July and August. If there was someone coordinating the chain, sweetpotato production would be staggered and the irrigation farmers stand a better chance in getting high market prices if they produce during the dry season when the dryland farmers are not producing. The independent variable t-test showed that there is a significant difference on the length of the selling period between irrigation and dryland farmers whilst Table 5 shows that the average selling period for irrigation farmers is 6.86 months and the average selling period for the dryland farmers is 3 months. This result shows that the irrigation farmers may not be fully utilizing the irrigation facility as they only sell for 6.86 months in a year whilst they can produce throughout the year. Another reason for the irrigation farmers to sell sweetpotato only for an average of 6.86 months in a year could be because they grow many other high value crops like green beans, peas, sweet corn and some leafy vegetables. These crops sell high in the dry season when dryland farmers are not producing therefore farmers tend to grow many vegetables and less sweetpotato in the dry season. They only remain with planting material which they normally grow in the citrus plantations.

Value shares in the sweetpotato chain differ with the route followed by the actor. If the farmers sell to the consumers directly they get 100% values share even though the margin share will be 56.5% for irrigation farmers and 43.5% for dryland farmers (Table 8). The margin share for dryland farmers and irrigation farmers differs with the cost of production per kg sweetpotato as shown on gross margin analysis Annex 1 and 2.

5.3 Sweetpotato handling

All the farmers interviewed were using hand harvesting method whereby hoes are used to dig out the tubers. Even though this method of harvesting is labor intensive and time consuming the damages encountered are not as alarming as when using mechanical harvesting methods as was argued by Brooke et al (2003).

According to the researcher's opinion, farmers use hand harvesting because it is the most available harvesting method used to harvest tuber crops in Chiweshe. Farmers do not have access to machinery due to affordability and availability of the machinery. Ploughing with ox drawn ploughs could be an option for harvesting sweetpotato but the damages are very high so farmers prefer digging with hoes. Even though the level of damage is low with digging, the loss as was obtained from the sweetpotato specialist is 11% and the total loss is 34%. This percentage loss caused by harvesting if expressed as the percentage of the total loss, it becomes 32% which is close to the 30% mechanical injury loss cited in Ray and Ravi (2005). Also another of preferring hand harvesting is the availability of cheap labor. The hired labor is usually paid in kind therefore this is not very difficult for irrigation farmers.

Curing of sweetpotato is not practiced in Chiweshe. Farmers interviewed, both irrigation and dryland farmers, were not curing their sweetpotato. According to Katinoja and Kader (2004) curing is an important practice that facilitates wound healing especially if the sweetpotatoes are to be stored for any length of time. The farmers seem to have no knowledge of curing or how it is done. On the other hand, since the production of these farmers is low and they only use an average of 0.45 hectares, the farmers find it not necessary to cure and store sweetpotato. For the farmers that were storing sweetpotato they only store a small portion for home consumption and not for marketing. Both dryland and irrigation farmers harvest what they want to sell at a certain period. This idea of harvesting small quantities at a time led these farmers to think that there is no need for storing sweetpotato.

In contrast, especially for irrigation farmers, leaving the tubers in the field will waste land that could be used productively for next crop in the rotation since these farmers grow many different crops. In another angle, leaving the tubers in the field for a length period of time expose the tubers to sweetpotato weevil infestation as highlighted by Stathers et al (2005). When grading sweetpotato the irrigation farmers do their grading in the field whereas the dryland farmers carry their sweetpotato to their homes for grading by the use of scotch carts and wheelbarrows. Three grades are common for both irrigation farmers and dryland farmers. These grades are; small, medium and large. Grading done by dryland farmers tend to be more effective since they will have more time to work on their sweetpotato at home.

According to Mupanda (2002), washing increase attractiveness of sweetpotato to the consumers at the market. Brooke et al (2003) agued that sweetpotato should be cured soon after harvesting before further handling to reduce further damage and weight loss.

The farmers in Chiweshe said they can not wash their sweetpotato before marketing because washing will damage the skin of the sweetpotato. Farmers in Chiweshe goes parallel to Mupanda (2002) 's idea of increasing attractiveness to the consumers, rather they sell their sweetpotato unwashed. This showed that farmers lack some knowledge on postharvest handling of sweetpotato and this clarifies why the farmers suggested that they would like to be trained on postharvest handling and marketing (Table 13).

5.4 Marketing

According to Stathers et al (2005) bags do not provide any protection to the sweetpotato and should be avoided were possible. Farmers in Chiweshe argued that bags are easy to handle and are easy to carry back home when they finish marketing as compared to other packaging material like boxes which will need to pay another transport cost to carry them back home. Irrigation farmers preferred using 50kg plastic woven bags whereas high number of dryland farmers was still using 90kg bags (Table 10). The irrigation farmers argued that carrying the 90kg bags when loading the vehicle is difficult because they are heavier than the 50kg bags. Also when supplying the retail market, it is difficult to sell the 90kg bags than 50kg bags. If the farmers use 90kg bags they tend to lose out to the retailers because the retailers will always negotiate for low prices. Farmers end up selling at low prices especially when approaching the closing time of the market place to reduce costs as they will be paying $US6 to the municipality each day they sell their produce in the market place.

