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AN ASSESEMENT OF TOMATO PRICE VARIABILITY IN
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AN ASSESSMENT OF TOMATO PRICE VARIABILITY IN LUSAKA
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By

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ABSTRACT

AN ASSESSMENT OF TOMATO PRICE VARIABILITY IN LUSAKA AND ITS EFFECTS ON SMALLHOLDER FARMERS

Mukwiti Nchooli Mwiinga

This paper discusses the structure and operation of the tomato subsector in Lusaka (Zambia), establishes the level of price variability for tomatoes in Lusaka's Soweto market, and assesses the impact of tomato price variability on returns to tomato production. Price variability determination involved analysis of the coefficient of variation, conditional variance and the ratio of the mean absolute positive to negative price prediction errors. These results were compared with four other wholesale markets in Costa Rica, Taiwan, Sri Lanka, and the United States of America (Chicago). These other countries were chosen to capture a wide range of supply chain development, as proxied by purchasing power parity Gross Domestic Product (PPP GDP). The study revealed that (a) PPP GDP is strongly negatively (positively) associated with price variability (predictability), and (b) Zambia has the lowest PPP GDP, highest price variability, and least tomato price predictability. Monte Carlo simulation analysis was then conducted to establish the effect that three different scenarios would have on the tomato farmers' net returns. Increased sales frequency reduces the variability of expected price but has no recognizable impact on the variability of profits. Supply chain improvements also reduced the variability of prices. The production of high quality tomatoes has very significant effects on returns to farmers. Some policy implications drawn include, the need to establish formal grades and standards, investment in cold chain systems and general improvement in the traditional wholesale and retail market infrastructure.

DEDICATION

This thesis is dedicated to my family: my late father, Elijah Musembwa Mwiinga, my mother, Margaret Duntuula Mwiinga, my siblings Malita, Maelo, Mugwagwa and Mutinta, and my nieces Chiedza and Duntuula. Special dedication goes to my dearest father who always insisted on hard work and discipline in school, and to my mother for all her love and support during my studies, but most importantly, for being the 'superwoman' in my life.

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KEY TO ABBREVIATIONS

FFV	Fresh Fruits and Vegetables
FDI	Foreign Direct Investment
FSRP	Food Security Research Project
GDP	Gross Domestic Product
Ksh	Kenyan Shilling
MACO	Ministry of Agriculture and Cooperatives
M-W-F	Monday-Wednesday-Friday
NRDC	Natural Resources Development College
PPP	Purchasing Parity Prices
RNPE	Ratio of the mean absolute values of negative to positive errors
SSA	Sub Saharan Africa
UCS	Urban Consumption Survey
UILTCB	USAID Initiative for Long Term Capacity Building
UMDP	Urban Markets Development Program
UN	United Nations
USD	United States Dollar
US/USA	United States of America
USAID	United States of America
Wk	Week
ZEGA	Zambia Export Growers Association
Zkw	Zambian Kwacha

CHAPTER 1
INTRODUCTION

1.1 Background

Research and programmatic activity on the horticultural sector in Africa over the past 15 years has been dominated by two issues: increasing horticultural exports and the influence of emerging supermarkets on horticulture trends. Early in the period, Kenya's success in exporting fresh produce to Europe led to a large body of research documenting the process and assessing its effects. For instance Jaffee (1995) investigated the organization and development of a dynamic African export oriented sector, specifically, Kenya's horticultural exports. Other documented research bring to light the recent developments in Sub Saharan Africa horticulture exports and the success story in Kenya's horticulture sector (Swernberg 1995; Kimenye 1995; Stevens and Kennan 1999; Dolan et al. 1999; Harris et al. 2001; Minot and Ngigi 2002).

With the success that has been recorded in Kenya's horticultural export sector, this has also led to many programmatic initiatives across the continent to help countries exploit what was seen as a rapidly growing and potentially very lucrative market. In Zambia for instance, Foreign Direct Investment (FDI) has been instrumental in increasing exports of horticulture and floriculture products in recent years. Much of the investment has gone into the transfer of skills and knowledge, the introduction of new varieties of flowers and vegetables, and made local farmers more familiar with the use of new pest control methods and irrigation. For instance, the Natural Resources Development College/Zambia Export Growers' Association (NRDC/ZEGA) was set up mainly by exporters, most of them foreign firms, in partnership with the government of Zambia.

Through this Trust, farmers are educated on the safe use of agricultural chemicals, pesticides and herbicides, and on personal and consumer safety (United Nations, 2006).

The second main focus of research on African horticultural sectors has been on the rise of supermarket chains. These chains have been seen as the leading edge of globalization in developing country food systems, and concerns have been raised about the ability of local retailers to compete, and also about the possible exclusion of smallholder farmers from these new supply chains (Weatherspoon and Reardon 2003; Humphrey 2007; Reardon and Berdegue 2002; Reardon and Timmer 2006).

Both strands of work – on horticultural exports and on the rise of supermarkets – have made important contributions to our understanding of African horticultural sectors. Exports have been a major and continuing success story in Kenya, and other countries, such as Cote d'Ivoire have also made some progress in developing these sectors. Supermarkets have also expanded fairly strongly in some African countries, and represent a potentially important force of change.

Though these two strands of work have highlighted important aspects of current fresh produce systems in Africa, they both miss two fundamental facts. First, the vast majority of fresh produce in the continent is purchased by domestic consumers, not foreign buyers. For example, Tschirley et al (2004) show that, in Kenya, during the period 1997 to 2000 retail domestic sales of vegetables accounted for 52% (valued at Kenya Shilling

(Ksh[1])7.5 billion) of total vegetable production, and vegetables that were retained on the farm accounted for 36% (Ksh 5.2 billion) while only 12% (Ksh 1,7 billion) of domestic production went to export sales. Yet Kenya is the foremost African success story in fresh produce exports; in other countries of the continent, the dominance of the domestic over the export system is even more accentuated. Second, within the domestic system, the "traditional" systems carry the vast majority of all fresh produce in all African countries except South Africa. (Tschirley 2007; Humphrey 2006; Traill 2006; Minten 2007). Even though there could be a steady rise in the volumes of horticultural sales passing through non-traditional channels such as supermarkets, many of these authors suggest that the market shares of traditional channels are likely to remain high for many years in Africa.

Despite the current widespread use of traditional horticultural retail channels, they have received very little public- or private investment since independence, and this lack of investment is a major problem, causing congestion, unsanitary conditions and high costs (Hichaambwa and Tschirley, 2006). High price volatility is a major challenge in all fresh produce systems due to their perishable nature. Even more challenging in traditional system is the lack of cold chains, little or no timely market information and the general absence of coordination mechanisms to regulate the flow of product to the market (World Bank 2007).

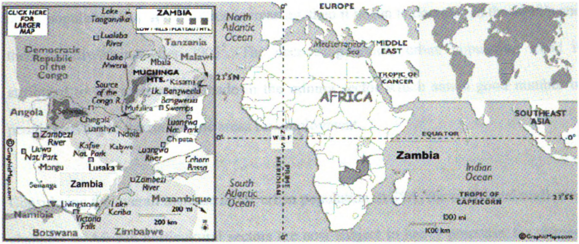
[1] The mean exchange rate to the US $ for the four year period between 1997 and 2000 was KSH 66 (KSH 59, KSH 60.5, KSH 70 ND KSH 76 for 1997, 1998, 1999 and 2000 respectively. www.oanda.com

Given these problems faced by traditional systems, if not vigorously addressed, they will only become worse over time, due to rapid urbanization and income growth that fuels even more rapid growth in demand in urban areas.

1.1.1 The Situation in Zambia

The republic of Zambia is a landlocked country located in Southern Africa bordered by eight countries namely: Mozambique, Malawi, Tanzania, Democratic Republic of Congo, Angola, Namibia and Zimbabwe (Figure 1.1). The country has a population estimated at 12.5 million with 65% being rural population and 35% urban population, and has a Gross Domestic Product (GDP) per capital of US$1,223[2].

Figure 1.1: Geographical Location of the Republic of Zambia



Source: http://www.worldatlas.com/webimage/countrys/africa/zm.htm

In Zambia, nearly 90% of all fresh produce marketed in Lusaka[3] flows through traditional retail channels, specifically the open air markets and street vendors and other informal traders operating outside the market, while modern retail channels such as supermarket

[2]International Monetary Fund (IMF) publications. http://www.imf.org/external/pubs/ft/weo/2008/02/weodata

[3] Lusaka is the capital city of Zambia and has the largest FFV wholesale and retailing system.

chains and independent supermarkets hold combined shares of less than 10% (Food Security Research Project Urban Consumption Survey, 2007). This clearly tells us that the traditional sector dominates the fresh produce system as in most of Sub Saharan Africa (SSA).

In many SSA countries, there has been rapidly rising share of urban population in total population. According to the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, over the past few decades and in the next to come, the percent of urban population has been and will continue to rise steadily compared to the rural population which is actually decreasing[4]. However, in Zambia this has not exactly been the trend. Over the period between 1980 to 2030, the percent of urban population had initially been increasing, then it begun to decrease in the 1990's and then steadily rising after 2005[5]. The decreasing annual urban population trend is attributed to the investments made in the mining sector which saw a good number of people moving to the rural mine areas for employment.

Considering the overall increase in the urban population in SSA, the traditional marketing channels in African horticultural sectors are now subject to heavy pressures for change. In Zambia, urban populations are growing rapidly and therefore the traditional horticulture systems need substantial investment. Since urban marketing infrastructure in most of the continent, Zambia included, has received very little investment in recent decades, the result has been often chaotic, unsanitary, and high-cost marketing systems

[4] World Urbanization Prospects: The 2007 Revision Population Database
http://esa.un.org/unup/p2k0data.asp
[5] http://esa.un.org/unup/p2k0data.asp

that don't serve the interests of farmers or consumers very well (Hichaambwa and Tschirley, 2006).

Soweto market in Lusaka is the largest wholesale and retail center for fresh fruits and vegetables (FFV) in the country. Located in the center of the city, it is a commercial hub for FFV and a wide assortment of other food items such as dry cereals, pulses, and tubers, among others. Despite the huge amounts of FFV and other food items it handles, this market has for a long time been in a poor state. It has poor and limited sanitation, a poor waste management system and a poor drainage system. Even though the local council authority collects market stall levies from the operators in this market, there has been little investments made to improve it. Coupled to its physical inadequacy is the absence of market information, and the lack of formal grades and standards. (Hichaambwa and Tschirley, 2006, Typsa Consulting Engineers and Architects, 2004)

In an attempt to address some of the concerns in Soweto market, the European Union, in collaboration with the Ministry of Local Government and Housing is currently investing over 16 million Euros into a program called the Urban Markets Development Program (UMDP). Among other things, the UMDP has focused on the construction of improved physical infrastructure in selected markets of Lusaka, Ndola and Kitwe cities. In Lusaka, Soweto market is one of the markets that has benefited from this program (Hichaambwa and Tschirley, 2006). This program is currently ongoing in all selected markets and works in Lusaka's Soweto market still continue. Despite the investment made by UMDP in Soweto market, it is not clear how meaningful a contribution the program will make towards lowering the costs, encouraging higher quality and better price predictability, among other things, for tomatoes and other FFV, and generally improving wholesaling and retailing of fresh produce in the market.

This paper shall focus on the wholesaling and retailing of tomatoes in Lusaka's Soweto market. Among all FFV, tomatoes have the second largest share in both production and consumption in Zambia, following rape, (FSRP UCS data, 2007). Tomatoes are therefore one the most widely consumed fresh fruits and vegetables. However, farmers, traders, and consumers of these tomatoes are faced with tremendous price variability from day to day and also within days. Given the high level of variability of tomato prices, two important questions arise. Firstly, what is the effect of this variability on the riskiness of returns to farmers? And secondly, can market information lead to improved decision making that raises and stabilizes returns? This paper shall address these two questions.

1.2 Objectives of the Study

The overall objective of this study is to evaluate the price variability of tomato in Lusaka's Soweto market and to assess the effects of different production and marketing strategies on farmers' performance. Soweto market accounts for the lion's share of wholesale fresh produce transactions in Lusaka.

The specific objectives of the study are:

1. To identify the level of price variability for tomato in Soweto market and evaluate how this compares with other markets around the world.

2. To determine the impact of price variability on the current level and variability of farmer returns to tomato production.
3. To assess the effects of alternative production and marketing strategies, and "generic" supply chain improvements on the variability of price and returns to farmers.

1.3 Organization of Thesis

The thesis organization is as follows: Chapter 2 gives a detailed overview of the tomato production and marketing system serving Lusaka. The data and methods of analysis used are also discussed. A tomato subsector channel map is presented with a discussion on the various actors in the subsector.

Chapter 3 presents the hypothesis, an analysis, results and discussion of the tomato price variability at wholesale level where a comparison of Soweto market with some other wholesale markets in other parts of the world was made. Tomato price variability in wholesale markets of the US, Taiwan, Costa Rica and Sri Lanka was analyzed and compared with that of Zambia's Soweto market.

Chapter 4 presents the data used, results and discussion on the various Monte Carlo analyses conducted. Both the conditional and unconditional distribution of the tomato growers net returns from tomato production are looked at. The conditional profits discussed are based on the tomato grower's production and marketing decisions and on the use of certain market information, while the unconditional profits are based on the tomato prices they observe in the market.

Chapter 5 concludes the thesis with a presentation of a summary of the study, policy implications, contributions and limitations of the study, and suggestions for future research.

CHAPTER TWO
TOMATO PRODUCTION AND MARKETING SYSTEM SERVING LUSAKA

This chapter provides a broad and detailed examination of the tomato production and marketing system serving Lusaka. It starts by explaining the broad array of data and the methods used. It then uses these data to examine fresh produce in consumer budget shares across four cities of Zambia. Next, it focuses on Lusaka, presenting an overview of the structure of the tomato production and marketing system for the city, organized around a detailed tomato channel map that brings together data and information from many sources. Key points about the organization of the sector are highlighted in this section, and are examined in more detail in subsequent sections. After the overview is a discussion of the entire vertical supply chain for the "traditional" sector followed by the "modern" sector. In closing, price behavior at the farm, wholesale, and retail levels is examined.

2.1 Data

The data used in this chapter comes from three sources: the Food Security Research Project[6] Urban Consumption Survey (FSRP-UCS), the FSRP wholesale and retail price and quantity data, and data on the FFV procurement systems adopted by some selected retail outlets and FFV processing firms in Lusaka.

2.1.1 Urban Consumption Survey Data

The UCS was conducted in 2007 and it contained household consumption data from urban consumers in Kitwe, Mansa, Lusaka and Kasama cities, all in Zambia. This survey was collected from a sample size of 2,160 urban consumers who were sampled using a

[6] The Food Security Research Project (FSRP) has operated in Zambia since 1999, with funding from U.S. Agency for International Development/ Zambia and, recently, from the Swedish International Development Agency. Over the past decade it has collected various household- and market level data sets in collaboration with local organizations; some of those data sets are used in this thesis.

randomized cluster sample design. This data contains specific information on the various FFV, other food and non-food items purchased and consumed by the household; the value of consumption for all the foods purchased, and the primary retail outlet in which each item was purchased. In total, there was data collected on 37 FFV and food items such as rape, tomato, onion, cabbage, cassava leaves, sweet potato leaves, pumpkin leaves, bananas, mangoes, oranges, apples and beans, and nine non-food items such as fire wood, paraffin, batteries and vaseline jelly. In addition to this data on the FFV, food and non food items, the survey also collected data on household expenditures, the households' participation in urban agriculture (horticultural crop production and livestock production) and the households' food security levels.

2.1.2 Tomato Wholesale and Retail Price and Quantity Data

FSRP market reporters collect price data at wholesale and retail, and quantity data at wholesale, for tomato, rape, and onions every Monday, Wednesday and Friday. This quantity data captures total volumes of tomatoes (and the other two crops) moving through Soweto market, while the price data is collected at Soweto and selected retail outlets. Soweto market is supplied with tomatoes from over 150 areas from Lusaka and Central provinces. Quantity data includes information on the area of origin and the size (number of crates) of every lot entering the market. By "area of origin" we refer to a production area at the sub-district level as identified by farmers and traders selling in the market. A "lot" is defined as the set of crates belonging to an individual farmer or trader whose tomatoes are being sold in the market. The Soweto wholesale price and quantity data[7] tracks entering[8], starting and ending volumes of tomatoes in the market from all the

[7] Food Security Research Project: Tomato wholesale and retail price and quantity data.

supply areas. Three price observations are collected and recorded each hour, and the mean of the three prices is taken as the hourly tomato price. This is particularly the case for the price data on entering volumes.

Retail outlets where price data is collected are Shoprite (Cairo/Kafue roads), Spar (Down town), and Melissa (Matero) supermarket chains, and Chilenje open air retail market. All these data have been collected since January 2007; however, in generating the subsector map, only data for the one year period January to December 2007 was used.

2.1.3 Data on Procurement Systems

Data on the procurement systems of selected retail outlets and FFV processors was obtained from interviews with the procurement managers of these institutions. The interview guide used for these interviews is presented in Appendix 1. This guide took the form of a checklist questionnaire with a combination of closed and open ended questions. Open ended questions were included in order to get the broadest possible insights into the nature of the procurement systems these actors have adopted. Some of the information solicited from the interview included what FFV they trade in, who their FFV suppliers are, and more specifically, who their tomato suppliers are, the geographic origin of the tomatoes from their suppliers, the quantity and specification requirements of the tomatoes, and their tomato pricing policy. The interview was conducted on three large independent supermarket chains; Shoprite (Fresh mark), Spar and Melissa, and the two main FFV processors in the country; Freshpikt and Rivonia.

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[8] Entering volumes are those entering the respective markets between 6am and 1pm; starting volumes refer to the volumes of tomatoes entering between the end of the previous day and 6am, while ending volumes are those sitting in the market still unsold at noon each day.

2.2 Methods

With these three sets of data, two types of analysis were conducted. The first involved ascertaining the importance of tomato among all the FFV and the second one involved the analysis of the tomato subsector which also included some analysis of the significance of the traditional retail sector.

The UCS data was used to ascertain the importance of tomato among all FFV, and also to show the significance of the traditional retail sector. Based on household expenditure, the first analysis involved calculating:

- budget shares of all food items purchased,
- budget share of FFV in overall FFV purchased, and
- budget shares of all FFV items for Lusaka by income quartiles

In determining the significance of the traditional retail sector, the analysis involved calculating:

- retail outlet market shares for all food items purchased,
- retail outlet market shares for tomatoes by expenditure, and
- retail outlet market shares for all FFV by expenditure quartile groups.

In conducting the tomato subsector analysis, the tomato wholesale and retail price collection data, the UCS data and the data on the FFV procurement systems were used. These data provided information on:

- main actors in the tomato sub sector,
- volumes of tomatoes from the various identified farm areas,
- volumes of tomatoes from the retail outlets,

- various channels through which tomatoes pass through before they finally reach the retail outlets,
- volumes of tomatoes which are handled by the traders and their sources,
- lot sizes of tomatoes from the farmers, and
- type of first sellers of tomatoes in Soweto market; farmers or traders.

Volume data on supply areas was used to calculate total supply of tomatoes from each area and also the total supplies channeled through the various identified marketing channels.

Data on the lot sizes of tomatoes from different supply areas was used to estimate the relative size of the farmers from these supply areas. The lot sizes from the farmers were then categorized into terciles. Based on where lot sizes from a particular area fell in the tercile groups, each supply area was categorized into three groups from the largest to smallest implied farm size. The strength of using this approach of categorizing the supply areas is that it gives a good estimate of the size of the majority of famers in a given area. However, the down side to this approach is that it may underestimate or overestimate actual sizes of the farmers in the supply areas. For instance, several small farmers may have been categorized as large farmers merely on the basis of a few large lot sizes of tomatoes they delivered to the market, or conversely, a few large farmers may have been consistently delivering small lot sizes of tomatoes very often and were subsequently categorized as small farmers. In general, however, the implied farmer size and resulting classification of production areas that emerged from this exercise agree with the perceptions of farmers and traders in the market regarding the farm structure in most areas.

To understand the FFV procurement systems of the large independent supermarket chains and FFV processors, interviews were conducted with the procurement managers of these institutions.

For the subsector analysis, the UCS provided data on the retail outlets the consumers purchase their tomatoes from and the volumes of tomatoes purchased in each retail outlet, and information on the tomatoes that were grown and consumed by individual households and the tomatoes which were given to the households as gifts. This information was obtained by summing up the quantities of tomatoes by each retail outlet or source. The main output of the tomato subsector analysis was a subsector map which shows all the main actors in the system and the total volumes of tomatoes in each identified channel.

2.3 Fresh Produce in Consumer Budget Shares

Fresh fruits and vegetables are one of the most widely consumed food items among households in Lusaka and the other three surveyed cities (table 2.1). In all four cities, vegetables and fruits account for 12% of all purchases. In Lusaka, FFVs are fourth (taken together) in budget shares after cereals/staples, meat/eggs and other foods.

In all four cities, tomatoes and onions are in first place, with an average share of 10% of all expenditure on FFV (table 2.2). Clearly, tomatoes are a major FFV consumption item and therefore have an important impact on households' purchasing power.