On the same issue of packaging materials, the dryland farmers tend to have a different opinion from the irrigation farmers. The dryland farmers prefer using 90Kg bags than 50kg bags because they want to reduce the number of units they carry as well as to negotiate for low transport cost. Table 11 shows that high number of dryland farmers prefers Machipisa retail market. With big bags (90Kg), farmers will have more money because they will repack their sweetpotato and sell in small quantities either direct to consumers or to vendors. The market prices fluctuate for both market places depending on the supply and demand. Prices tend to be low in the months of June, July and August when the supply is high and rise as the supply reduces.

Farmers who sell their sweetpotato in small quantities prefer selling at Machipisa retail market because there is less congestion of sellers and buyers as compared to Mbare wholesale market. The selling prices at all the market places do not differ for irrigation farmers and dryland farmers but only differs with supply and demand at the market. Dryland farmers agued that they stay on the road in search of cheap transport but the independent variable t-test proved that there is no significant difference on the market prices and transport cost between dryland and irrigation farmers.

According to the farmers from both dryland and irrigation scheme the market fees charged by Harare municipality is very high. Also there is no decent accommodation for farmers at the market place. If the farmers have to sleep at the market they normally sleep on the open or on verandas of nearest shops where they pay $1.00 per person per night to the security guards. Because of this insecure accommodation, farmers end up selling their sweetpotato at low prices especially when approaching the closing time of the market place.

Most farmers were not comfortable with the opening and closing time of the market places. The market place controllers argued that the closing time of 11:30 allows them time to clean the market place and start registering new sellers for the following day.

They said this is how they controlled the inflow of sellers and buyers into the market as these market places are not only for sweetpotato but for all vegetables. At 04:30 when they open, they do not allow buyers entrance before the farmers have finished setting up their sweetpotato and other vegetables and be ready to sell.

Considering the fact that there are no regulations on sweetpotato quality or residual pesticides farmers just bring their sweetpotato to the market. If AGRITEX have to promote high production with the use of fertilizers, it has to put quality regulations in place so as to protect the health of the consumers.

According to the independent variable t-test carried out on the results of the survey, there is a significant difference on the number of days taken by the irrigation farmers and dryland farmers to reach the market with their produce. It has been found out from the survey that the farmers in the irrigation scheme arrange with their transporters first before they harvest their crop for market. They agree on dates and quantities to be carried as well as the market place where the sweetpotato will be taken to. This differs with the dryland farmers' strategy. The dryland farmers harvest their sweetpotato, grade and pack it in bags before taking it to the road to look for any transport that comes along. If they are not lucky they spent up to seven days on the road with their sweetpotato. By the time this sweetpotato will get to the market it will have lost weight and freshness as compared to that of the irrigation farmers who only take one day on the road.

The transport which dryland farmers use will have its own destination therefore the farmers are mostly offloaded at the bus terminuses in Mbare where they have to hire trolleys to take their sweetpotato into the market. This adds an extra transport cost and increases high chances of more damages to the sweetpotato due to more loading and offloading and careless handling.

5.4.1 Marketing mix

In order for the farmers to make some marketing decisions of their sweetpotato, the marketing mix principle has to be used. The goal of using the marketing mix is to make decisions that center the four Ps on the customers in the target market in order to create perceived value and generate positive response. Marketing mix can be used in the sweetpotato chain as follows:

1. Product. Both irrigation and dryland farmers have to make decisions on what variety of sweetpotato to produce basing on the consumer preferences. Chingovha variety is the most preferred on the market (Mupanda 2002) but cordner is the most yielding variety. Farmers should decide on whether to produce high yielding or highly marketable varieties. Farmers can produce other varieties depending on the availability of planting materials and other required inputs. Choice of variety will greatly affect the marketability of the variety. Different varieties have different characteristics like texture when cooked, sweetness, cooking time, skin color, and flesh color (Mupanda 2002). Most consumers prefer white skinned sweetpotato that have a firm texture, sweet and short cooking time (Mupanda 2002)

2. Price. The pricing strategy for sweetpotato should take into account the cost of production, seasonality of the crop, demand of the variety and quality. Farmers should aim to spread the production of sweetpotato so that they can have high margins. According to the gross margin analysis done on Annex 1 to 7 the margin for farmers is small as compared to retailers and vendors. This is mainly because the farmers are

supplying the sweetpotato in the same period of June, July and August. The pricing at the market is controlled by supply and demand of the sweetpotato. For sweetpotato processor the pricing of sweetpotato products was still mainly determined by the phase in the product lifecycle on market. Since sweetpotato processing is just starting, the sweetpotato products are still in the introduction phase therefore the pricing done is to break through into the market.

3. Place. Place considers the whole logistical chain. It is also known as channel, distribution, or intermediary. It is the mechanism through which the sweetpotato are moved from the farmer to the consumer. Farmers in the sweetpotato chain take decisions on which market place to supply their sweetpotato as indicated in table 11. If sweetpotato processing could be established in the farmers' local areas, the farmers will have more option on where to sell their sweetpotato.

4. Promotion. Promotion represents various aspects of marketing communication that is the communication of information about the product with the aim of generating a positive customer response. In Zimbabwe promotion of sweetpotato products need to be given high priority so as to sensitize the public on the importance of sweetpotato as a food security crop and stop viewing it as a crop for the poor. Only through promotion can the sweetpotato products gain acceptance on the market. The marketing decisions especially for sweetpotato processors can include advertising the products through internet, televisions, radios and sales promotions. Sweetpotato processor can negotiate with the supermarkets for high price positioning of products like jams and chips on the shelves.

5.5 AGRITEX as a chain supporter

Bureaucracy in this organisation causes slow adaptation of the organisation to the changing environment. In this case, sweetpotato has become an important source of food security to many rural and urban household but the ministry has not yet developed policies that govern sweetpotato production and marketing. Even though tobacco, maize and cotton production has fallen, and the rainfall pattern has changed, AGRITEX has not adopted sweetpotato as a crop of major importance to the country, a crop that has a potential of solving the food security problems.. This has a limitation on the type of support they provide to the sweetpotato chain. If only sweetpotato can be adopted as an important food security crop in the country, facilities can be made available for farmers to get access to bank loans so that they can buy enough fertilizers and pesticides required to increase production to the potential levels of 60tonnes per hectare as cited in Chipangura and Jackson (1993).

5.6 Processing research

Sweetpotato processing has proved to be a way of adding value to sweetpotato as was indicated by the researchers at DTC-UZ and can improve sweetpotato marketing. Processing of sweetpotato is still at research level. According to Visser and Van Goor (2006), the phase of the products in the life cycle at market affects the pricing of that product. As shown on Figure 8, the processor is incurring high costs of production and gaining a very small gross income. Gross margin analysis showed that the processor is incurring loss. The sweetpotato processor suggested that if they collaborate with local engineering companies to design processing technology that would reduce cost of production especially on washing, peeling and chipping which the processor was doing manually.

Chapter 6: RECOMMENDATIONS AND CONLUSIONS

6.1 Conclusion

The sweetpotato chain has a potential of becoming a business enterprise for the farmers as shown by the gross margin analysis for different chain actors however there is still a lot of work that need to be done to improve the marketing system from a traditional marketing system to value chain approach. Irrigation farmers are organized than dryland farmers and their production level is high therefore chain development should start focusing more on irrigation farmers.

The bulkiness of sweetpotato limits its production in high quantities as most farmers mainly in the dryland farming system have difficulties in transporting their produce to the market. Lack of postharvest technology and postharvest handling knowledge causes low production as farmers were afraid that if they produce more the sweetpotato will lose quality due to poor storage.

Sweetpotato value addition in Zimbabwe is still lagging behind even though the research carried out at DTC-UZ showed that sweetpotato can be developed into various products. This idea of sweetpotato processing seems to be more interesting, however, if mass production of sweetpotato products is to be done, acceptance of these products on the market should be considered as the most important factor.

Besides being a business enterprise sweetpotato has a potential of solving the food security problems prevailing in Zimbabwe if production is done to its maximum potential level with enough inputs available. Commercial processing of sweetpotatoes into baking flour can stimulate production of the crop, increase incomes, improve food and nutrition security and create employment opportunities, thereby helping to alleviate poverty in rural areas. In long term this might also be a strategic intervention at national level in that the much needed foreign currency required to import supplementary wheat could be reduced. This commercial processing can increase rural incomes through marketing of the raw material when the processing enterprise creates a local demand for sweetpotatoes

6.2 Recommendations

- AGRITEX is being affected by high staff turnover; this means that Public Services Commission (PSC) which is the employer of all government workers should address the working conditions of the AGRITEX staff so that they can be able to deliver their services effectively and efficiently. This recommendation is beyond AGRITEX's capabilities therefore none of the AGRITEX staff can be able to implement this but if this has to be considered it will have a greater impact on the support in which farmers are given by AGRITEX
- AGRITEX should facilitate development of farmer and trader associations that will help in developing chain relations. Farmer representatives should then be selected from the farmer associations and trader representatives also selected from trader associations. These two associations should then collaborate and coordinate the chain functions. The creation of farmer and trader association would ease out the marketing problems by creating a platform where the traders and farmers can meet and negotiate and share information. Also these two groups will be able to discuss problems they are facing in marketing and find solution together.