Table 2.1: Budget Shares for all Food Items Purchased by Households, in Four Cities of Zambia

Food Group	All 4 Cities	Kitwe	Mansa	Lusaka	Kasama
		------ Share in total food expenditure ------			
Cereals/ staples	0.22	0.25	0.26	0.19	0.23
Meat, eggs	0.20	0.17	0.16	0.21	0.18
Other foods	0.17	0.14	0.16	0.20	0.15
Non-food items	0.13	0.13	0.13	0.13	0.14
Fish	0.10	0.09	0.11	0.10	0.12
Vegetables	0.07	0.10	0.09	0.05	0.08
Fruit	0.05	0.05	0.05	0.05	0.04
Legumes	0.04	0.04	0.04	0.04	0.04
Dairy	0.03	0.04	0.02	0.02	0.03

Source: Food Security Research Project Urban Consumption Survey Data 2007

Table 2.2: Budget Share of Different FFV items in Overall FFV Purchased by Households in Four Cities of Zambia

Consumption Item	All cities	Kitwe	Mansa	Lusaka	Kasama
Tomato	0.10	0.10	0.11	0.10	0.10
Onion	0.10	0.10	0.10	0.09	0.09
Rape	0.09	0.09	0.09	0.10	0.09
Impwa	0.07	0.07	0.06	0.06	0.08
Cabbage	0.07	0.06	0.06	0.07	0.07
Sweet potato leaves	0.07	0.07	0.07	0.06	0.07
Pumpkin leaves	0.06	0.06	0.07	0.06	0.06
Bananas	0.06	0.06	0.06	0.07	0.05
Okra (lady's finger)	0.05	0.06	0.04	0.07	0.04
Oranges/ tangerines	0.05	0.05	0.05	0.05	0.04
Cassava leaves	0.05	0.05	0.07	0.02	0.04
Mangoes	0.04	0.04	0.05	0.03	0.04
Bean leaves	0.03	0.03	0.04	0.02	0.05
Lemons	0.03	0.04	0.03	0.04	0.02
Amaranthus (bondwe)	0.03	0.02	0.03	0.03	0.05
Avocado pear	0.03	0.03	0.02	0.02	0.04
Apples	0.03	0.03	0.02	0.04	0.01
Guavas	0.02	0.02	0.01	0.02	0.02
Green beans	0.01	0.01	0.00	0.03	0.01
Watermelons	0.01	0.01	0.00	0.01	0.00
Eggplant	0.01	0.01	0.00	0.01	0.00

Source: Food Security Research Project Urban Consumption Survey Data 2007.

Analysis of the budget shares of the different FFV items consumed by the households over their total expenditure on FFV, by expenditure quartile was also conducted (Table 2.3). Using the data on all the food and non-food expenditure items, the households were grouped into expenditure quartiles. These quartiles were calculated by first summing all household expenditures for food and non-food items. Households were then ordered from the highest to lowest total expenditure then broken into four groups of equal size. Quartile 1 is the least expenditure group and has a mean total expenditure of ZMK[9] 489, 700, while quartile 4 is the highest expenditure group with a mean of ZMK 3, 867, 700. Quartile 2 is the second lowest expenditure group with an average income of ZMK 894,

[9] The mean exchange rate to the USD during 2007 was (Zambian Kwacha) ZMK 4, 114; Source: www.oanda.com

800 and quartile 3 is the second highest expenditure group with a mean expenditure of ZMK 1, 508, 205.

The results show that, tomatoes rank first in the first expenditure quartiles, while tied with rape in first rank in the quartiles 2 through 4. Among the households in the third and fourth expenditure quartiles, tomatoes had a budget share of 9% of the total FFV expenditures of the household while the households in the income quartile 2 and 1 had 10% and 13% budget share of tomatoes respectively, over all FFV items. Both rape and tomatoes have the largest budget share among the relatively poor households (rape forms a very prominent part of relish eaten with nshima[10] for these households), they both have the same pattern across all the quartiles falling from 13% to 9% for tomatoes, and 12% to 8% for rape.. This basically shows the importance of tomatoes regardless of the household income levels.

[10] Nsima is a maize meal pulp made from maize flour and is the main staple consumed by households in Zambia.

Table 2.3: Budget Share of Different FFV Items in Overall FFV by Expenditure Quartile for Households in Lusaka

Consumption Item	Expenditure quartile1	Expenditure quartile 2	Expenditure quartile 3	Expenditure quartile 4
Rape	0.12	0.10	0.09	0.08
Tomato	0.13	0.10	0.09	0.09
Onion	0.11	0.10	0.09	0.09
Cabbage	0.08	0.07	0.07	0.07
Chinese cabbage	0.01	0.02	0.01	0.01
Cassava leaves	0.02	0.02	0.02	0.02
Sweet potato leaves	0.06	0.06	0.06	0.05
Pumpkin leaves	0.06	0.06	0.06	0.05
Amaranthus (bondwe)	0.03	0.03	0.03	0.03
Bean leaves	0.01	0.02	0.02	0.02
Okra (lady's finger)	0.08	0.07	0.07	0.06
Impwa	0.06	0.07	0.06	0.06
Eggplant	0.00	0.01	0.01	0.02
Green beans	0.02	0.02	0.03	0.04
Bananas	0.05	0.06	0.07	0.07
Mangoes	0.03	0.03	0.03	0.03
Oranges/ tangerines	0.04	0.05	0.06	0.05
Apples	0.02	0.03	0.04	0.05
Avocado pear	0.01	0.02	0.03	0.03
Watermelons	0.01	0.01	0.01	0.02
Guavas	0.01	0.02	0.03	0.02
Lemons	0.04	0.03	0.04	0.04

Source: Food Security Research Project Urban Consumption Survey Data 2007

2.4 The Structure of the Tomato Production and Marketing System Serving Lusaka

This section examines the structure of the tomato production and marketing system serving Lusaka. This system is composed of tomato farmers categorized in three areas based on the farmer types that dominate the area, tomato assemblers/processors, tomato wholesalers, and a wide range of retailers.

Over 90% of tomato wholesale volume flows through the traditional sector, with less than 10% volumes flowing through the modern sector comprising Freshmark, which is a formal wholesaler and processors Freshpikt and Rivonia.

The retail sector is composed of both informal and formal actors. The informal system is composed of open air markets and the "ka sector[11]", which refers to all small FFV vendors, while the formal system is composed of the large independent supermarkets, large chain supermarkets, mini marts and small super markets

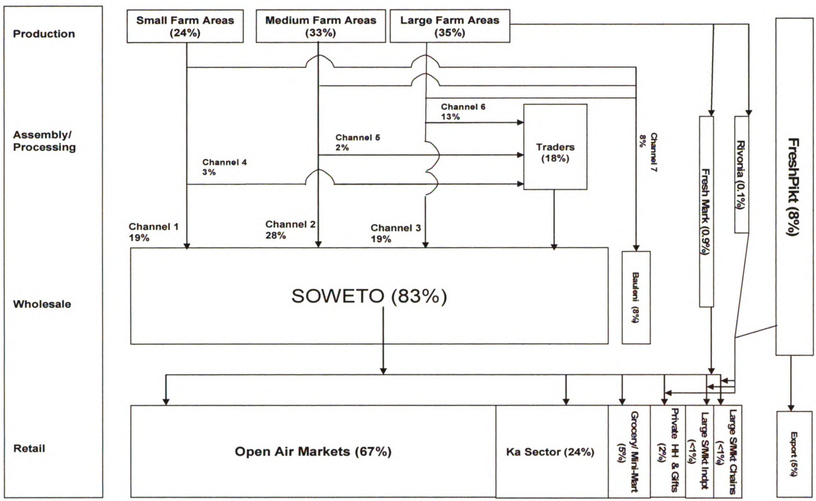
2.4.1 Overview

Figure 2.1 presents a simplified channel map for the tomato system serving Lusaka. About two-thirds of all tomato in Lusaka comes from areas dominated by large and medium size farmers. Also about three quarters of all volume is directly marketed by farmers with less than one-fifth of these tomatoes first going through rural traders. Travel times from the production areas to Soweto are mostly under 1 ½ hours, with the longest times being 4 hours. The market channel for tomatoes arriving into Lusaka is therefore actually quite short. Freshpikt is the predominant FFV processor in Zambia and it accounts for 8% of the tomatoes in the system all of which it produces on its own.

Over 80% of tomatoes from farmers end up in Soweto market with less than 10% going to Bauleni market. Soweto market clearly dominates as the main wholesale entity in Lusaka. The processing and modern wholesaling sectors, dominated by Freshpikt (Freshmark and Rivonia have extremely small shares) take less than 10% of the market. In the retailing section, the traditional sector dominates with over 90% of the market.

[11] The "ka sector" refers to the informal retail outlets for FFV and these include market stands, market stall vendors, mobile vendors, street vendors, ka table (small table stall), kantemba (small rudimentary shop) and ka shop (kiosk) (FSRP Urban Survey Training Manual, 2007)

Figure 2.1: Channel Map for Tomato System Serving Lusaka



2.4.2 The "Traditional" Sector

The traditional wholesale sector is made up of Soweto and Bauleni markets which together have an overall market share of 91% at this level. At retail, the traditional sector has a 92% market share and is composed of the open air markets and the ka sector. These results clearly show how both the wholesale and retail traditional sectors dominate the tomato subsector.

Soweto market is the main wholesale channel through which tomatoes pass before they reach the various retail outlets. This market is supplied by a wide range of geographic areas that include small, medium and large farm areas. Bauleni market on the other hand is a small wholesale market that has much of its tomato supplied by farmers in small farm areas, specifically from Manyika in Chongwe district. Bauleni market is on the from this area to Soweto market, and as such, quite often farmers from Manyika would opt to sell their tomatoes in this market when they have smaller quantities which can easily be purchased in this market, thus making proceeding to Soweto market unnecessary.

i. Production Areas

The FSRP price and quantity data base described earlier identifies 150 distinct areas that supplies Lusaka with tomato during 2007. Of these, the twelve main geographical areas that produce and supply tomatoes to Soweto market are Chalimbana, Chisamba, Choona, Lusaka West, Makeni, Masansa, Manyika, Mkushi Farm Block, Mwaalumina, Mwembeshi, Nkolonga and a special grouping of farmers from Kapiri Mposhi district (table 2.4). These twelve areas account for 68% of the tomato supplies that reached Soweto market during 2007.

Table 2.1: Key Characteristics of Tomato Production Areas Supplying Lusaka in 2007

			Farmer Size				
Area	Province	Market share	Median Lot Size (mt)	Mean Decile Ranking of lot size[1]	Farmer Description	Seasonality (Supply months)	Weighted Average Price Received (ZMK/kg)
Lusaka West	Lusaka	0.104	1.12	5.78	All types of farmers: farmers are almost evenly spread out across all deciles but with modes in the 7th and 9th deciles.	Most sales during low price period of May to September 2007, short peak during high price month of February 2007	1,024
Masansa	Central	0.098	1.96	6.84	Large farmers: most of the farmers are in the top three deciles.	Highest sales March/April 2007, straddling high and low price months; also November 2007 (high price) and March/April 2008 (low price).	1,262
Chisamba	Central	0.082	1.96	7.01	Large farmers: the majority of the farmers are in the top two deciles.	Sales are mostly concentrated in the low price months - May to July 2007, with another sales peak during high price months - November & December 2007	1,013
Choona	Central	0.07	0.59	4.15	Small farmers: most of the farmers are in the lower deciles.	Caught end of high price period in March and early April 2007, but otherwise sales concentrated in low price months of April/May 2007 and March-April 2008.	1,118

Table 2.2 cont'd

Area	Province	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (ZMK/kg)
Manyika	Lusaka	0.061	0.7	4.59	Small farmers: most farmers are in the low deciles.	Highest sales during high price month of February 2007, also December 2007 to January 2008, but maintained a substantial amount of sales in the low price period of March 2007 to August 2007.	1,093
Mwembeshi	Lusaka	0.05	1.12	5.77	All types of farmers: the farmers are almost evenly spread out in all deciles with the 5th and the 9th deciles having more observations.	Sales heavily concentrated in low price months – May to September 2007.	928
Makeni	Lusaka	0.048	0.67	4.41	Small farmers: most of the farmers are in the lower deciles.	Sales heavily concentrated in low price months of July to September 2007.	921
Chalimbana	Lusaka	0.047	1.31	6.01	All types of farmers: the farmers are almost evenly spread out across all deciles but with mode in the 7th and 8th deciles.	Low price months - June to Aug 2007. High price month – December 2007	945
Mkushi Farm Block	Central	0.043	2.81	7.27	Large farmers: most of the farmers are in the top two deciles.	Most sales concentrated during high price months – February to March 2007 and December 2007 to February 2008.	1382

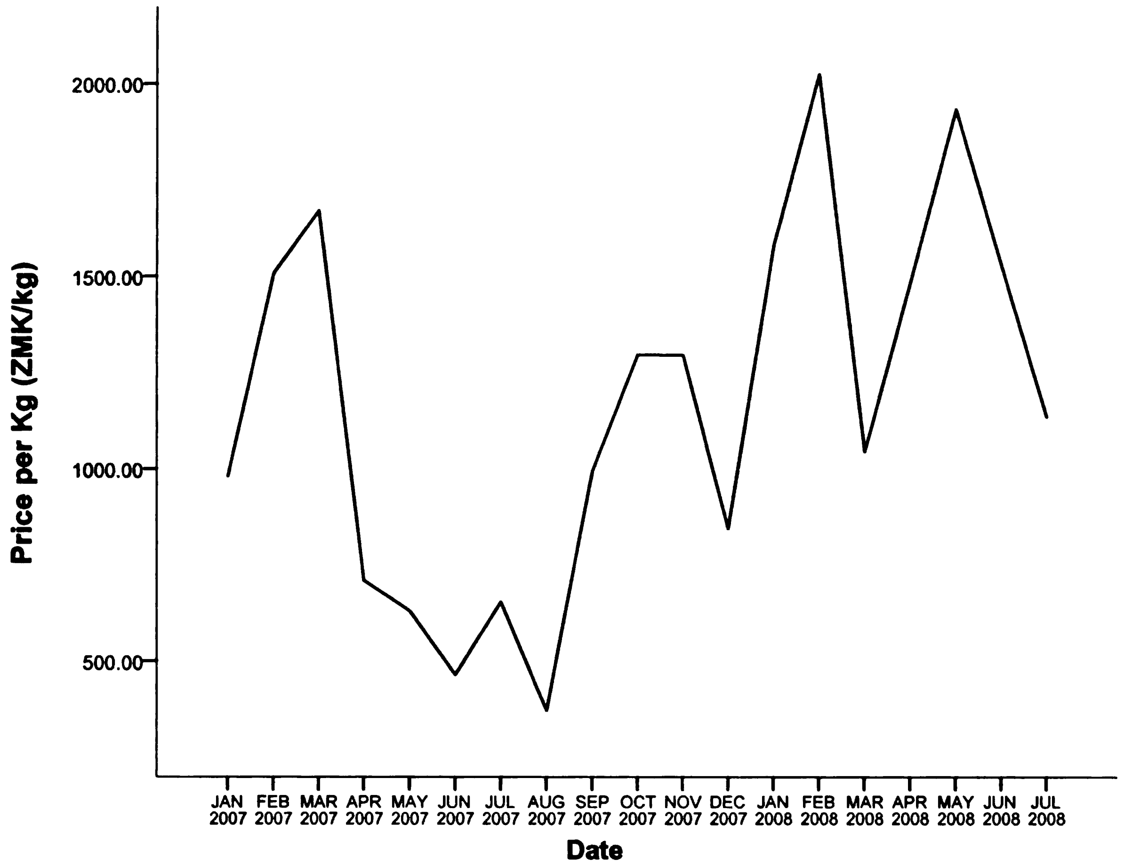
Table 2.3 cont'd

Area	Province	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (ZMK/kg)
Nkolonga	Central	0.031	2.36	7.54	Large farmers: most of the farmers are in the top three deciles.	Nearly all sales occurred during high price months – November 2007 to January 2008.	1,168
Farmers in Kapiri Mposhi district	Central	0.027	2.25	7.27	Large farmers: most of the farmers are in the top four deciles.	Most sales during high price months – October to November 2007, January 2008, and January to February 2007.	1,372
Mwalumina	Lusaka	0.022	1.16	5.78	Medium farmers: most farmers are located in the median deciles between 5 and 8 with more in the 8th decile.	Main peak during low price months of June to September 2007; second peak high price months of December 2007 to January 2008.	890
Average for all areas	-	0.68	-	-	-	-	1,079

Source: Food Security Research Project – Tomato Supply data 2007/2008
[1] 1 is the smallest possible mean decile and 10 is the largest possible mean decile.

Monthly wholesale prices per kilogram of tomato in Soweto market for the period between January 2007 and June 2008 were analyzed (figure 2.1). From the figure, over the 19 month period it was observed that there are a number of high and low price months and also sudden price drops which are a concern. The notable high price months during this period are February to March 2007, October and November 2007, and January 2008 and February 2008, while the low price months were around April to August 2007, December 2007 and March 2008. A closer examination of the seasonality during January through June in both years reveals that at the beginning of both years the prices are fairly high and then there is a sudden price collapse. In 2007, the price collapse occurred in April while the 2008 price collapse occurred in March.

Figure 2.2: Monthly Soweto Wholesale Tomato Prices January 2007 to July 2008



Source: Food Security Research Project – Tomato price data 2007/2008

Among the top twelve supply areas, those that supplied tomatoes to the market in both high and low price months are Lusaka West, Manyika and Mwalumina. Farmers in areas like Mkushi farm block, Nkolonga and Kapiri Mposhi district supplied their tomatoes mainly in the high price months. In the low price months, the dominant supply areas were Masansa, Chisamba, Choona, Mwembeshi, Makeni and Chalimbana.

Judging by the quantities of tomato that were supplied from the various supply areas in April 2007, Masansa, Choona, Manyika and Lusaka West had the highest volumes of tomatoes in that period (298mt, 182mt, 75mt and 75mt respectively) and accounted for 59% of the tomatoes on the market. On account of this, their supplies are likely to have been the main cause of the April price collapse

In the case of the March 2008 price collapse, Choona and Masansa collectively supplied the market with 49% of the tomatoes. Choona alone accounted for 20% and supplied the market with 247 mt while Masansa supplied 174 mt. The supplies from the two areas are to some extent largely responsible for the March price collapse.

As noted earlier, supply areas such as Mkushi farm block, Nkolonga and farmers in Kapiri Mposhi district supplied the market with tomatoes mainly during high price months. These supply areas are dominated by large farmers who generally have more financial resources and farming knowledge than small farmers. The high price months these farmers supplied their tomatoes in is indicative of a tomato crop grown in the rainy season, during which production costs can be very high. These high production costs are associated with high weed management requirements and more frequent pest and disease outbreaks which require chemical applications for their management. Being large farmers, it is easier for them to grow and manage a rain fed crop since they have more financial resources to engage labor for weeding and buy chemicals for pest and disease control. In addition to this, with the edge they have in farming knowledge, this puts them in a better position to manage their crops well.

On the basis of the different supply areas and the different farmer types found in each supply area, the channels through which tomatoes enter the system is presented in figure 2.1. Channels 1 through 3 represent tomatoes taken directly to the markets by farmers from all 150 supply areas while channels 4 through 6 represent tomatoes that were first sold to traders.

Channel 1 represents the flow of tomatoes from small farm areas into Soweto market. Among the top twelve supply areas, channel 1 was made up of famers from Choona, Manyika and Makeni. This channel has a 19% share of tomatoes entering Soweto market. The Soweto data on the origin of tomato supplies shows that the majority of the farmers in this channel are located in the lower deciles with only a few in the top two deciles. Farmers in this area mainly supplied their tomatoes to Soweto market in the low price months of March to May 2007 and March of 2008.

The medium farm area is represented by channel 2 and among the top 12 supply areas had farmers from Lusaka West, Mwembeshi, Chalimbana and Mwalumina. A large number of farmer observations are well distributed in all the deciles with the majority of them lying in the 5th and 9th deciles. The farmers in this channel account for 28% of the tomato volumes in Soweto market. This area supplied most of its tomatoes in the low price months of May to September 2007.

The large farm area is represented by channel 3 and among the top 12 supply areas had farmers from Masansa, Chisamba, Mkushi farm block, farmers in Kapiri Mposhi district and Nkolonga. Most farmers in this area are concentrated in the top four deciles. About 19% of the tomatoes in Soweto market are from this area, and most of their tomatoes were supplied in the high price months of February to April 2007 and December 2007 to January 2008.

Eighteen percent of the tomatoes that enter Soweto market come through traders (Channels 4-6). The tomatoes from the traders are originally from the farm areas but are channeled through these intermediaries before they finally reach Soweto market. Channel 4 represents the tomatoes that come from the small farm areas to the traders, while channel 5 represents tomatoes from the medium farm areas to the traders and finally channel 6 representing tomatoes from the large farm areas to the traders.

Tomatoes from the different supply areas are then wholesaled in Soweto and Bauleni markets and then eventually channeled out to the retail outlets. Among the various retail outlets are the open air markets which account for 67% of the volumes of tomatoes, followed by the Ka sector with 24%, with the remaining 9% being transacted in the grocery mini marts (5%), large super market chains (<1%), large independent supermarkets (<1%), and the remaining amount accounted for by gifts and private household production and consumption (Table 2.5).

The informal retail system, in the form of the open air markets and the ka sector dominates tomato retail. Almost 80 % of the FFV sales are carried out in the open air market and the ka sector retail outlets, with only 5% share in the large supermarket chain outlets and only 1% in the large independent super markets.

Table 2.7: Retail Outlet Market Shares on Overall Food (Lusaka)

Market Group /Retail Outlet	Share for all foods	Share for all FFV	Share for Vegetables	Share for fruits	Share for tomatoes
Open Air Market	0.32	0.55	0.64	0.45	0.67
Ka Sector	0.16	0.20	0.20	0.21	0.24
Grocer / Mini mart	0.21	0.01	0.02	0.003	0.05
Own Production	0.02	0.09	0.07	0.13	0.01
Private HH	0.02	0.01	0.01	0.01	0.01
Gift	0.03	0.06	0.04	0.09	0.01
Large Independent Supermarkets	0.01	0.01	0.01	0.01	0.01
Large Supermarket Chains	0.09	0.05	0.02	0.09	0.003
Butcher	0.14	0.00	0.00	0.00	0.00
Small Supermarkets	0.01	0.001	0.001	0.001	0.00
Other Purchasing Channel	0.01	0.00	0.00	0.00	0.00
Baker	0.001	0.00	0.00	0.00	0.00

Source: Food Security Research Project Urban Consumption Survey Data 2007

The broader literature[12] on supermarket expansion in the developing world shows that the general pattern of their development has mainly been through the spread of foreign direct investment (FDI). Zambia is no exception. Much of the FDI in supermarkets in Zambia is from South Africa where the supermarket share of the national food retail is 55%[13]. The shares in South Africa are similar to those found in some Latin American countries such as Argentina and Chile[14]. In Zambia however, the growth rate of these supermarkets has not been as fast as in these parts of the world and hence the small share they have in the retail outlet markets.