- Formation of cooperatives should be encouraged to the farmers especially those in the dryland so that they produce their sweetpotato as a group and this will help to look for transport which can be hired by farmers to carry their sweetpotato like what the irrigation farmers do, instead of waiting on the road for anything that comes along.
- AGRITEX should collaborate with NGOs like Africare to help dryland farmers to access small scale irrigation equipment like treadle pumps or drip kits. This would increase the production level or yield per hectare in the dryland farming system because farmers will be able to irrigate their crop in the mid season droughts and even produce during the dry season with the use of water available in rivers and streams. This small scale irrigation equipment can be easily used if the farmers form cooperatives.
- AGRITEX should collaborate with DTC-UZ and other stakeholders like Plant Protection department, and Horticulture Reseach Centre to produce improved sweetpotato varieties that can increase crop production and improve farmers' yield.
- Farmers, through cooperatives can have a central garden or plot where they keep their planting material so that when planting time comes they do not cut the vines from the field which they are going to harvest as this disturbs dry matter accumulation resulting in low yield.
- Harare municipality should reduce market fees for the farmers as this fee is too high and it eats away the framers' money at market. Farmers end up not wanting to spend more days at market therefore sell their sweetpotato at give away price. The $US6 per day which is charged to the farmers is very much unfair if compared to the $US10 charged to the retailers per month. Reducing this fee will spread the farmers' costs and therefore, farmers can be able to buy fertilizers without seeking help from banks.
- AGRITEX should design training programmes and train farmers on proper handling and marketing of sweetpotato. These should include the use of chemical fertilizers for increased production and curing and storage of sweetpotatoes as well as value addition. These trainings will address the risks of careless digging during harvesting and poor handling of sweetpotato as mentioned in Table 9. Also there should be trainings on curing and storage and its benefits to the farmers.
- For sweetpotato products produced by DTC-UZ, product promotion should be done by collaborating with food processing companies like Cairns Foods Limited, who are already known for their good reputation in food industry in Zimbabwe. DTC-UZ should also collaborate with local engineering companies like Tan Roy Engineering to develop processing technology that can help in increasing the speed of processing of sweetpotato. This technology will reduce labor costs incurred by hiring labor to wash, peel and chip the sweetpotato manually.
- AGRITEX, through the agricultural bank (Agribank) should facilitate farmers' access to bank loans like what they do for crops like maize, tobacco, wheat and cotton. In this sense AGRITEX will help farmers to come out with the cash flow budgets that are required by the bank. Bank loans will enable farmers to buy enough inputs like fertilizer which will increase yield.
- AGRITEX should liaise with Harare municipality so that farmers can be provided with decent accommodation when they are at market or agree on putting in place a central warehouse managed by either one of them or by both. Farmers will then send their sweetpotato to the market without them also going to the market

place. From this central warehouse, retailers, vendors and consumers can buy at defined prices for well known grades.

- AGRITEX should put in place standard ways of measuring area and farmers' yield so that they can have the actual yields estimates of sweetpotato. Knowing production level of different sweetpotato farmers will enable AGRITEX to help farmers market their sweetpotato. AGRITEX can create a website where information on sweetpotato varieties and production level is displayed so that if there are companies who want to buy sweetpotato, they can just visit the website, check the information and go and buy direct from the farmers' fields. Companies which might want to contract farmers may also find the information of where to get the varieties they need from the AGRITEX website.
- There should be quality standards governing sweetpotato production and marketing in the AGRITEX crop production regulations.
- Farmers with the help of AGRITEX can develop central warehouses in their local areas where they can store and process their sweetpotato through the farmers' cooperatives as was done by Soroti farmers through SOSPPA in Soroti district in Uganda. This farmers'association has managed to build a central warehouse where the farmers can store and add value to their sweetpotato thus reducing transport cost of transporting the bulky sweetpotato to the market in towns. Through this warehouse system, Soroti farmers are able to access bank loans from Stanbic and Centenary banks.

REFERENCES

1. Agritex., 2008. *Agricultural policy for Zimbabwe*. Harare: Ministry of Agriculture.

2. Brooke, A.E., 2003. *Postharvest Handling of Sweetpotatoes.* North Carolina: North Carolina Coorperative extension Services.

3. Chikwenhere, G.P., 2000. *Major pests of sweetpotato, Ipomea batatus L. with special references to problems related to the sweetpotato weevils, Cylas spp. in Zimbabwe*. Harare: Plant protection Research institute

4. Chipangura, B. & Jackson, J.E., 1993. *Sweetpotato for high yield in Zimbabwe: Farming world.* Harare: Horticulture Research Centre.

5. Chivhinge, O.A., Rukuni, T. & Mutungamiri, A., 2000. *Dissemination of sweetpotato production and processing technologies in Zimbabwe.* Harare: University of Zimbabwe.

6. Clark, C. et al., 2006. *Preliminary Report: Louisiana and North Carolina Sweetpotato Packing line Surveys*. North Carolina: University of Georgia.

7. Dhliwayo-Chiunzi, P.D., 2004. *From tubers to riches: a guide to profitable production of sweetpotatoes*. Harare: Biotechnology trust of Zimbabwe.

8. FAO., 2008. *Issues in global tobacco: raw materials, tropical and horticultural products, services, commodities and trade division.* Rome: FAO Economic and Social Department.
www.fao.org/docrep/006/y4997e00.htm Accessed: 28 June 2009

9. FAO., 2009. *Crop prospects and food situation - No.1 February.* Rome: FAO Economic and Social Department,
http://www.fao.org/docrep/011/ai480e/ai480e00.htm *Accessed: 3 July 2009*

10. FAO., 2009. *FAO/WFP Crop and food security assessment mission to Zimbabwe report.* Rome. FAO Economic and Social Department.
http://www.wfp.org/food-security/reports/CFSAM. Accessed 4 September 2009

11. FAOSTAT. http://faostat.fao.org/default.aspx *Accessed: 5 July 2009*

12. Fuglie, K.O., 2007. Priorities for Sweetpotato Research in Developing Countries: Results of a Survey. *HortiScience* 42(5), p.1200–1206. Nairobi: International Potato Centre.

13. Kader, A.A., 2002. *Postharvest technology of Horticultural crops* 3rd ed. Califonia: University of California.

14. Katinoja, L., & Kader, A.A., 2004. *Small-Scale Postharvest Handling Practices: A Manual for Horticultural Crops.* 4th ed. California: University of California.
http://www.fao.org/docrep/009/ae075e/ae075e00.htm *Accessed: 2 July 2009*

15. KIT., Faida MaLi., & IIRR., 2006. *Chain empowerment: Supporting African farmers to develop markets.* Amsterdam: Royal Tropical Institute., Arusha: Faida Market Link. and Nairobi: International Institute of Rural Reconstruction.
http://www.kit.nl/net/KIT_Publicaties_output/ShowFile2.aspx?e=885

16. KIT and IIRR., 2008*. Trading up: Building coorperation between farmers and traders in Africa.* Amsterdam: Royal Tropical institute. and Nairobi: International Institute of Rural Reconstruction.