Further analysis on the retail outlet market shares for all FFV purchases made by the households by the expenditure quartiles was conducted, and the results show that the traditional retail still ranks highest among all the retail outlets used by all the expenditure quartile groups (Table 2.6). In the two lowest income quartiles, the open air markets and

[12] Reardon and Timmer, 2006; Tschirley 2007
[13] Weatherspoon and Reardon, 2003.
[14] Weatherspoon and Reardon, 2003.

the ka sectors combined have shares of over 90%, while the top two income quartiles (3 and 4) have shares of at least 80%. Households in the highest income quartile tend to use the formal retail outlets (specifically the small supermarkets and the large supermarket chains) more than the other income quartile groups.

Table 2.8: Retail Outlet Market Shares for all FFV Purchases by Income Quartile

Market group/Retail outlet	Expenditure quartile 1	Expenditure quartile 2	Expenditure quartile 3	Expenditure quartile 4
Open Air Market	0.67	0.70	0.62	0.53
Ka Sector	0.26	0.22	0.26	0.27
Grocer / Mini mart	0.002	0.002	0.009	0.037
Small Supermarkets	0.00	0.00	0.001	0.001
Large Independent supermarkets	0.00	0.00	0.00	0.01
Large Supermarket Chain	0.002	0.004	0.02	0.06
Butcher	0.00	0.00	0.00	0.00
Baker	0.00	0.00	0.00	0.00
Private household	0.01	0.02	0.02	0.02
Other Purchasing Channel	0.00	0.00	0.00	0.00
Own Production	0.02	0.03	0.05	0.06
Gift	0.02	0.02	0.02	0.02

Source: Food Security Research Project Urban Consumption Survey Data 2007

An examination of the retail outlets shares for tomatoes by expenditure quartiles, also reveals that the open air markets and the ka sectors combined have the largest retail outlet market share (Table 2.7). The highest income quartile has a combined retail outlet market share of 85% in the open air markets and the ka sector while the other income quartiles all have over 90% share. The highest income quartile are the main group that use the grocery/mini mart and large independent supermarkets for the purchase of tomatoes with shares of 7% and 1% respectively.

Table 2.9: Retail Outlet Market Shares for Tomato Purchases by Expenditure Quartile

Market group/Retail outlet	Expenditure quartile 1	Expenditure quartile 2	Expenditure quartile 3	Expenditure quartile 4
Open Air Market	0.58	0.64	0.65	0.55
Ka Sector	0.37	0.28	0.30	0.30
Grocer / Mini mart	0.00	0.00	0.002	0.07
Small Super markets	0.00	0.00	0.00	0.00
Large Independent Super markets	0.00	0.00	0.00	0.01
Large Supermarket Chain	0.00	0.00	0.003	0.00
Butcher	0.00	0.00	0.00	0.00
Baker	0.00	0.00	0.00	0.00
Private households	0.03	0.03	0.03	0.04
Other Purchasing Channel	0.00	0.00	0.00	0.00
Own Production	0.01	0.03	0.01	0.01
Gift	0.02	0.02	0.00	0.01

Source: Food Security Research Project Urban Consumption Survey Data 2007

Evidently, the informal sector comprising the open air markets and the ka sector are very important. The formal sector has a very low percentage share for the transaction of FFV and especially for tomato, despite the manner in which it is well organized and the infrastructure in place. In view of the high percentage share of FFV transactions occurring in the two identified informal channels, it would be paramount to ensure that the performance of this sector is enhanced by way of identifying means through which there would be a more efficient handling of the volumes of FFV that pass through it.

2.4.3 The 'Modern' Sector: Supermarkets and Processors

The modern sector of the tomato system is composed mainly of supermarkets and processors. The supermarkets that dominate this sector are Shoprite, Melissa and Spar while the processors include Freshpikt and Rivonia. The supermarkets and the processors in this sector jointly have a 9% share in the tomato system. The following section gives some details of these supermarkets and processors and also looks at the tomato procurement system they have adopted.

i. Shoprite Supermarket/Freshmark

Freshmark serves as a wholesale procurement and distribution channel for tomatoes supplied to all 17 Shoprite retail outlets countrywide. Shoprite is the largest super market chain in Zambia and mainly relies on Freshmark for all its FFV requirements. It however handles less than one percent of the tomatoes consumed in the country.

In its tomato procurement system, Freshmark currently has four farmers that supply it with tomatoes; three commercial farmers and one small scale farmer. All of these farmers are located in Lusaka province. The small farmer is located in Makeni, South of Lusaka city. One of the large commercial farmers is located in Chisamba area while the other two are South of Lusaka city in Kafue area.

Ninety percent of the tomatoes supplied to Freshmark come from the three commercial farmers and the remaining 10% comes from the small scale farmer. Ambrosia farm accounts for 40% of the supply while the other two commercial farmers account for the remaining 50% with each one supplying approximately 25%.

To qualify as a tomato supplier to Freshmark, the suppliers have to adhere to a number of quality standards that are above what would be expected in an open air market. Some of Freshmark's quality requirements are, firm, champagne red color tomatoes, free of any blemishes and able to have a shelf life of 3 days at the time of delivery.

Freshmark mostly prefers to have large farmers as tomato suppliers as they are more reliable and stick to the terms and conditions of the contracts they enter into. The procurement manager indicated that small farmers, other than having production constraints which hinder them from supplying required quantities and their inability to produce a product that meets Freshmark's quality requirements, have a tendency to break the contracts and supply a market that offers a better price at a given point in time. The small farmer that currently supplies tomatoes to Freshmark is a very committed farmer but has land area limitations that hinder him from expanding his tomato production.

In cases where the local tomato suppliers are not in a position to meet Freshmark's demand, Freshmark outsources tomatoes from Freshmark South Africa. This is particularly the case in the rainy season when the local tomato supplies are very low and prices high.

An average of 4 mt of tomatoes is supplied to the various Shoprite retail outlets every week. Seventy-five percent of these tomatoes end up in Lusaka while the remaining 25% go to the Shoprite retail outlets outside of Lusaka. Tomatoes are very important in the vegetable procurement system as they rank second from potatoes in sales volumes, and rank fourth in Shoprite's overall FFV supply system with bananas, potatoes and apples taking the lead in this order.

Freshmark usually seeks to maintain stable prices during the course of the year. To achieve this, the contracted farmers are offered less variable prices for their tomatoes for the whole one year contract period they enter. Due to this pricing policy, during the peak supply season when the tomato prices are generally lower Freshmark offers its farmers higher prices than what the market is offering, and when the tomatoes are in short supply and prices expected to be higher, Freshmark's prices would be lower. It is during the high market price period that most contracted farmers (particularly the small ones) would default and sell their tomatoes where the price is higher.

ii. Melissa Supermarket

Melissa supermarket is a Zambian grocery store chain with three outlets in Lusaka city located in Northmead, Kabulonga and Matero. The Matero outlet is the most recently opened and forms the focus of the following discussion.

Among all the FFV products purchased by Melissa, tomatoes are important, however onions top the list in importance. Melissa has an internal procurement system for tomatoes with contractual arrangements with three commercial farmers, Eco Veg, Agir Link and Lilayi farms. Each of these farmers supplies Melissa with an assortment of FFV, but only Eco Veg supplies them with tomatoes.

In addition to procuring tomatoes from the commercial farmer, Melissa also obtains some from small independent farmers. These independent farmers are basically walk-in suppliers without contracts with Melissa, but meet the quality requirements for firm, semi ripe, blemish- free tomatoes. Melissa has therefore adopted a dual procurement system which enables it to cushion the effects of price fluctuations and unstable supplies.

With the dual procurement system that it has adopted to manage the supplies of tomatoes from both sources, Melissa supermarket ensures that it has a weekly tomato supply of 350 kg. Eco Veg supplies them with tomatoes on Mondays, Wednesdays and Fridays while the other suppliers supply the tomatoes on the other days.

Melissa supermarket has a fixed price arrangement with Eco Veg over each contract period, which may vary from a few months to one year. During the contract period, irrespective of whether the market price of tomatoes drops or rises, Melissa supermarket pays Eco Veg only the agreed amount. In periods when the supply of tomatoes on the market is high and the market price lower than the negotiated price with Eco Veg, Melissa procures most of its tomatoes from the other suppliers (small independent farmers). On the other hand, when the supply of tomatoes on the market is low and the market price is higher than the negotiated price with Eco Veg then Melissa procures most of its tomatoes from Eco Veg. This procurement arrangement enables Melissa to keep its prices fairly stable over a given period of time. With supplies from both sources, Melissa averages out the prices received; given the fixed price from Eco Veg and the variable price from the other suppliers which may be lower or higher than the Eco Veg price.

Melissa is comfortable with this dual supply system and does not have any preference for either. The benefits of having such a system are better than having one supply source. Considering the tomato supplies from the farmers, Melissa supermarket has preference for supplies from large farmers as their quality of tomatoes is better than what is obtained from the smaller farmers.

iii. Spar Supermarket

Spar supermarket is the newest supermarket chain in Zambia with its origins in the Netherlands. The first Spar retail outlet was opened in 2004. It currently has six outlets countrywide; two in the Southern province towns of Livingstone and Choma, and four in Lusaka province: Downtown Spar, Soweto Spar, Arcades Spar and Chawama Spar which was just recently opened in mid 2008.

Each of the Spar outlets is run as an independent operation by its own manager, and each with its own FFV procurement system and pricing policy. Downtown Spar markets a wide range of vegetables such as carrots, peppers, onions, cucumbers, tomatoes, potatoes, green beans, and others. Most of the vegetables and other fresh produce they sell come from three large farms: Buyabamba farm, Osuma farm and Birchwood farm. The large farms account for 60% of the vegetables they are supplied with while the remaining 40% is supplied by small farmers and independent traders who deliver the tomatoes to their premises.

On a weekly basis, downtown Spar sells an average of 125kg of tomatoes. To ensure that they have a steady supply of tomatoes throughout the year, the store heavily relies on Buyabamba farm which consistently has tomatoes throughout the year.

iv. Freshpikt

Freshpikt is the dominant FFV processing firm in the country. At present, it produces its own tomatoes and supplies its processed products to the grocery mini-marts, large supermarket chains, the large independent supermarket retail outlets and exports 5%.

Compared to Soweto market which had an 83% share of raw tomatoes in the system, Freshpikt had an 8% share for raw tomatoes in 2007.

Freshpikt produces 18 different canned products which include baked beans, mixed beans, tomato puree, tomato paste, tomato and onion mix, whole peeled tomatoes and an assortment of fruit chunks, jams and juices from pine apples. Tomatoes, beans, sweet corn and onions are the main vegetables they process and tomatoes are the major ingredient used in most of their salty canned products.

Freshpikt currently sources all of its tomatoes from its own 40 ha farm plot in Lusaka East. At 50 mt per week, all year round, the plant is operating well below its capacity of 60 mt per day. It has plans to step up its processing volumes for tomato products once it engages small tomato grower cooperatives on a contractual basis in its supply chain.

v. Rivonia

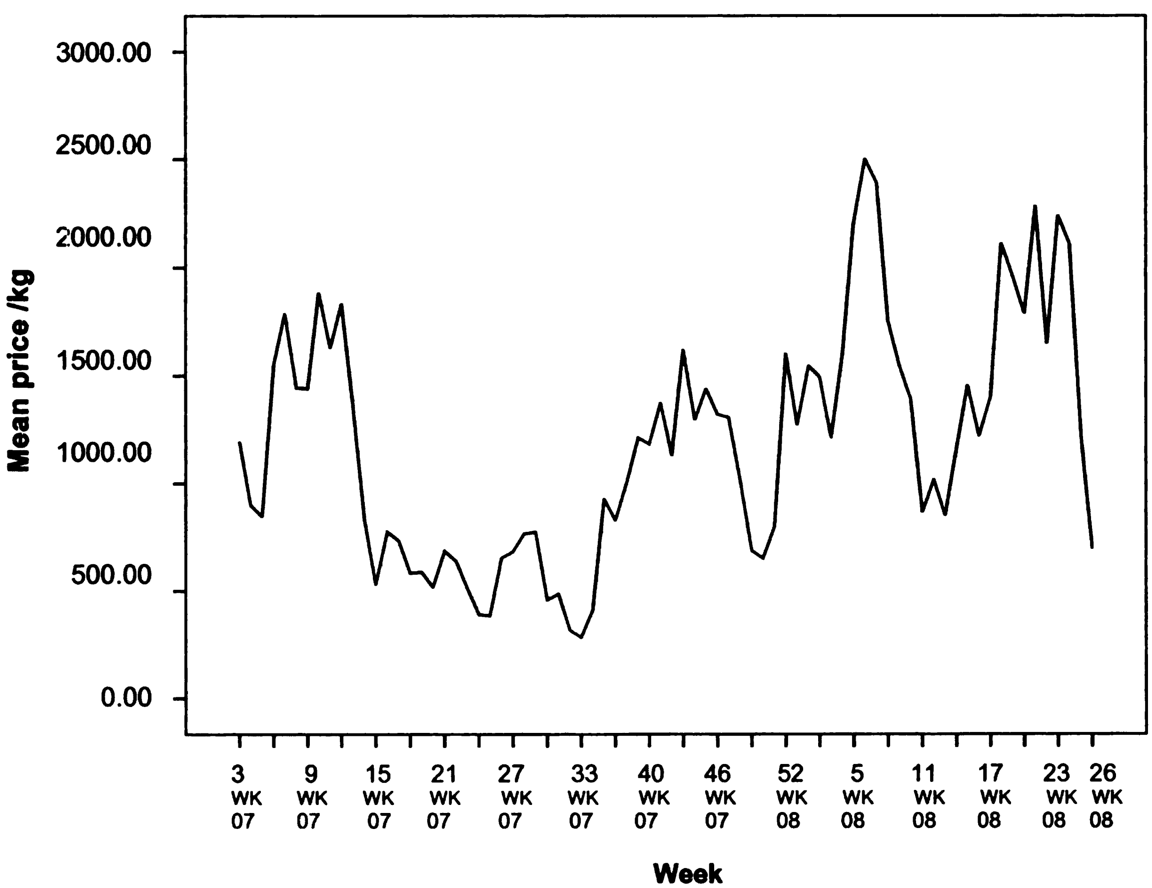
Rivonia is another FFV processing firm specialized in the production of tomato sauces. They use local raw tomatoes and imported tomato paste for their sauces. They currently procure 540 Kg of tomatoes per week from independent tomato growers in Lusaka province. At present, the volumes of tomato that come from the farm areas to Rivonia have a share of less than 1% in the system. As with Freshpikt, its processed products end up in grocery mini marts, large supermarket chains and the large independent supermarket retail outlets.

2.5 Price Behavior

2.5.1 Weekly Wholesale Prices in Soweto Market

Soweto market is the main wholesale market in Lusaka and serves as the main source of tomatoes for most of the retail outlets in the city. The graph presented below shows the weekly wholesale per kg tomato prices that prevailed in Soweto market over the period Jan 2007 to July 2008. These are the prices received by farmers and traders selling in the market.

Figure 2.3: Weekly Soweto Wholesale tomato prices January 2007 to July 2008



Source: Food Security Research Project – Tomato price data 2007-2008

During this period, tomato prices were quite variable in Soweto market. It was observed that, despite strong seasonal patterns, there is a fair amount of price variation within a given season. A notable feature in the graph over the whole period is the sharp price declines experienced in April 2007 (15 Wk 07), December 2007 (49 Wk 07), March 2008 (11 Wk 07) and June 2008 (25 Wk 08).

2.5.2 Weighted Average Prices by Marketing Channel

Going by the channels identified in the channel map (Figure 2.1), table 2.8 shows the weighted average prices for a kg of tomatoes in each of these channels. Taking a look at the channels for tomatoes that get into Soweto from the farm areas, it can be observed that the farmers from large farm areas (channel 3) received the highest prices of ZMK 1,138 followed by farmers in the small farm areas (channel 1), ZMK 1,055 and finally farmers in the medium farm areas (channel 2) receiving ZMK 1,007.

Interestingly, when we look at the channels for tomatoes that pass through the traders before they reach Soweto market, we observe a similar price pattern. The tomatoes sold by traders buying form the large farm areas (channel 6) are sold at the highest price, ZMK 1,223, followed by those sold by traders buying from small farm areas (channel 4, ZMK 989) and finally from traders buying from the medium farm areas (channel 5, ZMK 932).

Table 2.10: Weighted average tomato prices by market channel

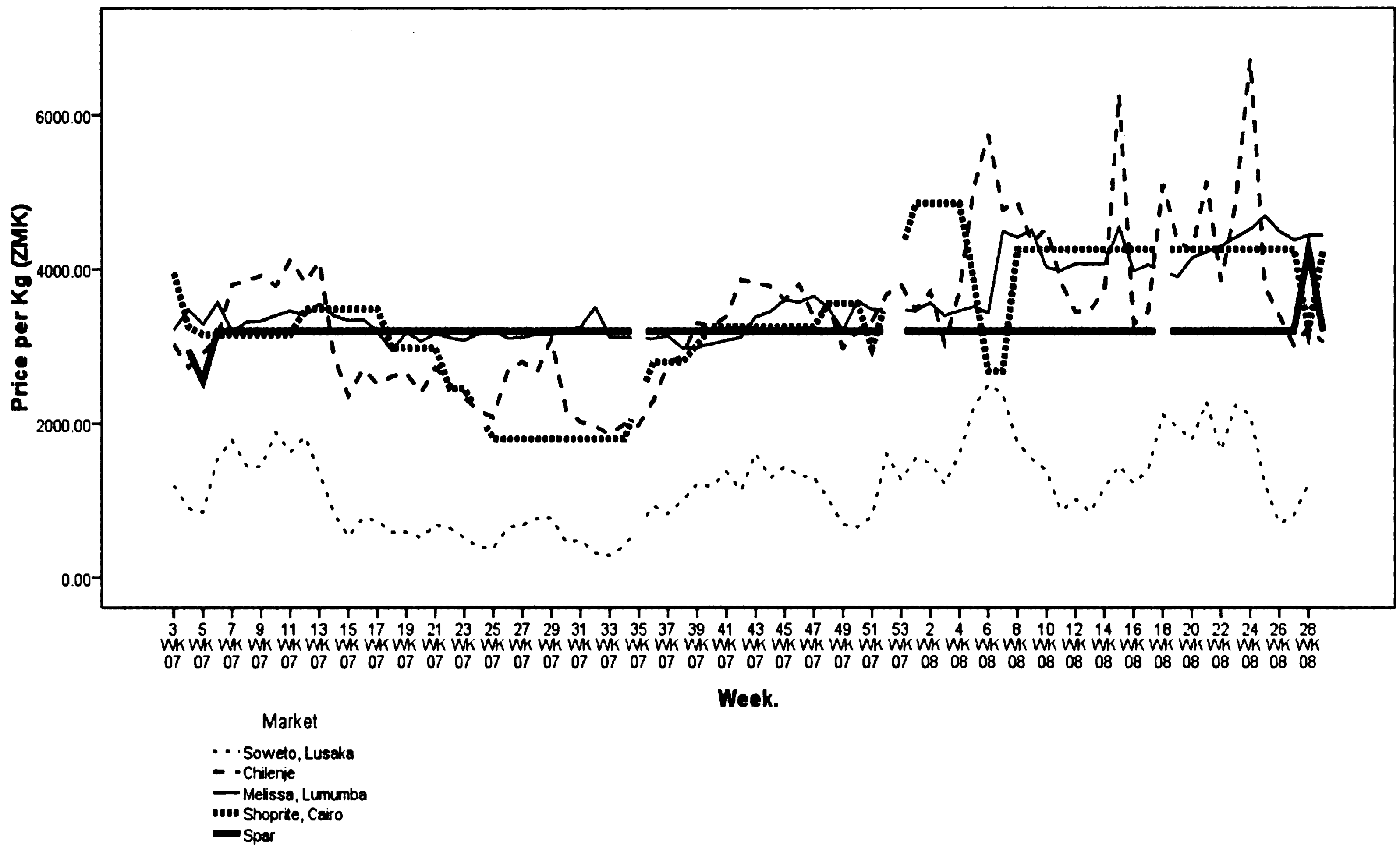
Channel Number	Channel Description	Weighted Avg. Price (ZMK)
6	Sales by traders buying from large farm areas	1,223
3	Direct farmer sales into Soweto from large farm areas	1,138
1	Direct farmer sales into Soweto from small farm areas	1,055
2	Direct farmer sales into Soweto from medium farm areas	1,007
4	Sales by traders buying from small farm areas	989
5	Sales by traders buying from medium farm areas	932

Source: Food Security Research Project – Tomato price data 2007-2008

2.5.3 Tomato Wholesale and Retail Prices

A comparison of tomato prices for Soweto market and four selected retail markets, namely Spar, Shoprite and Melissa supermarkets, and Chilenje open air market, was made by examining the price trend over the period between January 2007 and July 2008 (figure 2.4) We observe that Soweto wholesale prices for tomatoes for the whole period averaged ZMK 1179, while the retail prices in the selected retail markets were ZMK 3,450 for Chilenje open air market, ZMK 3,545 for Melissa supermarket, ZMK3,408 for Spar supermarket and ZMK 3,390 for Shoprite supermarket (table 2.9).

Figure 2.1: Tomato Pricing at Wholesale and Retail Level



Source: Food Security Research Project – Tomato price data 2007-2008

On the basis of these mean weekly prices observed for these markets (figure 2.4), we see that Chilenje market followed a very similar price pattern as Soweto market. Much of the tomatoes in Chilenje market are obtained from Soweto market and the prevailing prices in Chilenje reflect a fairly stable price mark up averaging ZMK 2,284 per kilogram of tomato. To demonstrate the fairly stable price margin over the period, the price margin was graphed (figure 2.5). However, in mid March and late June (Week 13 and 25 respectively) there were price margin spikes experienced in Chilenje market. In these periods, Soweto market experienced some price drops and despite these price drops, Chilenje market seems to have maintained their price mark ups thereby resulting in the high price margin.