17. Lunning, P.A., Marcelis, W.J & Jongen, W.M.F., 2006. *Food quality management: a techno-managerial approach.* Netherlands: Wageningen Academic.

18. Manzungu, E., Senzanje, A., & Van Der Zaag, P., 1999. *Water for agriculture in Zimbabwe: constraints and opportunities in the smallholder farming sector*. Harare: University of Zimbabwe.

19. Moyo, P.S., 2008. *Farming for future: A guide for conservation agriculture in Zimbabwe*. Bulawayo: ICRISAT

20. Mupanda, K., 2002. *Trends in sweetpotato consumption and vending in Harare and Chitungwiza.* Harare: University of Zimbabwe

21.Mutandwa, E., 2008. Performance of Tissue-Cultured Sweetpotatoes among Smallholder Farmers in Zimbabwe. *The journal of agrobiotechnology management and economics.* 11(1), p48-57. Bindura. Bindura University of Science Education.
http://www.agbioforum.org/v11n1/v11n1a05-mutandwa.htm *Accessed 24 may 2009*

22. Mutandwa, E. & Gadzirai, C.T., 2006. Comparative Assessment of Indigenous Methods of Sweetpotato Preservation among Smallholder Farmers: Case of Grass, Ash and Soil based Approaches in Zimbabwe. *African Studies Quarterly* 9(3), p Bindura. Bindura University of Science Education
http://web.africa.ufl.edu/asq/v9/v9i3a4.htm *Accessed 15 June 2009*

23. Mutungamiri, A., Zingoni, C. & Rukuni, T., 2001. *Evaluation of sweetpotato varieties and pectin from fruit source for acceptability of jam.* Harare: Development Technology Centre-University of Zimbabwe.

24. Nciizah, A., 2009. *Root and tuber crops research and development priorities in Zimbabwe.* Harare: Agronomy Research Institute.

25. Poincelot, R.P., 2004. *Sustainable horticulture: today and tomorrow*. Upper Sadle River, New Jersey: Pearson Education.

26. Ray, R.C. & Ravi, V., 2005. Postharvest Spoilage of Sweetpotato in Tropics and Control Measures. *Critical Reviews in Food Science and Nutrition*, 45(7), p623 — 644. Trivandrum: Central Tuber Crops Research Institute.
http://dx.doi.org/10.1080/10408390500455516

27. Stathers, T. et al., 2005. *Manual for sweetpotato integrated production and pest management farmer field schools in Sub-Saharan Africa.* Kampala: International Potato Centre (CIP).

28. USAID., 2009. *Global food security response: West Africa value chain analysis protocol.* United States. USAID.
http://www.scribd.com/doc/17028560/mR-153-Global-Food-Security-Response-West-Africa-Value-Chain-Analysis-Protocol Accessed 20 June 2009

39. Vermeulen, S., Woodhill, J., Proctor, F. & Delnoye, R., 2008. *Chain-Wide learning for inclusive agrifood market development: a guide to multi-stakeholder processes for linking small-scale producers to modern markets.* Wageningen: Wageningen University and Research Centre.
www.regoverningmarkets.org *Accessed: 17 June 2009*

30. Visser, H.M., & van Goor, A.R., 2006. *Logistics: Principles and practice*. Groningen/Houten. Wolters-Noordhoff.

31. Will, M., 2008. *Promoting Value Chains of Neglected and Underutilized Species for Pro-Poor Growth and Biodiversity Conservation: Guidelines and Good Practices. Global Facilitation Unit for Underutilized Species,* Rome,.
http://www.underutilized-ecies.org/Documents/PUBLICATIONS/promoting_vc_lr.pdf
Accessed 17 June 2009

32. Research Into Use., 2007. *The Value chain approach to poverty reduction and development of livelihoods*
http://www.researchintouse.com/nrk/RIUinfo/valuechain/valuechain.htm Accessed: 25 August 2009

33. Zeblon, E. 2006. *Starting a Warehouse Receipt System for Kyere*. Uganda. Linking Local Learners
http://www.linkinglearners.net *Accessed 24 May 2009*

ANNEX 1: Gross Margin Analysis for irrigation farmers

Variable costs	Amount	Cost/Unit ($US)	Calculation	Total Cost ($US)
Fertilizer AN	3*50Kg	35	Volume* price	105.00
Compound D	5*50Kg	30	Volume* price	150.00
Seed (kg/ha)	5000	0.025	Volume* price	125.00
Mancozeb	1*1L	10	Volume*Price	10.00
Labor (days)	100	1.6/day	Days* wage/day	160.00
Transport	10 000kg	0.04/kg	Volume* price	400.00
Subtotal				**950.00**
Miscellaneous	0.02			19.00
Calculated interest	0.05		(new price+scrape price/2)* interest rate	24.23
Total variable Cost				**993.23**
Fixed costs				
Land				25.00
Irrigation water	12 months	14/month	Volume*price	168.00
Municipality fee	20 days	6	Volume*price	120.00
Total Costs			**Fixed costs +Variable Costs**	**1,306.23**
By-products (vines)	5 000	0.025	Volume*price	125.00
Cost price			Total costs – by-products/volume	0.12
Yield Kg/ha	10 000			
Selling price/Kg		**$0.18**		
Gross Output/ha		1,800.00		
Gross output/Kg		0.18		
Gross margin= Gross output-Variable costs				
1,800.00 – 993.23 = 806.77				
Gross margin/Kg =Gross output-Variable cost = 0.18 – 0.10 = **0.08**				

Profit =Gross margin - Fixed costs = $806.77 – $313.00 = $513.15
Calculated Family Labor =50*$1.60 =$80.00
Net farm income =profit/loss + calculated family labor
=$513.15 + $80.00 = **$593.15**

Farmers in the irrigation scheme use both hired and family labor therefore calculated family labor is calculated at half the cost of labor. The calculated family labor is the amount which if the family had hired some labor would have paid it out, but the family has served this cost by using family labor instead of hired labor.

ANNEX 2: Gross margin analysis for dryland farmers

Variable costs	Amount	Cost/Unit ($US)	Calculation	Total cost ($US)
Fertilizer AN	3x50kg	35	Volume* price	105.00
Compound D	5x50Kg	30	Volume* price	150.00
Seed (kg/ha)	5000	0.025	Volume* price	125.00
Mancozeb	1x1L	10	Volume*Price	10.00
Labor (days)	100	1.6/day	Days* wage/day	160.00
Transport	6 000kg	0.04/kg	Volume* price	240.00
Subtotal				**790.00**
Miscellaneous	0.02			15.80
Calculated interest	0.05		(new price+scrape price/2)* interest rate	20.15
Total variable cost				**825.95**
Fixed costs				
Land		**25**		25.00
Municipality fee	20 days	6	Volume*price	120.00
Total costs			**Fixed costs +Variable costs**	**970.95**
By-products (vines)	4 000	0.025	Volume*price	100.00
Cost price			Total costs – by-products/volume	0.15
Yield Kg/ha	6 000			
Selling price/Kg		**$0.18**		
Gross Output/ha	1,080.00			
Gross output/Kg	0.18			
Gross margin= Gross output-Variable costs = 1,080.00 – 825.95 = 254.05				
Gross margin/Kg =Gross output/kg -Variable cost/kg = 0.18 – 0.13 = **0.05**				

Profit =Gross margin - Fixed costs =254.05 – 145.00 = 109.05
Calculated Family labor = 100*1.60 = 160.00
Net farm income =profit/loss + calculated family labor
$254.05 + $160.00 = **$414.05**

Dryland farmers have low level of production as compared to irrigation farmers. Their cost of production per kg of sweetpotato is higher than the cost of production for the irrigation farmers.

ANNEX 3: Gross Margin Analysis for Retailer level

Variable costs	Amount	Cost/Unit ($US)	Calculation	Total cost ($US)
sweetpotato	15, 000kg	0.18	Volume*price	2700.00
Transport	7.5*500kg	1.00	Volume*price	7.50
Packaging material	375*20kg	0.04	Volume*price	15.00
	300*10kg	0.04	Volume*price	12.00
	600*5kg	0.02	Volume*price	12.00
	750*2kg	0.02	Volume*price	15.00
Subtotal				**2761.50**
Miscellaneous	0.02			55.23
Calculated interest	0.05		(new price+scrape price/2)* interest rate	70.42
Total variable cost				**2,887.15**
Fixed Costs				
Municipality fee	1months	10.00	Volume*price	$10.00
Total costs			**Fixed costs + variable costs**	**2,897.15**
Cost price			Total cost – by-products/volume	0.19
Selling price/Kg	**$0.23**			
Gross output		3,450.00		
Gross output/Kg		0.23		
Gross margin= Gross output-Variable costs				
3,450.00 – 2,887.15 = 562.85				
Gross margin/Kg =Gross output/kg -Variable cost/kg = 0.23 – 0.19 = **0.04**				

Profit =Gross margin-Fixed costs =$562.85 – $10.00=$552.85
Net income =$552.85

Calculations are based on one month's sales assuming a retailer selling 500kg per day. The total sales become 15 000kg per month.

ANNEX 4: Gross margin analysis at vendor level (Mbare)

Variable costs	Amount	Cost/Unit ($US)	Calculation	Total Cost ($US)
sweetpotato	1,200kg	0.18	Volume*price	216.00
Transport	2 trips(bus)	0.50	Volume*price	1.00
	sweetpotato	0.50	Volume*price	0.50
Subtotal				**217.50**
Miscellaneous	0.02			4.35
Calculated interest	0.05		(new price+scrape price/2)* interest rate	5.55
Total variable cost				**227.40**
Fixed Costs				
Municipality fee	1months	0	Volume*price	0.00
Total costs			**Fixed costs + variable costs**	**227.40**
Cost price			Total cost – by-products/volume	0.19
Selling price/Kg	**$0.3**			
Gross output		360.00		
Gross output/Kg		0.3		
Gross margin= Gross output-Variable costs = 360.00 –227.40 = 132.60				
Gross margin/Kg =Gross output/kg -Variable cost/kg = 0.3 – 0.19 = **0.11**				