Melissa supermarket maintained a fairly stable price over the period with the tomato price averaging ZMK3,545 per kilogram. Shoprite on the other hand seemed to follow the traditional retail market (Chilenje) prices in a stepwise fashion.

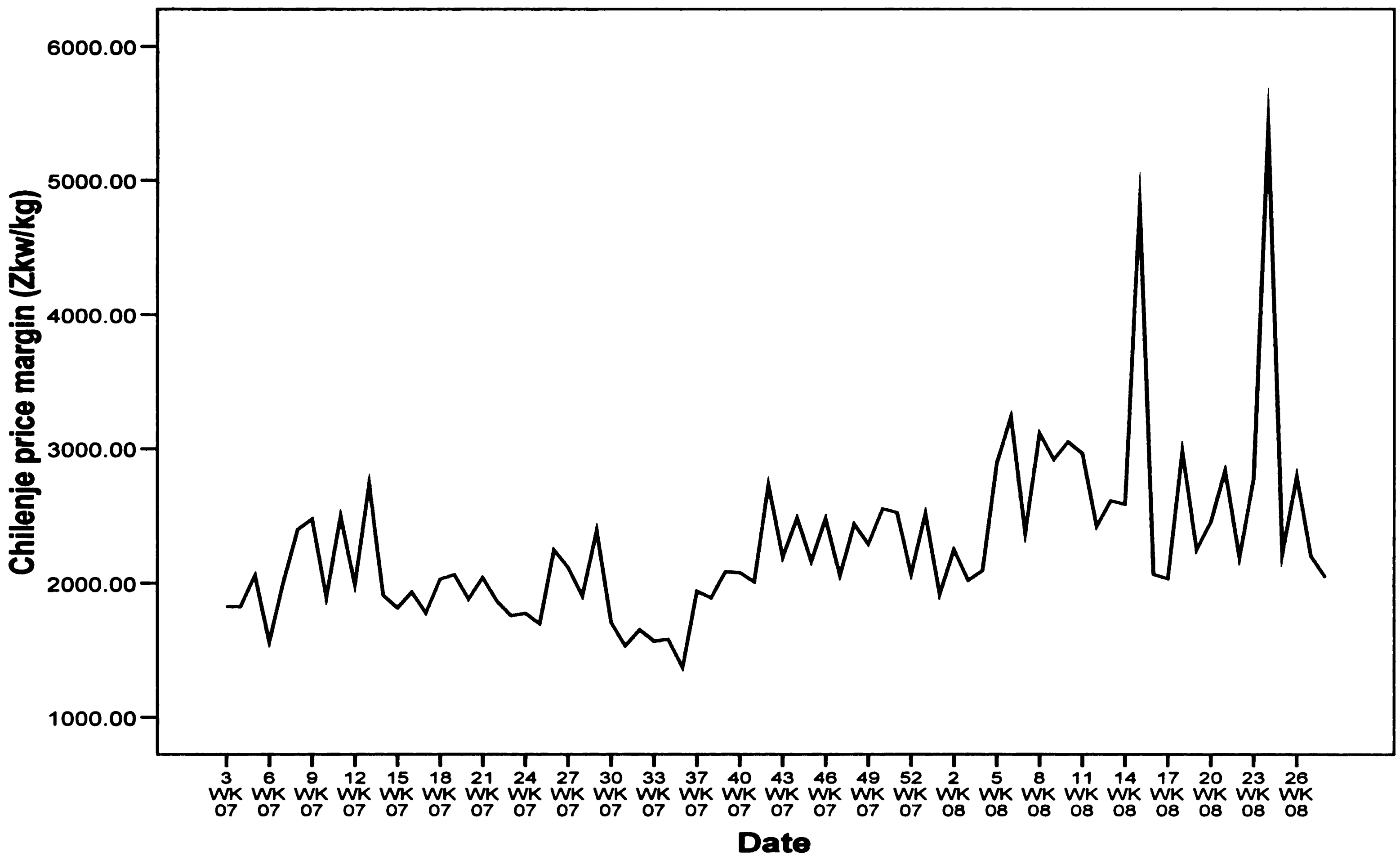
Of all four retail markets evaluated, Spar supermarket had the most stable year round prices for tomato at a mean price of ZMK 3,400 for most of the year. In both the peak and low supply periods, it maintained this stable price with the exception of the low supply period of January when it had a low price of ZMK 2,700.

Table 2.11: Mean Tomato Prices for Wholesale and Retail Outlets in Lusaka (January 2007 to July 2008)

Outlet	Type of outlet	Mean tomato price (ZMK)
Soweto	Wholesale	1179
Shoprite supermarket	Retail	3390
Spar supermarket	Retail	3408
Chilenje open air market	Retail	3450
Melissa supermarket	Retail	3545

Source: Food Security Research Project – Tomato price data 2007/2008

Figure 2.1: Price Margin for Chilenje Retail Market



2.5 Summary and Conclusions

2.5.1 Importance of Tomatoes

Fresh fruits and vegetables are a major food item purchased by households in Lusaka, Kitwe, Mansa and Kasama urban centers. In all these cities, the budget shares for all food items purchased by the households shows that FFV are an important food item as they rank third after cereals/staples and meat/eggs respectively. Detailed examination of the specific FFV items consumed by the households reveals that tomatoes rank first in the FFV budget shares, with almost 10% of the expenditure on all FFVs going to tomatoes. Further examination of the budget shares for tomatoes over all FFV by expenditure quartiles in Lusaka also reveals that tomatoes rank high in expenditures taking up an average of 10% of the FFV budget for households.

Based on these results, it is clear that tomatoes are an important FFV item and that takes up a substantial amount of the consumers' incomes, thereby impacting on the households' purchasing power.

2.5.2 The Tomato Subsector

The tomato subsector in Lusaka is made up of tomato farmers, traders, wholesalers, processors/assemblers, and retailers. The farmers supplying tomatoes in the system are from large, medium and small farm areas, however, the large and medium farmers dominate the system and supply about two thirds of the tomatoes in the system.

Among the wholesalers, processors/assemblers and retailers in the tomato subsector, these actors make up the traditional sector and the modern sector of the tomato subsector.

The traditional sector refers to the informal sector which is mainly made up of the Soweto and Bauleni markets, and accounts for over 90% share of tomato volumes at wholesale level. At retail level, we have the open air markets and the ka sector which collectively account for 91% of the retail sector. The modern sector, on the other hand is a formalized sector of the tomato subsector. It is comprised of the FFV processors, Freshpikt and Rivonia, and Freshmark, a large wholesale operator. At retail level, the modern sector is made up of the large independent supermarkets, the large supermarket chains, mini marts and small supermarkets.

Atleast sixty six percent of all tomatoes entering Soweto market are directly marketed by farmers, while 18% are marketed through traders. Traders buy the tomatoes either at the farm gate, then transport and sell them in Soweto, or from the farmers at Soweto market then sell them to wholesalers there. Eight percent of the tomatoes from the farm areas were sold directly to the wholesalers in Bauleni market, and less than 1% was sold to Freshmark wholesalers and Rivona. The remaining tomatoes in the system are grown by one of the FFV processing firms, Freshpikt.

Farmers from twelve main geographic areas dominate the system and account for 68% of all the tomatoes in the system; the other 32% was split among over 150 other supply areas. These farmers supplied tomatoes to Soweto market at different times of the year with some of them predominately supplying them in the low price months while others supplied them in the high price months.

In the period January 2007 to June 2008, tomato prices were quite variable, and some of this variability in the prices was the normal price variability one would expect due to seasonality of production. Notable high price months for tomatoes over this period were in February to March 2007, September and November 2007, and December 2007 to February 2008. The observed low price months were around April to August 2007, November 2007 and March 2008. Also worth noting were the sudden price collapses that were experienced in April 2007 and March 2008.

Analysis of the farmers that supplied tomatoes in the market reveals that among the top twelve supply areas, the areas Masansa, Choona, Lusaka West and Manyika are partly responsible for the price collapse experienced in April 2007. These four areas supplied 59% share of tomato volumes during this period. In the case of the price collapse that occurred in March 2008, farmers from Choona and Masansa may have caused it as they account for 49% of the tomatoes in the market at that time.

Once the tomatoes from the different supply areas arrive in the wholesale markets, they are then channeled out to the consumers through the various retail outlets. The traditional retail sector, comprising the open air markets and the ka sector dominate the retail market, with 91% share. Analysis of the UCS also shows that the traditional retail sector dominates with over 90% of FFV sales occurring in it. Further examination of the retail outlets used for FFV purchases by income quartile groups also shows that the traditional retail sectors dominates with very few purchases being made in the modern sector supermarkets.

The modern sector is mainly made up of supermarkets and processors which jointly have a 9% share in the tomato system. Shoprite, Spar and Melissa are the dominant supermarkets while Freshpikt and Rivonia are the main FFV processors.

The analysis conducted in this chapter has shown that tomatoes are an important FFV item among urban consumers in Zambia. It has also further shown us the dominance of both the wholesale and retail traditional sectors of the tomato subsector. Given the dominance of the traditional wholesale and retail sector in the tomato sub sector, and the poor infrastructure that exists, particularly in Soweto wholesale market, it is important that particular attention be paid to them so that they are better able to serve the needs of both the sellers and the consumers. Some of the key areas that need improvement for the better function of these systems are in the improvement of market infrastructure (roads, physical buildings, sanitation, and drainages), market information and cold chains. Therefore, developing these markets has the potential to increase the incomes of farmers due to the efficiency that would result from it. In addition to this, their improvement would pave way for further upgrading the systems to standards that are comparable to the modern sector of the tomato subsector.

CHAPTER 3
TOMATO PRICE VARIABILITY AT WHOLESALE LEVEL: COMPARING SOWETO MARKET (ZAMBIA) WITH OTHER WHOLESALE MARKETS ACROSS THE WORLD

This chapter examines tomato price variability for wholesale prices in Soweto market, Zambia and compares it with variability of other tomato wholesale prices across the world: United States of America (Chicago), Taiwan (Taipei), Costa Rica (San José), and Sri Lanka (Colombo). United States of America (USA), Taiwan, Costa Rica and Sri Lanka were chosen for comparison with Zambia because of the wide range of levels of market development in these countries, with USA and Taiwan being the most developed, Sri Lanka expected to be similar to Zambia, and Costa Rica expected to lie somewhere between these extremes.

We first discuss factors that influence price variability and predictability, followed by a detailed presentation of the methods used in the analysis. Then finally, the results and discussion of the analysis shall be presented.

3.1 Factors Influencing Price Variability and Predictability

Price variability refers to the state of prices being variable over a given period of time, while price predictability on the other hand refers to the degree to which prices can be forecasted correctly. In general, the higher the price variability for a given product, the more difficult it is to predict the price for that product. Over the course of a year, the prices of a product can be fairly variable due to the seasonal production of the product. This kind of price variability is expected to show some consistency from year to year. However, because the precise seasonality of production can vary from year to year due to variable weather patterns, the seasonal pattern of prices is not fully predictable. Since product prices directly affect the incomes that a farmer makes, an improved knowledge of the patterns of price variability and the forces behind it might help them better understand and manage their price risks.

The variability of prices and the degree to which prices can be predicted is influenced by a number of factors. Many of these factors have to do with supply conditions for a given product, such as the seasonality of supply and supply shocks that the product could be subject to. A third factor has to do with random day-to-day variations in the quantity of product that arrives in the market; perishable horticultural products are especially vulnerable to this type of variation. Finally, improved grades and standards can improve price predictability for a farmer without affecting price variability.

i. Seasonality of Supply

Seasonality refers to fluctuations in product output related to the season of the year. Agricultural products, whose production is affected by weather patterns over the course of the year, are usually subject to seasonality of supply. Zambia is warm all year round but has three distinct seasons[15]. Between December and April the weather is hot and wet; from May to August it is cooler and dry; between September and November conditions are hot and dry. Average high temperatures during the hot wet and hot dry seasons range between 77°F to 95°F (25°C to 35°C), while in cool dry season the variation increases ranging from 43°F to 75°F (6°C to 24°C).

[15] Information on the seasons and climate in Zambia is drawn from http://www.wordtravels.com/Travelguide/Countries/Zambia/Climate/

In the hot wet season, disease prevalence, pest and weed infestation in vegetable crops are high. Crop management requirements for diseases, pests and weeds are therefore high during this season and as such, the amount of vegetable production that takes place is limited. As a result of this, there is an overall short supply of fresh vegetables in the market during this season. In the cooler dry and the hot dry seasons, disease prevalence, pest and weed infestation are not as pronounced as in the hot wet season, and as a result, the cost of managing a crop during these two dry seasons are lower. Due to the much more favorable vegetable growing conditions in these seasons, particularly the hot dry season, the supply of fresh vegetables on the market is higher in these two seasons. These seasons are however faced with higher irrigation costs as they do not depend on rainfall for irrigation, but we expect that the cost of irrigation will be lower than the cost of pest, disease and weed control in the wet season.

Seasonal climate patterns in Zambia therefore greatly influences seasonality of production and supply of vegetable crops and other crops alike. Other factors that could affect seasonality of supply and ultimately also influence price variability and predictability include the degree of integration of product markets, the extent of irrigation and, more generally, the ability of a farmer to control their production environment.

a. Integrated Product Markets

Integrated markets may be considered as an interconnection of several markets not located in the same geographical area. Markets are interconnected by virtue of the common products they buy and sell and the movement of products between these markets based on the supply and demand conditions in each market. The end result of integrated markets is mainly in the provision of better signals for optimal production and consumption decisions and subsequent pricing efficiency. Well integrated markets therefore improve security of supply of a product and ensure that an equilibrium point is reached in that product market. Such an equilibrium is achieved when the flow of a product is from high supply areas to low supply areas.

Consider the case of two markets located in different production/consumption zones, which have different seasonal patterns of production. One market produces and sells the product for the first half of the year, while the other market produces and sells it in the other half of the year. If there is no trade between the two markets, each will have large price fluctuations over the course of a year. In the case where there is trade between them, thereby promoting integrated markets, price seasonality in each would be greatly reduced.

Despite the reduced price variability that could accrue from having integrated markets, not all markets are integrated. Some the factors that inhibit market integration include high costs of transporting products from one area to another, the absence of cold chain facilities and limited relevant market information.

High costs of transportation hinder integration of markets by impeding the transporting of products from high supply areas to low supply areas. The high transport cost could be manifest in the form of high fuel costs, long distance between markets, an inadequate road network or poor condition of the roads. To the extent that seasonal production patterns differ across markets, reduced trade due to high transport costs results in higher seasonality of supply in each area.

Cold chain systems enable the transportation of perishable products over longer distances. The integration of markets can be aided by the presence of cold chains. The lack of cold chains means that markets will be integrated only over smaller geographic areas. Where there is a cold chain in place, to the extent that seasonal production patterns are different across markets, this would reduce seasonality in all markets.

In the presence of market information, a farmer in a high supply area can make an informed decision about taking their product to an area where the supply is low. The effect of this would be to lower prices of the product in that area. In the absence of market information, suppliers could possibly end up taking their product to an area where the supply is high and would further depress the price of the product in that area. Therefore, poor market information limits the possibility of market integration and subsequently seasonality of supply would remain a prevailing concern.

b. Irrigation/Ability to Control Production Environment

Seasonality of supply is often affected by limited water supplies or poor production environment. Considering the case of limited water supply for crop production, a farmer could mitigate supply effects resulting from this by irrigating their crop. In the case of a poor production environment such as suboptimal temperatures and high humidity, or disease and pest infestation, farmers can avert supply effects from such by controlling their crop production environment through the use of green houses, insecticides and fungicides. If a farmer has access to irrigation and other technology that enable them control their production environment, seasonality of supply for a particular crop could be greatly reduced.

ii. Supply shocks (disease or pest outbreak, drought, flood)

A supply shock is an event that suddenly increases or decreases the output of a product or service temporarily. The result of this sudden change in supply changes the equilibrium price of the product or service. A negative supply shock (a sudden decrease in supply), will cause a rise in the price of a product or service while a positive supply shock (a sudden supply increase) will lower the price of a product or service. Some of the common supply shocks that would affect the supply of an agricultural product include disease or pest out breaks, drought and flood. Alternatively, especially good weather could lead to unexpectedly high supply and low prices.

In the absence of mitigation measures, supply shocks could be accentuated, and subsequently have adverse effects on agricultural production and the supply of the agricultural products. Some of factors that could help in mitigating the possible effects of a supply shock include the use of irrigation, the use of a controlled production environment (e.g. greenhouses), access to pest and disease control inputs and farmer knowledge of how to control pest and disease inputs.

Irrigation and control of production environment: Supply shocks that could result from adverse weather conditions such as drought or flood could be avoided through the use of irrigation or the use of green houses that have a well regulated water supply. In the case of a flood, its effects could also be avoided through the use of a controlled production environment such as a greenhouse.

Access to pest and disease control inputs: Easy accessibility to chemical pest control inputs reduces susceptibility to a pest or disease outbreak. However, the accessibility of these inputs is subject to the general development of the input markets in a country and also the credit or cash availability to the farmers that use these inputs. Poorly developed input markets and the financial limitation of farmers would mean that they would not be able to counter the effects of a disease or pest outbreak on their agricultural product.

Farmer knowledge: If on the other hand a farmer has easy access to pest and disease control inputs but lacks the knowledge on how to properly use them, then the farmer would not be able to either identify the disease or pest problem, or to use the correct control inputs, or to administer them incorrectly. The problem may further be accentuated by the absence of extension services in their area and the absence of an early warning system against pest or disease problems moving into the area.

iii.Random Fluctuations in Quantity Supplied to the Market

Already discussed is the issue of seasonality of supply and that of supply shocks and how they tend to cause price variability. Another factor that could influence price variability is the random fluctuations in the tomato quantities supplied to the market. Random fluctuations of the quantity of a product supplied in a particular market may be by the day or by the week. In both case, such fluctuations would entail that the price for the produce would be variable as would be dictated by the supply and demand situation in the market.

For any given FFV, random fluctuations in the quantities supplied to a market may be the result of the presence of a varying number of suppliers in the market at different times of the day or days of the week, uncoordinated production and supply of the product in the market, the absence of market information on the demand and supply conditions of a product or the differences in marketing strategies (such as when to harvest and take the produce to the market) adopted by the producers.

Therefore, even without a supply shocks or production seasonality, the quantities of tomatoes that arrive at a market will show a random component from day to day or week to week. The end result of this would be big effects in price variability and predictability.

iv.Grades and Standards

The factors discussed above influence both price variability and predictability. Some factors are however specific to price predictability and these include grades and standards. Grades and standards allow trading of a product on the basis of specific parameters identifying their quality and other characteristics, thereby making the market more transparent and reducing unpredictable variation in prices without necessarily making prices less variable. Where there are poor or no grades and standards, a farmer will not be certain of the price they will receive within a given range of prices being paid at any one point in time. The use of more grades and more precise specification of those grades increase price predictability for a given level of price variability of a product.

3.2 Hypothesis Testing

The level of price variability for a given product in a given market is related to the level of development of the economy in which the market operates. In this context, a well developed market is a market which (among other things) is capable of moderating the effects of seasonality of supply and supply shocks and thereby experiences less price variability. In more developed markets, better market information can reduce random variability in quantities of a product arriving on the market as it would give an indication of the supply and demand situation for a given product in different markets thereby enabling producers of the product to channel that product to an appropriate market; better information also gives sellers in a market more ability to plan the supplies they bring to the market and to source those supplies from the most competitive market. With better market information, suppliers of a given product would be knowledgeable about markets that are in short supply of the product they are trading in. Based on this knowledge and the coordinated efforts of several suppliers of the product, then the problem of random variability in quantities of the product arriving in the market would be less pronounced.

More developed countries also often have stronger grades and standards that define the prices at which a product would be sold. With grades and standards in place, then it would be possible to make some price predictions with some degree of accuracy. Therefore, in view of better market information, and grades and standards present in the markets of better (more) developed economies, these markets are likely to have less price variability and better price predictability than markets in less developed economies.

As a proxy for the level of economic and market development, per capita GDP (Gross Domestic Product) in purchasing power parity (PPP) terms was used for Zambia and the four other selected countries whose tomato price variability was analyzed (table 3.1).

Table 3.1: GDP Figures for Zambia and Other Selected Countries (Purchasing Power Parity Terms)

Country	PPP GDP
USA	45, 790
Taiwan	30, 126
Costa Rica	8, 295
Sri Lanka	4, 259
Zambia	1, 359

Source: World Bank, 2007

The hypothesis to be tested is that countries with higher PPP GDP (and thus with more developed fresh produce markets) have less price variability and better price predictability than those with lower GDP.

3.3 Data and Methods

3.3.1 Data

The data used in this analysis is tomato price data from Zambia and the four other selected countries (table 3.2). Some of the price data is for periods as long as 83 months (Taiwan), while some of it is for shorter periods such as 19 months as is the case with Zambia. For specific details on the tomato price data on Zambia, please refer to section 2.1.2 of this paper.