Profit =Gross margin-Fixed costs =132.60 - 0
Net income = 132.60

Assuming that a vendor is selling 40kg of sweetpotato everyday, the total sales becomes 1200kg per month

ANNEX 5: Gross margin analysis at vendor level (Machipisa)

Variable costs	Amount	Cost/Unit ($US)	Calculation	Total Cost ($US)
sweetpotato	1,200kg	0.23	Volume*price	276.00
Transport	2 trips(bus)	0.50	Volume*price	1.00
	sweetpotato	0.50	Volume*price	0.50
Subtotal				**277.50**
Miscellaneous	0.02			5.55
Calculated interest	0.05		(new price+scrape price/2)* interest rate	7.08
Total variable cost				**290.13**
Fixed Costs				
Municipality fee	1months	0	Volume*price	0.00
Total costs			**Fixed costs + variable costs**	**290.13**
Cost price			Total cost – by-products/volume	0.24
Selling price/Kg	**$0.3**			
Gross output		360.00		
Gross output/Kg		0.3		
Gross margin= Gross output-Variable costs = 360.00 –290.13 = 69.87				
Gross margin/Kg =Gross output/kg -Variable cost/kg = 0.3 – 0.24 = **0.06**				

Profit =Gross margin-Fixed costs =$69.87 - $0
Net income =$69.87

Assuming that a vendor is selling 40kg of sweetpotato everyday, the total sales becomes 1200kg per month

ANNEX 6: Gross margin analysis at processor (unpeeled sweetpotato - flour)

Variable costs	**Amount**	**Cost/unit ($US)**	**Calculation**	**Total cost ($US)**
sweetpotato	1,000kg	0.18	Volume*price	180.00
Transport	5L diesel	1.25	Volume*price	6.25
processing	1,000kg	0.25	Volume*price	250.00
Subtotal				**436.25**
Miscellaneous	0.02			8.73
Calculated interest	0.05		(new price+scrape price/2)* interest rate	11.12
Total variable cost				**456.10**
Fixed Costs				
Electricity	1 month			50.00
Water	1month			35.00
Total costs			**Fixed costs + variable costs**	**541.10**
Cost price per kg			Total cost – by-products/volume	0.54
Output	450kg flour			
Selling price/Kg	$1.00			
Gross output	450.00			
Selling price/Kg of sweetpotato			(450/1000)*1.00=$ **0.45**	
Gross margin= Gross output-Variable costs = 450.00 – 456.10 = -6.10				
Gross margin/Kg =Gross output/kg -Variable cost/kg = 0.45 –0.46 = -**0.01**				

Profit =Gross margin-Fixed costs =$-6.10 – $85.00
Net Profit = $-91.10

Flour producer sells his flour at $1/kg. To calculate the selling price of 1kg sweetpotato at this level, the total amount of flour produced has been divided by the total sweetpotato used in producing the flour, i.e. 450kg flour/1000kg sweetpotato = $0.45.

ANNEX 7: Gross margin Analysis at Bakery

Variable costs	Amount	Cost/unit ($US)	Calculation	Total cost ($US)
Flour	3600kg	1.00	Volume*price	3600.00
Oil	6*20L	25.00	Volume*price	150.00
Salt	30kg	0.35	Volume*price	10.50
Sugar	120kg	1.70	Volume*price	204.00
Yeast(packets)	600	0.70	Volume*price	420.00
Transport	15L	1.25	Volume*price	18.75
Subtotal				**4403.25**
Miscellaneous	0.02			88.07
Calculated interest	0.05		(new price+scrape price/2)* interest rate	112.28
Total variable cost				**4603.60**
Fixed Costs				
Electricity	1 month			65.00
Water	1month			45.00
Total costs			**Fixed costs + variable costs**	**4713.60**
Output (Rolls)	5333			
Selling price/roll	$1.00			
Gross output	5,333.00			
Selling price/kg sweetpotato = (0.45/0.675)*$1.00 = **$0.67**				
Gross margin= Gross output-Variable costs = $5,333.33– $4603.60 =$729.40				
Gross margin/Kg flour =Gross output/kg -Variable cost/kg = 1.48– 1.28 = 0.20				

Profit =Gross margin-Fixed costs =$831.78 – $110.00
Net Profit = $721.78

From the calculations made, one roll is made from 0.675kg of flour. 1kg of sweetpotato = 0.45kg of flour. One roll was being sold at $1.00 therefore 1kg of sweetpotato was sold at (0.45/0.675)*$1.00 = $0.67

ANNEX 8: Questionnaire for farmers

A. Production cost questions

1. Where and how do you get sweetpotato vines and what quantities and price?

Sweetpotato vines	Virus free	Retained
Source		
Quantity		
Price per unit		
Area planted		

2. What other inputs do you use for sweetpotato production?

Input	Source	Quantity	Price	Area (ha)
Fertilizer				
Pesticides				
Irrigation water				
Other (specify)				

3. If no other inputs are used what could be the reason?
a) Can not afford the inputs b) inputs are not available in shops c) do not know how to use them d) other (specify)