Table 3.1: Description of Data Used in the Analysis of Tomato Price Variability

Country	Market Name	Frequency	Time period	Basis of price/Differentiation	Basis of price/Differentiation used in analysis	Cold chain
Costa Rica	San José	3 times/week (M-W-F)	82 months (January 2000 to October 2007)	Differentiation by three quality grades	Chose the highest quality grade	Some cold storage in wholesale market; not clear how developed full cold chain is.
Taiwan	Taipei	Daily excluding Monday	83 months (January 2000 to November 2007	Differentiation by color, size and grade	Chose the large, red tomatoes of standard grade	Likely to have a full cold chain
United States	Chicago	Daily excluding Sat & Sun	82 months (January 2000 to October 2007)	Differentiation by origin, size, color, variety and grade	Chose item size5X6S and mature green variety	Full cold chain
Sri Lanka	Colombo	Daily	46 months (January 2004 to October 2007	Differentiation by variety only	Chose Thilina variety	No cold chain
Zambia	Lusaka (Soweto)	3 times/week (M-W-F)	19 months (January 2007 to July 2008)	Some informal differentiation by grade for a wide range of varieties	Chose standard quality grade	No cold chain

Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

From the table above, we observe that the frequency of the price data ranges from three days in a week to daily prices. The Zambia price data has observations for only Monday, Wednesday and Friday. Therefore, Monday, Wednesday, and Friday prices were selected from all other countries so that analysis would be done on data with the same frequency.

3.3.2 Methods

The methods to be used in the analysis of the tomato price variability across the selected countries are the analysis of the coefficient of variation and the conditional variance analysis. The coefficient of variation is the simplest unconditional measure of price variability while the conditional variance analysis is a measure of price predictability.

A high conditional variance implies that price predictability is low and vice versa for a low one. In the case of the coefficient of variation, a low coefficient of variance indicates low price variability and a high one indicates high price variability.

Coefficient of Variation

The coefficient of variation is a common statistic used for measuring the variability of data. It is an expression of the dispersion of the observed data values as a percent of the mean. It is a unit free statistic and therefore facilitates comparison of price changes in different directions, across different time periods, different commodities, different countries and currencies.

The coefficient of variation was calculated as follows;

$$\text{Coefficient of Variation} = \frac{\sigma}{\overline{P}} = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(P_t - \overline{P}\right)^2}}{\overline{P}}$$

Where;

σ - the standard deviation for tomato prices.

$\overline{P}$ - the mean price for tomatoes.

P_t - the observed tomato prices.

Conditional Variance

The conditional variance is the tool of analysis that was used in determining the level of tomato price predictability in the selected countries. To calculate the conditional variance, the following steps were followed;

Step one – Generation of a prediction model

In calculating the conditional variance, a price prediction model had to be generated. The prediction model used was based on a simple farmer price expectations process and not a structural model. The model was a basic regression model which takes the following form;

$$\hat{P}_t = \beta_0 + \beta_1 X_{1t} + \dots\dots\dots + \beta_{12} X_{11t} + \beta_{13} P_{t-1} + \beta_{14} T_t + u_t$$

Where;

P_t is the dependent variable and represents the predicted price for tomato in time t;

X_{it} - are dummy variables for the months of January through December, excluding the month which has a price closest to the mean. These dummy variables are included in the model to take account of the influence of seasonality in production on tomato prices.

P_{t-1} - is the single period lagged price for tomato. This is included in the model to take into account the influence of the previous prices on the current price and also because it is the price a farmer will most likely look at in forming a price expectation.

T_t - is a time variable in days. This is included in the model since it has an influence on price predictability. This variable actually controls for seasonal price fluctuations.

For the full regression results containing the model summary and coefficients, please refer to appendix 2.

Step two – Computation of the Conditional Variance from the regression outputs in step one.

Using the residuals from the regression outputs, the conditional variance was calculated using the following formula:

$$\text{Conditional Variance} = \frac{\sum_{t=1}^{t=n}\left(\frac{P_t - \hat{P}_t}{P_t}\right)^2}{n} = \frac{\sum_{t=1}^{t=n}\left(\frac{u_t}{P_t}\right)^2}{n}$$

Where;

P_t - the observed tomato prices in the market,

$\hat{P}_t$ - the predicted tomato price in time t,

u_t - the error term or residual, and

n – the number of price observations

The standardized residual is squared. Squaring of the residual therefore widens gap between a big price prediction error and a small one. To ensure that the conditional variance is unit free and comparable across time periods and countries, it is standardized by first dividing the residual (u_t) by the price.

Based on the regression outputs, appendix 3 presents a plot of the residuals for tomato prices for each country which provide a basis for comparing the extent to which these country's experiences positive and negative price prediction errors.

3.4 Results

3.4.1 Variability and Predictability of Prices

Computation of the yearly and mean coefficients of variation of nominal tomato prices in Lusaka's Soweto market and in other countries was conducted and later analyzed (table 3.3). Two points stand out: the difference in the mean coefficient of variation across all countries and the difference in price variability by year for each country.

Table 3.3: Yearly and Mean Coefficient of Variation of Nominal Tomato Prices in Selected Countries

Year/Country	USA	Taiwan	Costa Rica	Sri Lanka	Zambia
2000	0.11	0.18	0.22	-	-
2001	0.18	0.21	0.21	-	-
2002	0.15	0.26	0.24	-	-
2003	0.12	0.17	0.20	-	-
2004	0.21	0.22	0.21	0.28	-
2005	0.19	0.18	0.20	0.21	-
2006	0.20	0.19	0.22	0.27	-
2007	-	0.16	0.21	0.24	0.24
2008	-	-	-	-	0.26
Mean	0.16	0.20	0.22	0.25	0.25

Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

A closer look at the means across all the countries shows that all but Zambia and Sri Lanka have different mean coefficients of variation. On the basis of the PPP GDP[16] which was used as a proxy indicator for economic and market development, it is noted that the USA which has the highest PPP GDP is the most developed of the five countries. Examination of its coefficient of variation confirms this as it is the lowest. Zambia and Sri Lanka on the other hand, with the lowest PPP DGP figures are expected to have the least developed horticulture markets, have the highest coefficients of variation at 25%. Taiwan and Costa Rica which have higher PPP GDP figures compared to Zambia and Sri Lanka, are expected to have better developed horticulture markets, and their lower coefficients of variation of 0.20 and 0.22 respectively, confirm this. A comparison of Taiwan and Costa Rica shows that Taiwan, with a lower coefficient of variation than Costa Rica, has a higher PPP GDP.

[16] Reference to table 3.1.

A look at price variability in each country during individual years shows that the price variability in the USA is consistently lower than all countries each year. In fact, the USA never in any year reaches even the mean level seen in Zambia and Sri Lanka, while Taiwan reaches those levels only once. From these results, we see that the most developed horticulture markets (as proxied by PPP GDP), USA and Taiwan, consistently show less variability than the two least developed horticulture markets of Zambia and Sri Lanka.

The conditional variance for Zambia and the four other selected countries was also computed and analyzed (table 3.4). From these results, one point that clearly stands out is how the conditional variance figures for all countries fluctuate substantially from year to year. We also note that the yearly conditional variance figures for the USA are consistently much smaller than all other countries.

Table 3.4: Yearly and Mean Conditional Variance of Nominal Tomato Prices in Selected Countries

Year/Country	USA	Taiwan	Costa Rica	Sri Lanka	Zambia
2000	53	285	723	-	-
2001	142	336	568	-	-
2002	85	434	561	-	-
2003	91	328	477	-	-
2004	196	385	446	1252	-
2005	207	291	513	362	-
2006	111	310	459	896	-
2007	-	242	400	376	702
2008	-	-	-	-	787
Mean	127	329	521	734	731

Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

Zambia and Sri Lanka have the highest mean conditional variance and they are expected to have the least developed markets of all five countries. From the PPP GDP proxy indicator for economic and market development, the high conditional variance figures are consistent with the low PPP GDP figures, indicating that the horticultural markets in these countries are not that well developed and subsequently experience high price variability.

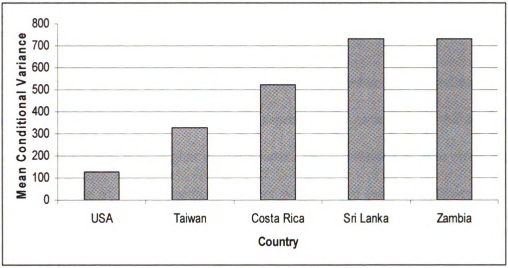
Followed by Zambia and Sri Lanka is Costa Rica with a lower conditional variance of 521. Again, as proxied by the low PPP GDP, Costa Rica is expected to have a less developed horticulture market. However, compared to Zambia and Sri Lanka, Costa Rica has a market that is better developed.

Taiwan has a much lower conditional variance and a higher PPP GDP. As proxied by the PPP GDP, Taiwan has a well developed horticulture market when compared to Zambia, Sri Lanka and Costa Rica. A look at the low US conditional variance figures and the high PPP GDP proxy for economic and market development, these results reveal that the US horticulture market is the most developed one of the five countries as it has the highest PPP GDP and the least conditional variance.

In the analysis of the conditional variance we observe that the ranking of the PPP GDP is consistent with the ranking of the mean conditional variance for these countries. The countries with well developed horticulture markets, as proxied by PPP GDP, have a lower mean conditional variance than those with less developed horticulture markets.

For further comparison of the mean conditional variances for Zambia and the four other selected countries, the mean conditional variance figures for each country were plotted (figure 3.1). The higher the conditional variance, the less developed a country's horticulture market is as proxied by the PPP GDP indicator for economic and market development.

Figure 3.1: Mean Conditional Variance for Zambia and Four Selected Countries



Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

3.4.2 The Problem of Predicting Sharp Price Declines

In fresh produce markets, the absence of cold chain facilities and the need for the product to clear in the market can lead to sudden sharp price declines. The effect of this is in the greater difficulty in predicting price drops compared to price rises for a given fresh produce. To examine this matter, the mean absolute values of positive and negative tomato price forecast error and the ratio of the mean negative price forecast error to the positive tomato price forecast error for Zambia and the other selected countries were computed and compared (table 3.5), .

Table 3.5: Mean Absolute Values of Positive and Negative Tomato Price Forecast Errors

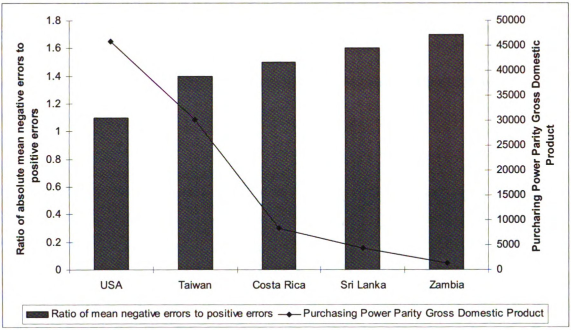
	USA	Taipei	Costa Rica	Sri Lanka	Zambia
Mean Absolute Value					
Positive errors	0.0675	0.1120	0.1297	0.1294	0.1382
Negative errors	0.0746	0.1597	0.2022	0.2043	0.2443
Ratio of negative and positive errors	1.1	1.4	1.5	1.6	1.7

Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

A price prediction error is defined by the difference between the predicted price and the actual price. The mean positive errors represent the mean of all the prediction errors when actual prices were higher than predicted, and the mean negative errors represent the absolute mean of all the prediction errors when actual price was lower than predicted. Where the value for the mean of the (absolute value of) negative errors is higher than the mean of the positive errors, this implies that operators in the market under consideration have greater difficulty predicting price drops than they do price rises.

We observe that the US has the least ratio followed by Taiwan, Costa Rica, Sri Lanka and Zambia. A comparison of these results with the PPP GDP proxy for economic and market development of a country, we further observe that as this ratio increases, the PPP GDP also decreases (figure 3.2). The conclusion that is drawn from this is that countries with higher ratios have a problem of unanticipated sharp declines in tomato prices and hence have poorly developed horticulture markets as proxied by the PPP GDP.

Figure 3.2: Comparison of the Ratio of the Absolute Mean Negative Errors to the Positive Errors and the PPP GDP by Selected Countries



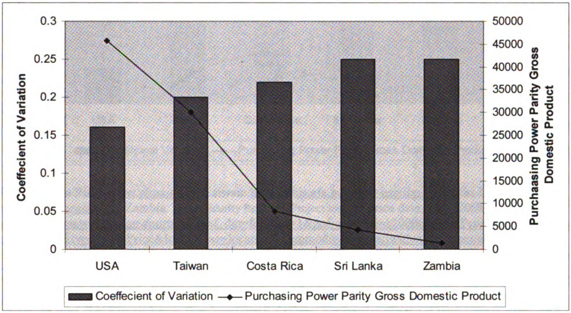
Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

3.5 Summary and Discussion

From the results of the coefficient of variation, conditional variance analysis and the ratio of the mean absolute values of negative to positive errors (RNPE), and with reference to the PPP GDP which was used as a proxy indicator for economic and market development, we see a clear consistent pattern that shows that tomato price variability is higher and predictability is lower in countries that are considered to have horticulture markets that are not very well developed. The results all point to the fact that countries with well developed horticulture markets, as proxied by the PPP GDP, have lower coefficients of variation, conditional variance, and RNPE.

The inverse relationship between the results of the conditional variance analysis and the PPP GDP was visually compared by plotting the two (figure 3.3). A higher PPP GDP corresponds to a lower coefficient of variation and vice versa for a lower one.

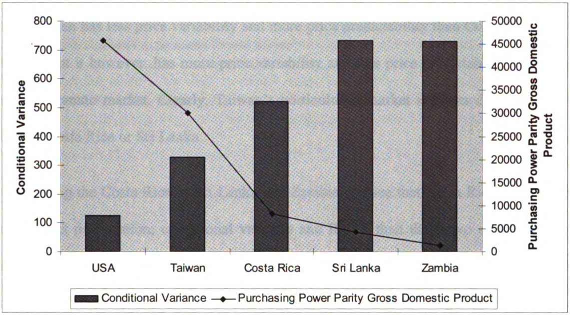
Figure 3.3: Comparison of the Coefficient of Variation and PPP GDP by Selected Countries



Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

The inverse relationship between the conditional variance results and the PPP GDP by country was also plotted (figure 3.4). The countries with low conditional variance have better developed horticulture markets, as proxied by the PPP GDP, have higher PPP GDP.

Figure 3.4: Comparison of Conditional Variance and PPP GDP by Selected Countries



Source: Costa Rica: www.pima.go.cr; Taiwan: http://amis.afa.gov.tw/v-asp/top-v.asp; Sri Lanka: www.ggs.lirneasia.org; Zambia: Food Security Research Project tomato price data, 2007/2008; USA: http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allwithoutornamental

Of all the five countries, Zambia has the highest coefficient of variation, conditional variance and RNPE and has the least PPP GDP. From the PPP GDP as an indicator for economic and market development, these results show that Zambia has high tomato price variability and low tomato price predictability which is consistent with a country that has a poorly developed horticulture market. On the extreme end is the US which has the highest PPP GDP and the lowest coefficient of variation, conditional variance and RNPE. The conclusion from this is that the US has low tomato price variability and high tomato price predictability. From its PPP GDP proxy, this is consistent with a horticulture market which is well developed.

Closely following the US results is Taiwan, followed by Costa Rica and finally Sri Lanka. From the coefficient of variation, conditional variance and the RNPE, we observe that Taiwan has less price variability and more price predictability than Costa Rica or Sri Lanka, but it however, has more price variability and less price predictability than does the US tomato market. Clearly, Taiwan's horticultural market is better developed than that of Costa Rica or Sri Lanka.

Comparing the Costa Rica to Sri Lanka and Zambia, we see that Costa Rica has a lower coefficient of variation, conditional variance and RNPE than these two countries. This indicates that it does not have as much price variability and its horticulture market better developed. This conclusion is confirmed by the higher PPP GDP (proxy indicator for economic and market development) it has compared to Sri Lanka and Zambia.

In the earlier part of this chapter, we suggested that seasonality of supply, supply shocks, and random variation in quantities arriving to the market are the main factors that affect price variability and predictability. In addition to these factors, price predictability is also affected by the absence of grades and standards. Unlike the US market which has well specified grades and standards for tomatoes and other horticultural products, Zambia has no formal grading system. Costa Rica and Taiwan showed less price variability than Zambia. Each of these has more formalized grades and standards defined by either product variety, color or quality grade. Costa Rica for instance has three different quality grades while Taiwan has grades and standards system that incorporate variety, color and quality. Clearly, where there are well specified grades and standards for tomatoes which farmers are familiar with, then the pricing system in the market is more transparent thereby making the farmers more confident of the price they are likely to get relative to the overall, prevailing price level in the market.

3.5.1 Tomato Seasonality of Supply

In cases where a FFV product is faced with seasonality of production due to the differences in the geographic production conditions in a country, markets that are well integrated over space would reduce the severity of seasonal price variation. In the US for instance, the climatic differences across its geographic regions implies seasonality of production for all FFV. However, to the extent that the horticulture markets are integrated across the different geographical regions, seasonality of supply and prices in each region is reduced.

In Zambia, climatic differences across the country are minimal and as such seasonality of supply of tomatoes could be the result of the size of the "market shed"[17]. Larger market sheds mean a market can draw from a larger area with greater variability in seasonality, and thus reduce its own seasonality. However in the case of a smaller market shed, the opposite is true. A smaller market shed can only draw from a smaller geographic area, and with variability in seasonality over that small area, seasonality of supply would be inevitable.

Soweto market in the capital city of Zambia, Lusaka, is the largest wholesale market and can be considered as a large market shed which draws tomatoes and other FFV from a large geographic area. Other fairly large wholesale markets in the country which however

[17] The geographic area over which produce tends to move to a specific market.

draw FFV produce from smaller geographical areas include Maramba market in Livingstone in the southern part of the country and Chisokone market in Kitwe, in the central northern part of the country. Owing to the small size of these market sheds and the small degree to which all the market sheds may be integrated, seasonality of supply is a concern.

Some of the factors that influence the size of the market shed and the degree to which they could be integrated include the following;

a. High transportation costs. Though distances across these market sheds are not large, roads are often of poor quality, increasing the time and also the repair and maintenance cost of transport. This coupled with high fuel costs (Zambia has the highest petrol cost in Africa) makes transportation of fresh produce from one market to another very costly.
b. The lack of formal grades and standards in the markets. Where grades and standards are either absent or not formalized, farmers or traders supplying that market would not be confident of the prices they are likely to receive for a given quality of their produce. On the other hand, traders who make tomato orders from farmers would not be confident about the quality of tomatoes they would expect from the market they are placing their orders in.
c. Poor road network. The main roads linking these market sheds are not well maintained and as such would add to the high costs involved in transporting the fresh produce. This is further accentuated by the absence of cold chain systems.

d. The absence of cold chain systems. Zambia does not have a cold chain system which could handle the transportation of highly perishable products like tomatoes over long distances.

e. Poor market information. Zambia does not have a market information system that can provide general information about a product's supply and demand situation or the prices for the products being traded in the markets. Given such a situation and the need for timely information on the availability of alternative markets for perishable products such as tomatoes, random fluctuations in the quantity of tomatoes in a market would occur very often. With market information, suppliers could strategically channel their tomatoes to areas where they are needed and not deprive a market or oversupply another market. In the case of tomato traders, market information would also allow them to make their orders easily.

f. When contractual arrangements between suppliers and buyers are not met, participants in a market would not be confident about being a supplier (or buyer) in the market. This would particularly be the case where a market does not have a transparent and competitive system. This problem would be accentuated by an ineffective legal system to deal with cases of defaults. Given this, a supplier (or buyer) would be comfortable and confident about participating only in the market shed they operate in.

Another factor that accentuates seasonality of supply in Zambia is the fact that many tomato growers, especially rural smallholder farmers do not have irrigation facilities to enable them to provide adequate water for their tomato crop. Furthermore, almost none of these farmers have facilities such as green houses that would enable them have better control over their tomato production environment.

3.5.2 Tomato Supply Shocks

Supply shocks such as disease or pest outbreaks, droughts or floods also often affect the supply of tomatoes in Zambia. This problem may be accentuated by the fact that some tomato growers may not have the capacity to avoid or reduce the effects of such supply shocks.

a. The use of irrigation or a controlled production environment could help in mitigating the effects of drought or floods. Some farmers may have the most basic irrigation technology (pump and pipes) that would only enable them irrigate a limited size tomato field. Therefore, in the time of a drought, such farmers would be at risk of losing their crop especially if their fields are larger than what their irrigation technology can cater for. Controlled production environments such as green houses are quite costly. For a small farmer to have access to such facilities, they would have to get a loan or access credit. However, in Zambia small farmers, who make up the majority of farmers in the country, may not have access to sufficient credit or cash to enable them acquire such technology.
b. In the case of a pest and disease outbreak in their tomato crop, tomato growers' access to pest/disease control chemicals may be limited due to their cash constraints or the general limited availability of chemicals from input suppliers in their production areas. This is particularly the case with farmers that solely

depend on local suppliers for their agricultural inputs. In the rural areas where you find such farmers, the input markets are not very well developed.

c. Tomato supply shocks are also affected by the farmers' poor knowledge of how to control pests and/or diseases that affect their tomato. This is further worsened by the fact that they may not have access to agricultural extension services or any early warning on tomato disease or pest outbreaks.

3.5.3 Random Fluctuations in the Quantities of Tomatoes Arriving in the Market

Another factor that influences tomato price variability and predictability is random fluctuations in the quantities of tomatoes arriving in the market. In Lusaka's Soweto market, these fluctuations have been observed to occur within the day and also within the week.

Some of the factors that contribute to these random fluctuations in supply have to do with the variations in the number of tomato suppliers in the market at any given point in time. This is especially the case since the suppliers all work independently of each other and are interested in offloading their product whenever it is ready for the market. In addition to this, the absence of coordinated production and marketing of tomatoes among tomato growers also contributes to this. Where farmers are more organized and coordinate their production and supply, as would be the case with outgrower schemes, random fluctuations in the quantities of tomatoes arriving in the market could be reduced.

Farmers usually adopt different marketing strategies about when to harvest their tomatoes and about when to take them to the market. Some farmers may decide to harvest their produce and supply their tomatoes once a week while others may decide to harvest a similar field every other day. Considering the large number of tomato growers/suppliers, random fluctuations in their own production (for reasons discussed above), and the different marketing strategies they have adopted, random fluctuations in the quantities of tomatoes arriving in the market are inevitable.