4. What type of labor do you use? a) hired b) family labor c) family + hired labor

5. How many tonnes of sweetpotato do you produce per hectare? .....

Harvesting and Postharvest Questions

6. How do you harvest your sweetpotato? a) Digging b) ploughing c) other

7. How do you transport your sweetpotato from field? a) Scotch cart b) wheelbarrow c) Vehicle

8. Do you store sweetpotato for marketing? a) Yes b) No

9. What is the reason of not storing sweetpotato? a) Lack of storage facilities b) High market demand c) staggered harvesting d) Don't know how to store

10. Do you store sweetpotato for home consumption? a) Yes b) No

11. How do you preserve and store your sweetpotato? a) Underground pit with sand b) Underground pit with ash c) underground pit with grass d) other

12. What quantity do you store? .....

13. How many months do you store your sweetpotato? a) 0-1.5 b) 1.5-2.5 c) 2.5-3.5 d)more than 3.5 months

14. What storage problems do you encounter? a) rotting b) pests and diseases c) none

15. Do you grade your sweetpotato and how? a) Yes…….. ……. b) No

16. Do you cure your sweetpotato? a) Yes b) No

17. Do you wash your sweetpotato? a) Yes b) No

Marketing Questions

18. What type and size of bags do you use for packaging for market? a) 90kg plastic b) 50kg plastic c) 90kg jute d) 50kg jute

19. Where do you sell your sweetpotato? a) Mbare b) Machipisa c) other

20. At market who do you sell your sweetpotato to? a) retailers b) vendors c) consumers

21. How do you transport sweetpotato to market? a) Arranged transport b) anything that comes along the road

22. How many days do you spend on road? a) 0-1 b) 1.1-2 c) 2.1-3 d) 3.1-7

23. How much do you pay for transport per bag? .....

24. What are the market prices for the market that you supply? .....

25. How many months do you sell sweetpotato per year? .....

26. Which market place problem is more important to you? a) Accommodation b) opening and closing time c) High municipality charges d) congestion of sellers and buyers.

27. Where are highest loses encountered? a) Harvesting b) in field c) on road d) at market

28. Do you label your bags when going to the market? a) Yes b) No

ANNEX 9: Checklist for Case study

Sweetpotato production, postharvest handling and marketing – Ministry of Agriculture (AGRITEX)

- Sweetpotato production in general, production and yields (trend since 2000)
- challenges/constraints faced by farmers
- Production costs of sweetpotato and returns
- Actors and supporters in sweetpotato chain (producers, traders etc)
- Problems in sweetpotato postharvest processes and marketing
- Facts and figures for production, postharvest handling, marketing and losses incurred by farmers and traders
- What has been done to improve sweetpotato production and postharvest processes
- The future of sweetpotato postharvest processes
- What policies and regulations govern sweetpotato production, postharvest handling and marketing?
- What type of support do you give to farmers (financial, technical)
- As an organisation what challenges do you face in helping small holder sweetpotato farmers?

Postharvest handling – Retailers and Vendors

- Source of sweetpotato
- Ordering policy (contracts, spot market, information exchange and quantities)
- Choice of sweetpotato (quality, distance to the market place, Price)
- Price negotiations with farmers, selling price per unit and price setting
- Trading costs (transport, storage, repackaging and municipality charges)
- Type and sizes of packaging material
- Quality management in the whole trading operation (transport, storage and marketing)
- Quality grades, loses
- Challenges in sweetpotato trading and suggestions to solve these challenges

Sweetpotato Value addition - Development Technology Centre-University of Zimbabwe

- Source of sweetpotato and sourcing policy
- Production level and costs
- Products, selling price, price setting, value generated
- Marketing of the sweetpotato products
- Stakeholders in sweetpotato processing
- General acceptance of sweetpotato products in the food industry
- Information flow to and from the sweetpotato suppliers

Market place Logistics - Market Controllers

- Control of inflow and outflow of sellers and buyers
- Municipality charges
- Monitoring of farmers entering the market
- Opening and closing times
- Maintenance of the market place

ANNEX 10: Independent Variable t-test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
What is the size (HA) of your sweetpotato plot?	Equal variances assumed	9.886	.004	-.266	28	.792	-.01333	.05008	-.11592	.08925
	Equal variances not assumed			-.266	19.832	.793	-.01333	.05008	-.11785	.09119
How many tonnes of sweetpotato do you produce per hectare?	Equal variances assumed	3.464	.073	6.140	28	.000	4.70333	.76595	3.13435	6.27232
	Equal variances not assumed			6.140	19.095	.000	4.70333	.76595	3.10072	6.30595
How much do you pay for transport per bag?	Equal variances assumed	2.027	.166	1.025	28	.314	.09333	.09110	-.09327	.27993
	Equal variances not assumed			1.025	27.859	.314	.09333	.09110	-.09331	.27998
What are the market prices for the market that you supply?	Equal variances assumed	1.202	.282	-.220	28	.828	-.05333	.24279	-.55066	.44400
	Equal variances not assumed			-.220	27.427	.828	-.05333	.24279	-.55113	.44446
How many months do you sell sweetpotato per year?	Equal variances assumed	2.778	.107	3.829	28	.001	2.100	.548	.977	3.223
	Equal variances not assumed			3.829	23.319	.001	2.100	.548	.966	3.234
How many days do you spend on road?	Equal variances assumed	.588	.450	-4.736	28	.000	-1.733	.366	-2.483	-.984
	Equal variances not assumed			-4.736	27.250	.000	-1.733	.366	-2.484	-.983