Some of the factors that could help reduce random fluctuations in the quantities of tomatoes arriving in the market include the following;

a. Coordinated production and supply of tomatoes. If the farmers coordinated their production and supply of tomatoes in the market, then they would be able to regulate and manage these fluctuations. This coordination could be done through the farmer cooperatives the farmers are affiliated to or through the formation of marketing cooperatives which would have a mandate to plan which crops the farmers should grow when, and facilitate group marketing of the famers' produce. With coordinated production and supply of tomatoes, farmers harvesting tomatoes at a given time would then adopt marketing strategies that would make it possible for the farmers to ensure consistent flow of tomatoes into the market at given periods of time within the day or the week without necessarily oversupplying the market.

The provision of market information on the demand and supply conditions of a market or the availability of alternative markets. With such information, tomato farmers and suppliers would be able to be more strategic about where they offload their tomatoes.

CHAPTER 4
MONTE CARLO ANALYSIS OF CONDITIONAL AND UNCONDITIONAL NET RETURNS TO TOMATO PRODUCTION

From the analysis conducted in chapter 3, it was observed that tomato prices in Lusaka's Soweto market are quite variable and unpredictable. In addition to the high price variability and low price predictability, farmers and traders selling in the market are also faced with a special problem of unanticipated sudden sharp price declines. This high tomato price variability, low predictability and the unanticipated sharp price declines are a matter of concern to tomato growers who would like to make a good and predictable return on their tomato production investment.

In view of these challenges, this chapter will seek to address the following;

1. Characterize and group surveyed farmers based on their typical yields, costs of production, and seasonality of sales, and examine the average level and variability of returns to the resulting farmer groups;
2. Analyze the effects of greater sales frequency on the variability of price and returns for each group. Tomato farmers adopt different marketing strategies and some of them may include the frequency with which they go to the market to sell their tomatoes.
3. Analyze the effects of producing consistently high or low quality tomatoes on the level and variability of returns for each group. Soweto market data has shown that better quality tomatoes fetch higher prices and are usually sold early in the day

upon arrival in the market. Lower quality tomatoes usually sell for less and are sold later in the day.

4. Analyze the effects of supply chain improvements. Supply chain improvements such as better market information, cold chain facilities, assembling and packaging facilities, and others are expected to reduce price variability in markets. In more developed countries where the supply chains are well developed, the instances of price variability are not as pronounced as those that do not have well developed supply chains.

Analysis under point 1 will establish the baseline net returns to tomato production for the farmer groups while the points outlined in 2-4 above will establish net returns under three different scenarios.

This chapter shall begin with an overview of the data used and data analysis methods, followed by the results and discussion on the analysis conducted. Conclusions are presented at the end.

Data and methods

Two sets of data are used in this chapter: the FSRP tomato wholesale and retail price and quantity data as described in section 2.1.2 and data from a household cost of production survey conducted earlier in the year (2008) as part of this research.

4.1 Household Survey

During April/May 2008, a tomato survey was conducted in collaboration with the FSRP. In January through March, questionnaire design and a series of pre-tests and re-designing of the questionnaire took place. This was then followed by the training of twelve potential enumerators which involved reviewing of the questionnaire, role playing in data collection and pre-testing of the questionnaire and enumeration process. Based on the performance of the enumerators during the training exercise, ten were selected for the actual data collection exercise which lasted three weeks.

i. The Survey Instrument

The survey instrument used in the survey is presented in appendix 4. The instrument mainly focused on production and marketing costs of tomatoes. In addition to this, the survey was useful in gathering information on the production and marketing decisions farmers make as they try to get the highest return possible from their tomato production investment. Specific data collected in the survey included;

- Farmer household demographics,
- Permanent laborers employed,
- Production and sales of crops other than tomatoes,
- Timing of planting and harvest of tomato over the past 15 months,
- Cost data on field preparation and crop management operations such as irrigation, spraying, fertilizer and chemical applications, and others,
- Cost data on marketing activities such as sorting, loading, transport to the market, and unloading at the market,

- Assets used in tomato production,
- Harvest frequency and weekly quantities of tomatoes harvested and sold, and
- Access and use of market information, and others.

ii. Survey Area and Sampling Design

Volume data from regular data collection in Soweto market (see section 2.1.2) were used to identify the top 12 areas supplying tomatoes to the market. Volume data at the level of each lot were aggregated to get the total volumes from each area for the period January 2007 to April 2008. The top twelve areas were then chosen and characterized in more detail on farm size distribution (as proxied by data on individual lot sizes), seasonality of supply and estimated volume-weighted average price over the period. Weighted average prices were calculated as simple average daily prices, multiplied by total volumes for each day from the given area, that product summed and then divided by total volume from that area over the period.

Among these top twelve areas, Lusaka West in Lusaka district and Manyika in Chongwe district were chosen as the sample areas. Lusaka West was chosen because it has the largest tomato market share in Soweto market and because its population is made up of all types of farmers i.e. large, medium and small. Manyika on the other hand was chosen because among the top twelve areas with predominantly small farmers, it has the closest proximity to Lusaka city.

A total of 235 tomato growers were identified in both areas; 69 from Lusaka West and 166 from Manyika. The identification process involved the use of focus group interviews, contact farmers[18] (or community leaders) and/or snow ball identification techniques. In Lusaka West, the identification process involved the use of all these methods whereas identification in Manyika involved the use of only snow ball sampling techniques and contact farmers.

The focus group discussion was aimed at finding out the specific tomato crop production and marketing activities the farmers were involved in. At the end of the focus group discussion, the farmers present were asked to list the names of the tomato growers in their area. Where lead farmers or community leaders were identified, these farmers/leaders provided a list of tomato growers in their areas. In the snow ball identification technique, already identified tomato growers were used to identify others.

From the identified population of 235 tomato growers in both areas, a total of 121 were randomly selected for the survey using a systemic sampling approach from the developed lists. During survey implementation, however, only 102 of these 121 farmers were able to be interviewed, 32 from Lusaka West and 70 from Manyika.

In Lusaka West, the farmers were drawn from three areas, namely Kuma plot, Star cottage and Kacheta, while Chongwe had farmers drawn from five areas, namely Ncute, Maali, Kangombe, Kapilipili and Katoba. The distribution of sampled farmers in each area is presented in appendix 5.

4.2 Price Data

[18] Lead farmers in this case were the farmers that are well known in the farming community due to their exceptional farming abilities or the large quantities of tomatoes they produce.

Tomato price data used for analysis in section 2.1.2 of Chapter Two were also used for analysis in this chapter. In Chapter Two however, average daily prices in Soweto wholesale market were used because data from the other four countries was limited to daily averages. In this chapter, we took advantage of the more detailed data set in Zambia and used hourly average prices between 7am and 12 noon. The 6am and 1pm prices were not used as there were very few observations during these hours.

Analysis Methods

4.3 Overview of Monte Carlo Analysis[19]

In addressing the three research objectives, Monte Carlo simulation analysis was used. Monte Carlo simulation is a technique that involves using random numbers and probability to solve problems. It ultimately results in the generation of probability distributions on variables of interest which provide solutions to queries. In cases where the objective is to determine how random variation, the lack of knowledge, or error affects the sensitivity, performance, or reliability of a system that is being modeled, Monte Carlo analysis is used for analyzing the uncertainty spread.

This technique involves the use of simulations that make use of computer models to imitate real life or make predictions. The model has input parameters, random variables from specified distributions, and equations that use the parameters and random variables to generate a set of output variables. It then iteratively evaluates model using new randomly drawn values of the input variables in each iteration. By using some random

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[19] This section draws from http://www.vertex42.com/ExcelArticles/mc/MonteCarloSimulation.html.

variable inputs, rather than solely fixed parameters, a deterministic model is turned into a stochastic model.

Monte Carlo simulation is also considered as a sampling method since the inputs are randomly generated from probability distributions to simulate the process of sampling from an actual population. In view of this, the distribution which is chosen for the inputs is one which most closely matches data we already have, or best represents our current state of knowledge regarding the variables of interest.

Once the simulation is conducted, the output generated can be represented as probability distributions (or histograms) or converted to error bars, reliability predictions, tolerance zones, and confidence intervals.

There are five basic steps in conducting Monte Carlo simulation. These steps can be implemented in Excel for simple models, but for the analysis to be conducted in this research, the Excel add-on @RISK was used. The five steps are:

Step 1: Create a parametric model of the form $Y = f(X_1, X_2, \ldots\ldots Xq)$

Step 2: Specify a set of random inputs, $X_{i1}, X_{i2}, \ldots. X_{iq})$

Step 3: Evaluate the model and store the results as Yi.

Step 4: Repeat steps 2 and 3 for i = 1 to n.

Step 5: Analyze the results using histograms, summary statistics, confidence intervals, etc.

4.4 The Monte Carlo Model

The Baseline Model

@RISK version 3.5 was used to carry out the Monte Carlo simulation analysis. For the baseline simulation, the model used was a basic model of farmer total profit and farmer profit per hectare. These are both outputs in the model and are functions of the inputs; total gross revenue per trip, cost of production per hectare and the area under tomato production.

- Total gross revenue per trip is a function of tomato prices and sales of tomatoes made per trip.
- Tomato sales per trip are a function of total tomato production and the number of trips the farmer made to the market.
- Total tomato production is a function of tomato yields and the area under tomato cultivation.
- Number of trips a farmer made to the market is a function of the number of weeks the farmer sold tomatoes in the market and the number of trips the farmer made each week.

Based on these inputs and outputs, total profit is modeled as follows:

$$TP = \sum_{i=1}^{\overline{N}} \left(GR_i\right) - CH * \overline{A} \tag{4.1}$$

$$TP = \sum_{i=1}^{\overline{N}} \left(P_i * S_i * \overline{CF} \right) - CH * \overline{A} \tag{4.2}$$

$$S_i = \frac{T\Pr}{\overline{N}} \tag{4.3}$$

$$T\Pr = Y * \overline{A} \tag{4.4}$$

$$\overline{N} = \overline{NW} * \overline{TW} \tag{4.5}$$

Where;

$\overline{N} =$ Total number of trips made to the market from production on the chosen field. This is a fixed parameter.

$TP =$ Total Profit (ZMK),

$GR_i =$ Gross revenue per trip (ZMK),

$CH =$ Production costs per hectare of tomatoes (ZMK/ha). This is a stochastic random variable which does not vary across trips but does vary across iterations,

$\overline{A} =$ Area of the chosen field under tomato cultivation (ha). This is a fixed parameter.

$P_i =$ Price per crate of tomatoes (ZMK/crate) realized during the sales trip, drawn from the chosen distribution of prices during the season when the farmer was selling tomatoes. This is a stochastic random variable and varies across trips and iterations,

$S =$ Mean sales of tomato per trip (mt). This is a stochastic random variable equal to total production divided by number of trips; it does not vary across trips but does vary across iterations,

$\overline{CF}$ = Fixed conversion factor of 37. A crate of tomatoes weighs 27kg and therefore a metric tone of tomatoes would have 37 crates (1000kg/27kg),

$T\Pr$ = Total production. This is a stochastic random variable equal to the product of yield and area of field; it does not vary across trips but does vary across iterations,

Y = Tomato yield (mt/ha). This is a stochastic random variable which does not vary across trips but does vary across iterations,

$\overline{NW}$ = The number of weeks the farmer sold tomatoes in the market. This is modeled as a fixed parameter.

$\overline{TW}$ = The number of trips a farmer made each week. This is also modeled as a fixed parameter.

Total profit per hectare was obtained by dividing equation 4.2 by area ($\overline{A}$):

$$TPH = \mathrm{TP}/\overline{A} \qquad (4.6)$$

NW and *TW* are modeled as fixed parameters to simplify the simulation and because they are expected to have substantially less influence on the level and variability of profit than will the stochastic variables of price, yield, and cost per ha. Because these last three variables are modeled stochastically, our output variables of interest (farmer total profit and profit per hectare) are also stochastic variables whose distributions can be examined.

The simulation analysis of the baseline model was then followed with simulation analysis of three different scenarios:

1. Selling tomatoes more frequently in Soweto market ,
2. Sales of tomatoes associated with supply chain improvements,
3. Selling high quality versus low quality tomatoes in the market

Calculating production cost per hectare initially involved a calculation of the individual costs that go into their tomato production and marketing activities. Total costs were then obtained by summing up all these individual costs. Total cost per hectare was then computed by dividing total costs by the area under tomato production:

$$CH = \sum_{z=1}^{Z} \frac{C_Z}{\overline{A}} \tag{4.7}$$

Where,

$Z =$ The number of production or marketing activities,

$CH =$ Production costs per hectare of tomatoes,

$\overline{A} =$ Fixed area under tomato production, and

$C_Z =$ The cost associated with each production/marketing activity.

The following were the activity costs included in this variable;

- Seedling costs
- Seed costs
- Field preparation costs – ripping, ploughing, disking and ridging
- Irrigation costs
- Cost of permanent labor
- Cost of piece work labor
- Cost of fertilizer
- Cost of chemicals (herbicides, fungicides, fungicides and bacterialcides)
- Harvesting and marketing costs

Defining farmer groups - Analysis of the baseline model and the other scenarios involved the use of four different groups of farmers. After extensive exploration of the data for variables that would distinguish farmers by their performance as tomato growers, two variables were chosen:

- The total number of months the farmers sold tomatoes over the previous 12 months. This variable considered all tomato fields the farmer operated, not just the specific tomato field being analyzed; and
- The season during which the farmer planted and sold their tomatoes from the specific field chosen for analysis. Season was divided into two: the dry season, in which farmers planted their field between April and June and sold during July to October, and the wet season, in which farmers planted their tomatoes between August and December and sold during November to March.

This classification scheme resulted in four farmer groups:

Group 1: Produced from selected field during dry season, and sold tomatoes from all fields during six months or less

Group 2: Produced from selected field during rainy season, and sold tomatoes from all fields during six months or less

Group 3: Produced from selected field during dry season, and sold tomatoes from all fields during seven months or more

Group 4: Produced from selected field during rainy season, and sold tomatoes from all fields during seven months or more

The variable, 'number of months in which the farmers sold their tomatoes' was divided into those that sold their tomatoes in the market for six months or less and those that sold them for seven months or more. T-tests for the differences in means across a range of relevant performance variables for these two groups were computed and analyzed (table 4.1). Comparing farmers selling during seven months or more to those selling six months or fewer, the former planted more fields, had a chosen field nearly twice the size, sold tomato from that field for 50% more weeks, achieved more than double the yield, and had a one-third lower production cost per crate of 27 kg. Their production cost per ha was higher, but this was due to more intensive production resulting in higher yields. Differences in the frequency of sales and in our measure of market knowledge were not statistically significant. Finally, farmers from the two groups were spread nearly equally across the seasons in the timing of their planting and sales, suggesting that the observed differences were due to differences in farmer resources and abilities, not to seasonal effects on production.

Table 4.1: Results of t-test for Difference in Means

Characteristic	Means for farmers selling <= 6 months	Means for farmers selling >= 7 months	Significance level difference in means
Total number of tomato fields planted past 12 months	2.4	3.4	0.000
# of weeks harvesting from chosen field	7.2	10.9	0.000
Yield on chosen field (mt/ha)	31.6	67.1	0.000
Size of chosen field (ha)	0.28	0.48	0.000
Production cost/crate on chosen field	25,003	17,098	0.006
Production cost/ha on chosen field (ZKW)	22,352,235	33,133,132	0.007
# of sales trips per week from chosen field	1.2	1.4	0.445
Ranking on price level prediction (higher is better, max possible=5)	1.7	1.9	0.083

Other characteristics of the farmers groups were also examined based on a subset of variables ranging from farmer demographics to specific farmer attributes concerning their tomato production activities (table 4.2).

From the table presented, it is quite evident that there are reasonable differences in these farmers groups.

Controlling for season, and considering the two distinct farmer groups based on the length of time they sold tomatoes, the general conclusion is that farmers who harvested and sold tomatoes for seven months or more produced and managed their tomatoes at a higher capacity than those that harvested and sold tomatoes for six months or less. This can be seen from the lower unit production costs they achieve and the fact that they have higher yields and cultivate larger fields than the famers that harvested and sold their tomatoes for six months or less.

Additionally, the farmers that sold tomatoes for seven months or more planted larger and more tomato fields over the 12 month period reviewed, and during their harvest period, they made fewer sales trips per week than the farmers that harvested for six months or less. Further observation of other farm management practices and activities also reveals significant differences between the two groups. For instance, a look at the proportion of farmers that planted seedlings, it is observed that more of the farmers that harvested for seven months or more planted seedlings (utmost 23%) than did the farmers who harvested for six months or less (utmost 16%)

With regards to the application of lime in their tomato fields, all farmer groups had few farmers who applied lime to their fields. However, it is observed that the farmers that harvested their tomato crop for 7 months or more applied more lime to their tomato fields than those that harvested their tomatoes for 6 months or less.

Most of the farmers owned that animal traction they used in their fields. Amongst those that harvested their fields for 7 months or more, almost 60% of them owned animal traction, while amongst those that harvested their tomato fields for 6 months or less had at most 35% owning the animal traction they used.

A look at the use of permanent labor and piecework labor in tomato fields shows some differences among the four farmer groups. It is noted that among farmers in group 2 and 4, who grew wet season crop and harvested for 7 months or more used twice as much permanent labor as those in group 2 who harvested their tomatoes for 6 months or less.

Table 4.2: Farmer Characteristics Based on Selected Variables

	Farmer Group			
Farmer group variables	1	2	3	4
Mean number of adults (aged between 19-65 years old) in household	3.0	3.6	3.5	3.3
Mean total size of household	7.4	8.7	10.3	10.0
Mean highest number of years formal education across all members	9.9	9.4	10.6	10.9
Mean umber of people involved in non-farm business	0.6	0.4	0.3	0.3
Mean number of people involved in salaried jobs	0.2	0.1	0.1	0.2
Mean number of non FFV crops produced	2.0	2.1	2.4	2.8
Mean number of FFV crops other than tomato produced	3.7	3.8	4.5	4.6
Mean number of non FFV crops sold	1.1	1.2	1.4	1.7
Mean number of FFV crops other than tomato sold	1.5	2.5	2.5	2.3
Median quantity of maize produced (kg)	3,450	2,760	2,875	4,313
Mean total area of tomato planted across all fields (hectares)	1.65	1.65	3.34	3.21
Median expenditure per hectare on fertilizer (ZMK)	2,090,535	928,198	2,060,000	2,060,000
Median expenditure per hectare on plant protection chemicals (ZMK)	3,801,881	4,466,778	14,408,849	4,270,322
Median replacement costs for all production assets owned	22,142,900	4,683,000	8,619,000	18,769,000
Weighted average percent of tomatoes that go to waste in field	19	18	16	12
Percent farmers using hybrid seed or seedlings	31.6%	18.2%	35.5%	18.2%
Percent farmers that plant seedlings	15.8%	6.8%	22.6%	21.2%
Percent farmers using irrigation	97.4%	90.9%	100.0%	97.0%
Percent farmers that apply lime	7.9%	11.4%	19.4%	18.2%
Percent farmers that use animal traction	60.5%	56.8%	67.7%	66.7%
Percent farmers owning animal traction used	34.8%	32.0%	57.1%	59.1%
Percent farmers that use permanent labor in tomato fields	36.8%	25.0%	38.7%	45.5%

Table 4.3 cont'd

Percent farmers that use piecework labor in tomato fields	71.1%	59.1%	71.0%	75.8%
Percent farmers that use at least one safety precaution measure when handling chemicals	97.2%	97.7%	100.0%	100.0%

The model used in the simulation analysis incorporated the four farmer groups based on the variables field size; number of trips per week; total tomato sales per trip; tomato yield; tomato production costs per crate and the price per crate[20] (table 4.3).

[20] Variable means in Table 4.1 were calculated without regard to season, while season was considered in Table 4.3; mean values for common variables are therefore different across the tables.

Table 4.1: Basic Information on the Structure of Baseline Monte Carlo Simulation Model

Group	Total # of months selling tomato in past 12 months	# of field observations	Planting/sales season	Mean field size (fixed)	Fixed Random Variables (mean)			Stochastic Random Variables (Mean, Standard deviation , and Distribution)		
					Total wks selling from field	Trips/ week	Total # of sales trips	Yield (mt/ha)	Cost per hectare (ZMK)	Price (ZMK)
1	6 or fewer	38	**Dry Season** Planting: Apr-June Sales: July-Oct	0.35	8	1.3	11	Actual (34, 23, N/A) Fit (38, 60, Log logistic)	Actual (23,241,373, 15 391 932, N/A) Fit (23 241 373, 16 007 098, Inv Gauss)	Actual (23 115, 11 458, N/A) Fit (23 027, 11 977, Weibull,)
2		44	**Wet Season** Planting: Aug-Dec Sales: Nov-March	0.25	6	1.2	8	Actual (31, 24, N/A) Fit (31, 24,Weibull)	Actual (22 079 926, 15 757 098, N/A) Fit (22 961 579, 24 954 990 Log logistic)	Actual (36 349, 14 796, N/A) Fit (36 307, 14938, Weibull)
3	7 or more	32	**Dry Season** Planting: Apr-June Sales: July-Oct	0.45	12	1.3	15	Actual (71, 54, N/A) Fit (71, 58, Inverse Gauss)	Actual (34 348 668, 31 524 513, N/A) Fit (33 379 679, 30 038 668, Exponential)	Actual (23115, 11458, N/A) Fit (23,027, Weibull, 11,977)
4		33	**Wet Season** Planting: Aug-Dec Sales: Nov-March	0.52	10	1.6	16	Actual (65, 73, N/A) Fit (65, 89, Inverse Gauss)	Actual (32 759 783, 33 059 407, N/A) Fit (31 855 162, 29 852 516, Exponential)	Actual (36 349, 14 796, N/A) Fit (36307, 14938, Weibull)

Distributions

The distributions for the random variables yield and cost per hectare were identified using the Fit Distribution facility in @Risk 5.0[21].The distributions for costs are presented in appendix 6. In selecting the distributions used in the simulation analysis, a key concern was in closely approximating the mean, median and standard deviation of the empirical data while ensuring that the probability of getting negative random draws in these input variables was minimized.

With this in mind, the distributions for cost per hectare and yield that @Risk ranked first and the rank of the actual distribution used in the analysis are compared (table 4.3 and 4.4 respectively). For the cost per hectare distributions presented, in all cases, the model was designed so that any random draw below (above) the empirically observed minimum (maximum) cost per ha was replaced with that empirical minimum (maximum). This procedure resulted in replacement rates of between 1% and 3% (table 4.4).

Table 4.5: Distributions for Cost/ha

Farmer group	Distribution ranked first by @Risk	Distribution used in the analysis	Rank of distribution used in the analysis	% of random draws replaced with empirical minimum	% of random draws replaced with empirical maximum
1	Log Logistic	Log Logistic	1	1	2
2	Log Normal Inverse	Weibull	3	1.3	2
3	Inverse Gauss	Inverse Gauss	1	3.2	2
4	Log Logistic	Inverse Gauss	2	3	1

For the yield distributions (table 4.5), @Risk ranked first the very distributions used in the analysis. Based on examination of the empirical yield data and on the fact that

[21] Version 3.5 does not have a Fit Distribution facility. Version 5.0 was available only on campus based departmental computers; distributions were therefore fit using version 5.0 and then incorporated into the models based on version 3.5.

farmers can in practice suffer a total crop loss, negative random draws for these variables were replaced with values of zero, while the maximum was replaced with the empirical maximum. As in the case of cost per hectare, this procedure resulted in very few replacements (table 4.5).

Table 4.6: Distributions for Yield

Farmer group	Distribution ranked first by @Risk	Distribution used in the analysis	Rank of distribution used in the analysis	% of random draws replaced with zero	% of random draws replaced with empirical maximum
1	Inverse Gauss	Inverse Gauss	1	2.3	7.4
2	Log Logistic	Log Logistic	1	0.0	0.6
3	Exponential	Exponential	1	2.5	3.2
4	Exponential	Exponential	1	1.25	3.2

Correlation of Variables in the Simulation Analysis: The random input variables in the simulation model, yield and production cost per hectare, were highly and positively correlated with correlation coefficients of 0.63, 0.79, 0.819 and 0.924 for groups 1, 2, 3 and 4 respectively. If the simulation analysis was carried out without taking into account this correlation then we assume that the two are independent. When the two are treated as independent random variables, then the result of the random draws made during the simulation analysis would periodically result in very unlikely situations such as extremely high yield and low costs per hectare. In reality, such a situation can not be observed due to prevailing condition during tomato production such as poor weather conditions and plenty pest problems.

To deal with this correlation, when setting up the model in @Risk 3.5, the correlation coefficients for the two variables were placed in the correlation matrix before running the simulation. When this was done and the simulation was run, each random draw of either variable took account of the other and avoids unlikely situations.

Number of iterations for each simulation: Two thousand iterations were conducted for each simulation. With this number of iterations, the confidence interval for each mean is narrowed down. The baseline model was used as the basis of reference, and at 95% level of significance, the confidence intervals for mean profit per hectare for the four farmer groups were computed (table 4.6)

Table 4.7: Confidence Intervals for the Profits per Hectare Variable in the Baseline Model

Farmer Group	Standard deviation for profit per hectare	Mean profit per hectare	Confidence interval at 95% level of significance
1	16,179,220	5,043,388	5,043,388 ± 709,085
2	23,447,803	19,619,038	19,619,038 ± 1,027,645
3	29,107,832	25,793,930	25,793,930 ± 1,275,707
4	68,247,561	50,365,066	50,365,066 ± 2,991,081

4.5 Results

4.5.1 Distributions of Farmer Profits

Data for stochastic input and output variables from the 2,000 iterations of the baseline and each of the three scenarios were copied into SPSS for analysis[22]. Mean, median, and probability of negative returns were computed for each simulation.

[22] Histograms of farmer profits per hectare are presented in **appendix 7.** The horizontal and vertical axes of the histograms have all been scaled equally to facilitate comparison.

4.5.2 Simulation Results for the Different Scenarios

Baseline Results

Baseline level profits and prices for the four defined farmer groups were computed and later analyzed (table 4.7). Results presented reveal that farmers that sold their tomatoes in the rainy season were faced with higher costs but earned higher incomes and had much lower probability of losing money than those that sold their tomatoes in the dry season. For instance, an average farmer in group 2 would earn 19.6 million ZMK/ha and would have a 16% probability of making losses. In the case of the farmers in group 1 – the same farmers as group 2, but selling in the dry season rather than the wet season -- an average farmer would earn 5 million ZMK/ha and would have a 39% probability of making losses.

Table 4.8: Baseline Results for Simulation Analysis

	Farmer Groups			
Indicator	1	2	3	4
Profit per ha (ZKW)				
Mean	5,043,388	19,619,038	25,793,930	50,365,067
Std. deviation	16,179,220	23,447,803	29,107,832	68,247,561
Coefficient of variation	3.21	1.20	1.13	1.36
Share < 0	0.39	0.16	0.12	0.05
Average price				
Mean	22,966	36,275	22,966	36,275
Std. deviation	3,645	5,173	3,084	3,736
Coefficient of variation	0.16	0.14	0.13	0.10

A comparison of farmers in group 3 and 4 also reveal the same general pattern. An average farmer in group 3 earns 25.8 million ZMK/ha and would have a 12% probability of making losses compared to an average farmer in group 4 who would earn over 50 million ZMK/ha and would have only a 5% probability of making losses.

Therefore, for the data collected during this period of analysis, this means that the farmers that produced tomatoes during the rainy season when prices were high had better returns per hectare. Also noted is that the standard deviation of profits is consistently higher in the wet season (as expected), however the higher mean prices dominate, leading to lower probabilities of loss despite the greater variability in returns.

Farmers in groups 3 sand 4 (those that sold tomatoes – from all their fields, not just the chosen field -- for 7 months or more) have better returns than those in groups 1 and 2 (those selling for 6 months or less) even when they are faced with the same distribution of prices. Farmers in group 3 earned five times more on average than those in group 1, and similarly, farmers in group 4 earned than 2.5 times more on average than those in group 2. The higher returns for farmer groups 3 and 4 could be attributed to the farmers' better knowledge of tomato crop production techniques, greater access to inputs to control pests and diseases and greater access to financial resources to pay for labor for weeding and the procurement of other tomato production inputs.

Selling tomatoes more often reduces uncertainty regarding the average price that the farmer will obtain. Group 3 farmers had a coefficient of variation of price nearly 20% lower than that of group 1 and this is attributed to the 15 trips made by group 3 (facing the same price distribution) while group 1 only made 11 trips. Therefore, on account of the several trips the farmers in group 3 made, and assuming that the farmers are interested primarily in the average price they receive, not the price each trip, these farmers are faced with less price variability.

Scenario 1: Increased Sales Frequency (More trips made to the market)

In the analysis of the scenario of increased sales frequency, it was now assumed that all farmers in the four different groups made 16 sales trips to the market. Instead of the 11, 8 and 15 trips made by groups 1, 2 and 3 respectively, all groups made 16 trips like group 4 did. The cost calculations used in the analysis were not adjusted to take account of the increase in the number of trips. Total costs are expected to increase, but given that fixed marketing costs account for a about 6% of the total costs, these have been ignored. By doing this, the analysis is simplified and does not have major effects on the results.

Simulation analysis for increased sales frequency was conducted for the four farmer groups and resulting average profits per hectare and price levels analyzed (table 4.8).

Table 4.9: Scenario on Increased Sales Frequency

	Farmer Groups			
Indicator	1	2	3	4
Profit per ha (ZKW)				
Mean	5,179,823	19,651,172	25,856,600	50,039,507
Std. deviation	16,457,080	22,867,012	29,357,054	66,994,525
Coefficient of variation	3.18	1.16	1.14	1.34
Share < 0	0.40	0.16	0.12	0.05
Average price				
Mean	22,966	36,275	22,966	36,275
Std. deviation	2,939	3,790	2,919	3,657
Coefficient of variation	0.13	0.10	0.13	0.10

Changes in the average profits and prices from the baseline were then computed and analyzed (table 4.9). From these results, it is observed that increasing the number of trips a farmer makes to the market does not have any effect on their profit levels since the distributions of yield, costs and price have not changed. Therefore, the small percent changes on the profit levels in the more trips scenario are not meaningful.

Table 4.10: The Effect of Increased Sales Frequency on Tomato Profits

Indicator	Farmer Groups 1	2	3	4
	----- % change from baseline -----			
Profit per ha (ZKW)				
Mean	0.03	0.00	0.00	-0.01
Std. deviation	0.02	-0.02	0.01	-0.02
Coefficient of variation	-0.01	-0.03	0.01	-0.01
Share < 0	0.03	0.00	0.00	0.00
Average price				
Mean	0.00	0.00	0.00	0.00
Std. deviation	-0.19	-0.27	-0.05	-0.02
Coefficient of variation	-0.19	-0.27	-0.05	-0.02

The effect of a farmer making more sales trips to the market is in having more stable average prices. It is observed that increasing the number of trips to 16 from 11 and 8 in farmer groups 1 and 2 respectively, decreased price variability as can be seen from the reduction in coefficients of variation by 19% for group 1 and 27% for group 2. In group 3 and 4, the number of sales trips barely increased and as a result, the price variability fell much less than was the case in groups 1 and 2.

When a farmer makes more trips to the market, one would expect that this would lead to more stable incomes for the farmer due to more stable average prices. However, in this particular instance, this was not the case as very small (and not statistically meaningful) changes in the variability of profits were observed. From this analysis, the variability of yields and costs of production are much more important than the variability of prices in determining the variability of profits.

This however does not mean that price variability is not important for individual farmers facing the market, but rather it is very important because the farmers would have prior knowledge of what their yields and cost of production are such that the main uncertainty they would have to face is price. For instance, taking the case of a farmer in group 1, at the beginning of their growing season the farmer would have some expectation on of what their yields or costs would be, however, their expectations may differ from the actual yields they get or costs they experience. As the farmer progresses in their tomato cropping season, their yield and cost distributions are narrowed as they would have started harvesting their tomatoes and would have incurred most costs associated with producing the crop. Therefore, since when harvesting starts, a farmer now knows with some confidence what their total tomato yields are likely to be and also knows on average what their total costs for the crop are, the yield and cost uncertainty they are faced with reduces. At this stage, the farmer is more uncertain about the price they would be faced with in the market. The only control they would have in ensuring that they get a good price for their tomatoes is in producing good quality tomatoes.

Scenario 2: Scenario on Supply Chain Improvements

Simulation analysis on supply chain improvements was conducted to assess its effect on tomato profits (table 4.10). Supply chain improvements are expected to lead to more stable prices that would subsequently result in greater profits.

To reflect supply chain improvements, in the analysis, the Soweto variability in prices was replaced with those of Costa Rica's Sa José market. San José wholesale market is more advanced than Soweto market as it has some cold chain system in its supply chain. Other supply chain improvements such as readily available market information, formalized grades and standards, and improved transportation are expected to have the net effect of reducing price variability in a market.

Table 4.11: Supply Chain Improvements

	Farmer Groups			
Indicator	1	2	3	4
Profit per ha (ZKW)				
Mean	5,193,568	19,674,735	25,707,641	49,797,011
Std. deviation	16,491,907	23,271,308	28,693,658	66,772,714
Coefficient of variation	3.18	1.18	1.12	1.34
Share < 0	0.39	0.16	0.12	0.05
Average price				
Mean	22,973	36,279	22,973	36,279
Std. deviation	3,144	4,556	2,657	3,412
Coefficient of variation	0.14	0.13	0.12	0.09

A comparison of the baseline results on tomato profits, and profits associated with supply chain improvements was carried out. As expected, supply chain improvement does lead to reduced price variability as can be seen from the decreasing price coefficients of variation in each farmer group (table 4.11). However, this reduced price variability resulting from supply chain improvements does not lead to any meaningful increases in farmer returns since the analysis was designed to retain the same mean price but a less variable price. The variability in yields and costs of production are more dominant in determining the variability of profits than the variability of prices.

Table 4.12: The Effect of Supply Chain Improvements on Tomato Profits

	Farmer Groups			
Indicator	1	2	3	4
	----- % change from baseline -----			
Profit per ha (ZKW)				
Mean	0.03	0.00	0.00	-0.01
Std. deviation	0.02	-0.01	-0.01	-0.02
Coefficient of variation	-0.01	-0.01	-0.01	-0.01
Share < 0	0.00	0.00	0.00	0.00
Average price				
Mean	0.00	0.00	0.00	0.00
Std. deviation	-0.14	-0.12	-0.14	-0.09
Coefficient of variation	-0.14	-0.12	-0.14	-0.09

Other than influencing stability in prices, some of the other aspects that a farmer would expect from supply chain improvements include less product spoilage, better market information, reduced transportation costs, assembling and packaging, etc. In this analysis, only its influence on price variability was examined. In view of this, if all aspects of supply chain improvements were considered, they would influence not just price variability but also cost levels, and would ultimately have a greater influence on the farmers' returns.

Scenario 3: Quality of Tomatoes Sold in the Market

Improvements in the quality of tomatoes farmers take to the market are expected to attract a higher price than the average quality of tomatoes would. With higher prices, higher profits would also be expected. In this analysis, the quality of tomatoes was defined based on their time of sale. The data used doesn't specify high or low quality tomatoes and furthermore making it impossible to directly compute prices for high and low quality. Instead, the time of sale was used to reflect the quality of the tomatoes based on the assumption that the retailers buying the tomatoes in the market would want to buy the best quality tomatoes first. The price data further illustrates that prices on sales made early in the morning are higher than those on sales made later in the morning, implying that the better quality tomatoes would be sold at a higher price than the others that are not of the same quality. The data also shows that over 90% of all tomato volumes arrive in the market by 6am. Farmers therefore get into the market early but the time when tomatoes sell is independent of the time that the tomatoes arrived in the market. The combination of this fact with the (reasonable) assumption that retailers will buy the highest quality first, suggests that our approach to computing high and low quality prices is reasonable. On this basis, the prices for high quality tomatoes included prices that were taken between 7 and 9 am while the low quality tomatoes used prices taken between 10 and 12am. Price observations between 9am and 10am were not included in this analysis so as to ensure greater separation between the two price categories.

To assess the effect of tomato quality on tomato profits, simulation analysis for high and low quality tomatoes for each farmer group was conducted and analyzed (table 4.12). In the analysis, an important assumption that was made is that a farmer could get better (or worse) quality tomatoes for the same cost of production per ha. This is true only to the extent that better knowledge leads to better management without higher cash outlays. However, on average over all farmers, better quality would require higher cost per hectare and lower quality would be on average associated with lower cost per hectare. From these results, it is observed that the quality of tomatoes has meaningful effects on the profit levels the farmers get.

Table 4.1: Production of Low and High Quality Tomatoes

	Farmer Groups							
	Group 1		Group 2		Group 3		Group 4	
Indicator	High quality	Low quality	High quality	Low quality	High quality	Low quality	High quality	Low quality
Profit per ha (ZKW)								
Mean	6,927,478	803,704	23,931,820	16,834,420	29,561,363	16,680,106	58,543,295	44,514,238
Std. deviation	17,652,016	14,830,718	26,742,320	21,803,170	31,884,487	23,961,915	76,812,011	61,791,241
Coefficient of variation	2.55	18.45	1.12	1.30	1.08	1.44	1.31	1.39
Share < 0	0.36	0.50	0.15	0.21	0.09	0.19	0.04	0.08
Average price								
Mean	24,365	19,401	39,967	33,728	24,364	19,401	39,967	33,728
Std. deviation	3,622	2,894	5,364	5,197	3,223	2,441	3,858	3,759
Coefficient of variation	0.15	0.15	0.13	0.15	0.13	0.13	0.10	0.11

Table 4.2: The Effect of Tomato Quality on Tomato Profits

	Farmer Groups							
	Group 1		Group 2		Group 3		Group 4	
Indicator	High quality	Low quality	High quality	Low quality	High quality	Low quality	High quality	Low quality
	----- % change from baseline -----							
Profit per ha (ZKW)								
Mean	0.37	-0.84	0.22	-0.14	0.15	-0.35	0.16	-0.12
Std. deviation	0.09	-0.08	0.14	-0.07	0.10	-0.18	0.13	-0.09
Coefficient of variation	-0.21	4.75	-0.07	0.08	-0.04	0.27	-0.03	0.02
Share < 0	-0.08	0.28	-0.06	0.31	-0.25	0.58	-0.24	0.52
Average price								
Mean	0.06	-0.16	0.10	-0.07	0.06	-0.16	0.10	-0.07
Std. deviation	-0.01	-0.21	0.04	0.00	0.04	-0.21	0.03	0.01
Coefficient of variation	-0.06	-0.06	-0.06	0.08	-0.02	-0.06	-0.06	0.08

To further assess the resulting profits and price variability from the analysis of low and high quality tomatoes, the change from baseline level was analyzed (table 4.13).

In all cases where the farmers took high quality tomatoes to the market, each farmer group registers significant percent increases in the profit levels of 37%, 22%, 15% and 16% for groups 1, 2, 3 and 4 respectively. The reverse is true for the farmers with low quality tomatoes. The low quality tomatoes resulted in significant profit decreases in each group, with some groups having quite high percent profit decreases such as 84% in group 1 while others had low percent profit decreases such as group 4 with 12%.

The price percent increases (decreases) are however not as large as the profit percent increases (decreases) because profit comes only from the excess price over the cost. In group 2, for instance, while price increased by only 10% with high quality tomatoes, returns increased 22%. On the other hand, for those producing poor quality tomatoes, price fell only 7% but returns dropped 14%. In group 1, this is even more pronounced with profits dropping 84% corresponding to a price decline of only 16%. This pattern repeats itself in the other groups as well.

It is also noted that the percent differences between high and low quality (as a percent of the low quality price) was much less during the wet season (18.5%) than during the dry season (25.5%). This pattern suggests that traders are less willing to pay a price premium during the wet season than the dry season. This finding is consistent with the scarcity of supply during the wet season, making traders willing to buy tomatoes with less regard to qua

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[3] The c

quality; when supplies are high in the dry season, traders can be more selective in what they buy, thus driving down the price of low quality produce.

Furthermore, the impact of the quality of tomatoes on the profit levels is such that the high quality tomatoes have registered fairly significant drops in the variability of profits[23] whereas the low quality tomatoes have registered increases in the variability of profits. The quality of tomatoes that a farmer takes to the market therefore has the effect of stabilizing the profits a farmer would get.

Further analysis in examining the probabilities of making losses reveals that producing higher quality tomatoes reduces the probability of a famer making losses while producing low quality tomatoes greatly increases a farmers' probability of making losses.

4.6 Chapter Summary and Conclusion

Chapter three highlighted problems of high variability and low predictability of tomato prices in Soweto market. On account of the price variability experienced in this market, this chapter examined the influence of price variability compared to yield and cost variability on the variability of tomato returns for three different scenarios.

Three scenarios were analyzed and compared with the baseline which served as a reference point. These three scenarios were;

- the effects of greater sales frequency on the variability of tomato returns,
- the effect of supply chain improvements

[23] The coefficient of variation was used in analyzing the variability of profits.

- the effects of producing consistently higher quality tomatoes and,

The baseline results revealed that famers that produce a wet season crop get higher profits than those that produce a dry season crop. Furthermore, the farmers that produced a wet season crop have lower probabilities of making losses. It should be noted that these results were obtained for the specific season that the data applied to, and there is no guarantee that the same would happen in another year.

Production of tomatoes in the wet season is usually associated with high costs of production due to the high prevalence of pest and disease problems and also the need for much more frequent weeding. What this means is that tomatoes grown in the wet season require high maintenance. However, even though the overall costs of producing a crop in the wet season is higher than in the dry season, the estimated cost differences per crate between the two seasons are not very large. For instance, it cost group 1 farmers, who were producing a dry season crop, approximately ZMK 18,500 to produce a crate of tomatoes while it cost group 2 farmers, who grew a wet season crop, ZMK 19, 300 to produce a crate.

Other than the differences in cost portfolios in the dry and wet season, the results of the analysis indicate that mean tomato prices in the wet season are 60% higher than in the dry season. Therefore, despite the high production costs the farmers may be faced with, and assuming they get high yields, they would still be able to recover their costs and make substantial profits. It should however be noted that there is a probability of self selection among the farmers that produce tomatoes during the wet season: it is likely that only better farmers would attempt to have a crop in the wet season. This therefore affects our results, as these farmers are able to get better yields at lower cost than the less efficient or less knowledgeable or less committed farmers who don't attempt a wet season crop.

Concerning these baseline level results, it should also be noted that the survey was conducted only once and this was during the period when the most recent crop the farmers had was a wet season crop. Since recall is worse for longer periods of time, it is possible that their recall about the (more distant in time) dry season crop was biased upwards by their experience during the most recent season (wet). There would therefore be value in future research gathering data on wet and dry season crops at different times so that the recall period for each is about equal in an attempt to eliminate any possible bias.

Examination of the results of farmers faced with the same price distributions but with different crop management level as reflected from the length of time they sold their tomatoes in the market, reveal that those farmers that sold for more than six months had higher profits per hectare than those that sold for a few months. This basically confirms the fact that one would expect a farmer that manages their tomato crop well to harvest their tomatoes for longer periods than those that don't manage them well. Furthermore, the results show that the probability of getting negative returns among the farmers that sold for fewer months was higher than the case with those that sold in the market for 7 months or more. The general conclusion drawn from the baseline analysis is that farmers that produce and sell a wet season crop have higher profits per hectare and a lower chance of getting negative returns than those that produced and sold a dry season crop.

Analysis of the effect of increased sales frequency on tomato profits revealed that the variability in profits is driven much more by variability in yields and cost than in the variability in prices. Price variability becomes increasingly important relative to variability in yields and costs as a farmer progresses through their tomato cropping cycle.

Similarly, analysis on supply chain improvements indicated that variability in yields and cost of production are most dominant in determining the variability of profits than the variability in prices.

The effect of producing high quality tomatoes revealed that there is a high payoff to farmers producing higher quality tomatoes. Farmers that manage their crop better due to the greater production knowledge they have are likely to produce a high quality crop. With the high prices, the farmers would subsequently have higher profits and lower probabilities of making losses than those producing low quality tomatoes.

CHAPTER 5
CONCLUSION

This study was conducted with the objective of understanding the structure and operation of the tomato subsector in Lusaka, establishing the level of price variability for tomatoes in Lusaka's Soweto market, and assessing the impact of tomato price variability on the returns to tomato production. An additional objective was to assess the potential role that market information could play in improving the marketing performance of tomato growers supplying tomatoes to Soweto market.

In addressing these objectives, both secondary and primary data were used. Secondary data included the FSRP Urban Consumption Survey data, which was collected in four urban centers of Zambia, namely; Lusaka, Kitwe, Mansa and Kasama, and tomato wholesale price data from five countries namely; the USA, Costa Rica, Taiwan, Sri Lanka and Zambia.

Data collected specifically for this study mainly constituted survey data on tomato growers' costs of production and data from interviews conducted with processors, wholesalers and retailers in the tomato subsector. The tomato survey was conducted on tomato growers from two selected farm areas of Lusaka province, namely Lusaka West and Chongwe. In addition to the costs of production, this survey gathered information on some of the production and marketing strategies farmers adopt, and their use of market information.

Interviews were also conducted with the main actors in the modern sector of the tomato subsector, namely processors Freshpikt and Rivonia; Freshmark wholesaler; and retailers Spar and Melissa. These interviews were conducted with the view to gain an understanding of their FFV procurement systems and pricing policy.

5.1 Summary of key results

5.1.1 Importance of Tomatoes

The results of this study have revealed that tomato is one of the most consumed FFV items among the four surveyed urban consumption areas. In the four cities surveyed, vegetables and fruits account for 15% of all food and non food purchases. Among all FFV tomatoes are second to rape in all four cities with a budget share over all FFV of 18%. Given the significance of tomatoes in the budget share of household expenditures and price variability which would affect both consumers and producers, further analysis into understanding this subsector was conducted.

5.1.2 The Tomato Subsector

The structure of the tomato production and marketing system serving Lusaka is comprised of tomato farmers categorized in three areas based on the farmer types that dominate the area, tomato traders, tomato processors, tomato wholesalers, and a wide range of retailers.

Ninety two percent of the tomatoes in the system come from over 150 production areas channeled into Soweto market with a small amount into Bauleni market, while the remaining 8% is produced by the production arm of the Freshpikt processing firm. The top twelve tomato supply areas accounted for 68% of tomatoes in Soweto market during the period January to December 2007. Three categories of supply areas were identified namely; large, medium and small farm areas all based on the predominant lot sizes (our proxy for farm size) of tomatoes arriving into Soweto from each area. The relative shares of each of these areas are; 35%, 33% and 24% for the large, medium and small farm areas respectively. About three-quarters of total tomato volumes marketed in the traditional wholesale markets of Soweto and Bauleni are directly marketed by farmers while the remainder is sold at farm gate through traders.

The tomato system is made up of traditional (informal) and modern (formal) sectors. The wholesale and retail systems of the tomato subsector are dominated by the traditional sector. At the wholesale level, Soweto and Bauleni wholesale markets jointly have a market share of 91%. At retail level, the traditional sector has a 92% share and is dominated by open air markets and the "ka sector".

The modern sector mainly consists of the formalized retailers and processers. The retailers are mainly the supermarkets with Shoprite, Melissa and Spar as the main actors. Shoprite is the largest with 17 outlets countrywide, followed by Spar with 6 outlets and Melissa with 3 outlets. The processors are Freshpikt and Rivonia. The supermarkets and processors jointly have a share of 9% in this sector, 1% for supermarkets and 8% for processors.

Retailers in the modern sector all follow different tomato procurement approaches and different tomato pricing policies too. Shoprite makes use of a centralized procurement system through Freshmark which supplies tomatoes and other FFV to all its retail outlets countrywide. It has preference for large farmers as suppliers of tomatoes as opposed to smaller ones who are not as reliable and able to meet Shoprite's quality and delivery requirements. To maintain fairly stable prices during the course of the year Shoprite offers its suppliers fairly steady tomato prices during the annual contract period they enter with them.

Unlike Shoprite, Melissa and Spar supermarkets do no operate centralized procurement systems for their tomatoes. Melissa has a dual procurement system that makes use of one contracted supplier and several non-contracted ones. It has a fixed price arrangement with its contracted supplier and this price is not altered during the contract period irrespective of the market price for tomatoes at any given point in time. With its non contract suppliers, the price offered for tomatoes is based on the market rate at any given point. Through this arrangement, Melissa supermarket is able to keep its prices fairly stable over a given period of time by averaging out the prices it pays to its two sources.

Spar supermarket is a franchise and each of its six outlets operates independently. Downtown Spar supermarket obtains most of its tomatoes from large farmers who are not under contract to them but are merely their regular tomato suppliers. In addition to tomatoes from their regular suppliers, Spar gets some tomato from small farmers and independent traders; these suppliers however have no guarantee of selling their tomatoes to Spar when they take it there.

Freshpikt and Rivonia are the main FFV processors in the country with Freshpikt being the larger of the two. In 2007, Freshpikt alone purchased 8% of tomatoes in the system. All these tomatoes were grown on their farm. Over 60% of its canned products are exported while the remainder is sold locally through various retail outlets. Rivonia specializes in the production of a wide range of tomato sauces and has less than a 1% market share

Having examined the traditional and the modern sectors, the pricing behavior of each sector was also examined. Soweto market supplies tomatoes to almost all the retail outlets. An analysis of the weekly prices for tomatoes in Soweto market over the period January 2007 to July 2008 revealed that prices were quite variable. A seasonal price pattern was observed, however, a great deal of price variation was observed within seasons. For example, from May 2007 to August 2007, which is the cool and dry season, prices were as high as ZMK 903 per kg and were as low as ZMK 232 per kg. In the months of April 2007, December 2007, March 2008 and June 2008, prices declined sharply. From peak to trough, the declines during these periods were 60%, 50%, 71%, and 69%, respectively, all occurring over no more than 3 weeks.

In the April 2007 price collapse, three supply areas, Masansa, Choona and Manyika, accounted for 65% of the tomatoes in the market and were the probable cause for this price collapse. In the case of the March 2008 price collapse, Choona and Masansa accounted for 68% of the tomatoes on the market and are the likely cause of that year's price collapse.

Based on the price pattern observed in Soweto market a comparison of these wholesale prices was made with four retail outlets, namely Shoprite, Spar and Melissa supermarkets and Chilenje open air market. While Soweto market had an average price of ZMK1,179, the retail outlets all had prices above ZMK3,000. The average price in Chilenje was ZMK3,450, ZMK3,545 in Melissa supermarket, ZMK3,408 in Spar supermarket and ZMK3,390 in Shoprite supermarket.

Further analysis of these prices revealed that Chilenje market followed a very similar price pattern as Soweto market with a fairly stable price markup averaging ZMK 2,284 for a kilogram of tomatoes. The pricing behavior in Shoprite supermarket followed Chilenje market in a stepwise fashion. Among all the retail outlets Spar supermarket had the most stable tomato price, remaining constant almost the entire period. The essential equality of mean prices across these retail outlets in the face of very different pricing strategies is a notable finding of this work.

5.1.3 Tomato Price Variability and Predictability

After examining the tomato subsector and the key actors in the traditional and modern sectors, analysis of tomato price variability in Soweto market compared to four other wholesale markets in the world was then conducted. To determine the extent of price variability in Soweto market, analysis of the coefficient of variation and the conditional variance was carried out and compared with wholesale markets in the USA, Taiwan, Costa Rica and Sri Lanka. These four countries were chosen for the analysis because of their wide range of market development which would adequately depict different levels of price variability in these countries. Calculation of the conditional variance was based on prediction errors from a price prediction model whereas the coefficient of variation was based on the simple measure of the standard deviation of price about the mean. To show how difficult it is to predict tomato price collapses in these wholesale markets, analysis of the ratio of the mean (absolute value) negative price errors to the mean positive price errors was also conducted.

In the absence of specific information about each country's tomato production and marketing system, Purchasing Power Parity GDP was used as a proxy measure for the level of economic and market development in each country. Higher PPP GDP is likely to be correlated with the following

- Better market information,
- More formalized grades and standards,
- A more reliable cold chain,
- More integrated markets over a larger geographical area, and
- Better coordination between demand and supply for fresh produce

We hypothesized that countries with a well developed fresh produce market (as proxied by PPP GDP) would experience less tomato price variability and better tomato price predictability.

Coefficient of Variation: The coefficient of variation is a simple unconditional measure of price variability. It is a unit free measure of the magnitude of sample values and the variation within them. A high coefficient of variation for tomato prices is an indication of high price variability.

Among the five countries, Zambia had the highest mean coefficient of variation followed in descending order by Sri Lanka, Costa Rica, Taiwan and the USA. This ordering of the coefficient of variation results is identically inverse to the ordering of PPP GDP across the countries. From the PPP GDP proxy indicator for market development, which is low in Zambia, the results of the coefficient of variation are consistent with a fresh produce market which is not well developed. Soweto market in Zambia lacks a cold chain, market information system, formal grades and standards, and has small geographic market shed for tomatoes. All these factors combined are some of the causes of the high tomato price variability the market experiences.

Conditional Variance: The conditional variance is a measure of price predictability. A low (high) conditional variance implies high (low) price predictability. From the PPP GDP proxy indicator for market development, the expectation is that a country with a low PPP GDP should have a poorly developed fresh produce market and thereby have high conditional variance and low price predictability. Like the results on coefficient of variation, the ordering of conditional variance results was exactly the reverse of PPP GDP.

Ratio of the mean negative price prediction error to the mean positive price prediction error: Unanticipated price collapses in the prices of fresh produce are characteristic of underdeveloped markets. Due to the perishable nature of fresh products, coupled with the absence of a cold chain system, there would be a tendency for tomato sellers in the market to unexpectedly lower the prices of the tomatoes so that they sell quick enough before they go bad. Coupled to this is the lack of market information and the poor coordination of market supplies which would lead to periodic excess supplies of the tomatoes. Through the analysis of the ratio of the mean negative price prediction errors to the mean positive price prediction errors, an assessment of the unexpected price declines was conducted for Soweto market in Zambia and the other four wholesale markets. A high ratio indicates that a given wholesale market is more often faced with unanticipated price declines than price rises. In such a case, operators (both sellers and buyers) in that market have greater difficulties predicting price drops.

The study revealed that among the five wholesale markets, Soweto market, Zambia, has the highest ratio followed by Sri Lanka, Costa Rica, Taiwan and finally the USA with the least. These results clearly demonstrate that Zambia wholesale market is the most problematic in terms of predicting such price drops.

Summarizing, the study found that all three quantitative indicators – price variability, price predictability, and the problem of unanticipated price collapses – exactly followed the ordering of our countries by the PPP GDP proxy measure of market development.

5.1.4 Baseline and Different Scenarios on Net Returns to Tomato Production

Baseline scenario: The main findings of this analysis is that farmers that sold their tomatoes in the wet season earned higher incomes and had much lower probability of getting negative returns, despite facing higher costs of production than those that sold their tomatoes in the dry season. At least during this year, price rises during the wet season more than compensated for higher production costs.

The results further showed that the farmers that sold their tomatoes in the market for seven months or more during the course of the year have better returns and lower probabilities of getting negative returns than those that sold for six months or less.

From baseline to other scenarios: Analysis of the different scenarios looked at the profit distributions of tomatoes conditional on sales frequency to the market, supply chain improvements and the quality of tomatoes sold in the market. The study revealed the following about these scenarios;

Scenario on increased sales frequency: The results of this analysis revealed that increasing the number of trips a farmer makes to the market does not have any effect on their profit levels. Increased sales frequency reduces the variability of expected price but has no recognizable impact on the variability of profits. This shows that variability in yield and costs is much more important than variability in prices for the population of farmers. But price variability matters very much for someone who has already raised their crop and has a good sense of what their yield and costs are going to be.

Scenario on supply chain improvements: Supply chain improvements such as market information, grades and standards, improved transportation and cold chain facilities are expected to have the effect of reducing price variability in a market, and with reduced price variability, the expectation is that variability in profits would also be reduced. We proxied this effect in Zambia by modifying its distribution of prices to maintain the same mean but lower variability, equal to that found in Costa Rica. However, this reduction in the price variability did not lead to any meaningful increase in the farmers returns. The variability is prices have very little impact in determining the variability of profits as do the variability of yields and costs of production.

Scenario on the quality of tomatoes sold: Good quality tomatoes are expected to attract higher prices than low quality ones and ultimately result in higher returns. The results of this analysis have revealed that high quality tomatoes have very significant effects on the returns of the farmers. With the baseline as the reference point, results show that farmers selling high quality tomatoes would earn increases in profits of between 15% and 37%. In addition, farmers also observe higher prices and lower probabilities of earning negative returns. On the other hand, farmers selling low quality tomatoes would receive significant declines in prices and profits. An interesting observation was that the percentage decline (rise) in profit among those that took low (high) quality tomatoes is much greater than the percent decrease (increase) in price, since profits come from the excess price over cost. It should be noted that premium prices for high quality tomatoes are higher in the dry season than they are in the wet season.

5.2 Contributions and Limitations of the Study

This research has examined the tomato subsector in Lusaka and has provided baseline information for further work in this area. It has further made a major contribution towards:

- Understanding the main actors in the system and the relative market shares they hold, specifically, the dominance of the traditional sector at both wholesale and retail level.
- Understanding tomato price variability in Lusaka's Soweto market and how this affects the tomato growers' profits.
- Understanding of the different procurement systems adopted by some of the main actors in the modern sector.

One of the limitations in this study was in the sample size that was used for the farmer survey on tomato costs of production. Out of over 150 tomato supply areas, only two areas were sampled and these areas did not include large commercial tomato growers who definitely have difference profit portfolios from the farmers that were interviewed.

Another limitation was that it was not possible to carryout meaningful analysis on the tomato price and quantity data to ascertain whether price information from a single market, collected every other day, will really allow farmers to improve their marketing performance. Analysis involving the use of price information from other alternative markets would generate much more meaningful and useful information to farmers. Furthermore, if the tomato cost of production survey could have also captured data on the type of market information farmers would need and the frequency with which they would require such information, then the analysis would be vey encompassing and provide some guidance towards some marketing strategy that could be adopted.

In the scenario analysis of increased sales frequency to the market, an important assumption that was made was that the farmers' marketing costs remained the same as when they made fewer trips to the market. This assumption did not have major impacts on the analysis, since on average, fixed marketing costs were less than 6% of total production costs; a doubling of trips for the same production level would therefore have increased total costs by no more than 6% and typically by less than this amount.

In the case of the scenario on supply chain improvements, tomato price variability experienced in Costa Rica's San José wholesale market replaced tomato price variability in Lusaka's Soweto market. The assumption is that Costa Rica's San José market, which is more developed than Zambia's Soweto market, was a reasonable proxy for how Soweto market might perform if supply chain improvements were made in Zambia's FFV system. While this assumption is somewhat arbitrary, it is reasonable in the sense that (a) Costa Rica has a unimodal pattern on rainfall, much like Zambia, and (b) Cost Rica's system is not so far above Zambia's present system that improvements on this scale in Zambia would not be possible at least in the medium term.

In the analysis of the scenario on quality of tomatoes sold in the market, the assumption that was made was that a farmer could get better quality tomatoes for the same cost of production per hectare. This however is only true to the extent that better knowledge leads to better management without necessarily increasing costs of production. The analysis did not therefore take account the possibility that producing better quality tomatoes would actually entail higher costs of production (e.g. for plant protection chemicals) to the farmer.

The approach used in indentifying the two groups of farmers and then dividing them by season of production, limited the type of analysis that could be done. Another approach that could have been used would have firstly involved estimating regression equations for yield and cost of production which would have included independent variables such as level of education, farmers' access to credit, total land size, and a farmers' access to extension credit. These independent variables would be included so as to establish their influence on a farmer's performance. The error term for each household would then be used to identify distributions using @RISK. With the defined distributions, then simulations analysis would be carried out to generate yield and cost of production numbers. These numbers would have two components, a deterministic component based on regression coefficients and values of the right hand variables of the regression; and a random component with a distribution function from the error term of the regression. With this kind of analysis, there is flexibility on the type of farmer that can be specified. This approach therefore would permit more interesting and flexible simulations than the approach that was used in this study.

5.3 Future Research

The tomato survey mainly focused on two of the top twelve supply areas. Considering that there are well over 150 areas that supply tomatoes to Soweto market, future research could consider surveying tomato growers from the other supply areas and also use a larger sample size. This would provide a better understanding of most of the tomato growers supplying Soweto market and would also give better insight on how the tomato price variability affects the different farmers from different geographical regions supplying Soweto market.

This study has shown that prices are extremely variable in Soweto market and the highly variable arrival of tomatoes into the market is one of the reasons for that. One of the factors that could reduce this price variability is market integration. Future research could look into the prospects of market integration in stabilizing the prices of tomatoes (or any other FFV) in spatial markets. Such a study could focus on how cold chain systems, improved transportation and market information could facilitate market integration in two alternate markets (say Soweto market in Lusaka province and Chisokone market on the Copperbelt province) when the prices for tomatoes (or any other FFV) are known. Where market integration is possible between two alternate markets, a cardinal point of analysis for future research would be on whether price information in the two different markets would be more useful to farmers in deciding where and when to sell.

5.4 Policy Implications and Recommendations

From this study, some very important issues have been identified. Among them, of key importance are the high level of tomato price variability and the dominance of the wholesale and retail traditional sectors of the tomato subsector. Another important issue that the study has brought out is how tomato price variability in Soweto market affects the returns of tomato growers.

Tomato price variability

With regards to the tomato price variability, there are some initiatives that could be carried out by the private sector, the public sector or the tomato producers in an effort to reduce it. Some of them include the following;

- Investment in cold chain systems. With cold chain systems in place, the unanticipated price drops in tomato prices and the overall price variability of tomatoes would be greatly reduced.
- Local market authorities to establish formal grades and standards which the suppliers would follow.
- On the part of the tomato producers, coordination among themselves to work towards better production and supply schedules thereby preventing large random fluctuations in supply of tomatoes on the market. The effect of this coordinated effort would also be in the prevention of the oversupply of tomatoes in the market and subsequent better prices. The provision of reliable and timely price and supply information from alternative markets would facilitate such coordination as it would provide the tomato producers with the basis for making informed decisions on when to produce their tomatoes, and on when and where to sell their tomatoes.
- Initiatives that would enable tomato growers access to low cost pest and disease control inputs through collective input procurement. In line with this would be the formation of localized tomato growers associations which would not only

facilitate the provision of low cost inputs but also foster information sharing that relates to tomato production or prevailing market prices.

- The provision of agricultural extension services specifically focused on tomato production activities. This could be undertaken by the private sector through some outgrower scheme which would be producing tomatoes for the wholesale markets or a specified food processor.

Dominance of the traditional sectors of the subsector

Considering the dominance of the traditional sector at both retail and wholesale level, infrastructure development is one of the main areas that would require improvements. In Soweto market particularly, the wholesaling area has poor roads, lacks pavements, poor drainage systems and has unsanitary conditions.

Through the UMDP, the Ministry of local government and Housing in Zambia embarked on infrastructural developments in the some of the wholesale markets countrywide. However, in Soweto market, despite investments made, there is very little improvement seen in the market. The market still has a poor drainage system, un-tarred roads, traffic congestion, and poor sanitation. In view of this there is still need to embark on programs that are aimed at improving the standards in Soweto market.

Regarding the traditional retail sector, the main recommendation would be in raising the standards of their operations and services delivery to standards that are nearly comparable to the modern sector. This could mainly be done by upgrading the current existing system. Some of the basic upgrading that could be done include;

- Improved hygienic ad sanitary standards
- The use of cold chain systems
- Improved market infrastructure such as pavement, roads, buildings and market stalls where the sellers use the floor or tables.

APPENDICES

APPENDIX 1.

Checklist for Interview with FFV Procurement Managers for Supermarkets and FFV Processors

1. Generally, how do they procure fresh produce? Get a general appreciation for how it is managed and the role of different types of suppliers in overall FFV.
2. Then focus specifically on tomato. Pay specific attention to these points:
    a. How important is tomato in their overall FFV strategy? Is it one of the most important fresh produce items, or are there others that are much more important?
    b. Do they have an internal or external procurement system? If they have an internal one, do they do this through a distribution center?
    c. What are the sources of supply of tomatoes? About what share of tomato supply comes from the following types of suppliers:
        i. large commercial farmers,
        ii. smallholder farmer associations,
        iii. independent smallholder farmers,
        iv. independent wholesale traders,
        v. actual market places like Soweto and others. Directly or through agents/traders?
        vi. others (describe)
    d. What has been the recent trend in supply from smallholder farmer associations and independent smallholders? If their share is small, is the company aggressively committed to increasing it? If so, why? If not, why not?
    e. How does tomato procurement from each of these suppliers work, e.g.,
        i. Do they have a list of preferred (farmer) suppliers? If they do have a list of preferred suppliers, how does that list work, e.g., how does one get on the list?; is it reviewed annually?; how do they decide if you stay on or fall off?
        ii. Do they use formal written contracts? If they use formal written contracts, is it with all suppliers or only some? What do the contracts specify?
        iii. What requirements do they impose on suppliers, such as
            1. periodicity of supply (weekly?). How often to they have to make procurements from their suppliers?
            2. quality standards,
            3. volume requirements,
            4. others.
        iv. What specific dimensions of tomato quality do they require?
        v. Do they buy completely ripe or slightly ripe tomatoes? Do they buy any mix between ripe and slightly ripe tomatoes?
        vi. What if any food safety practices or standards do they require?
    f. If they procure their tomatoes directly from farmers;

        i. What type of farmers do they prefer as suppliers? What are the reasons for this preference?
        ii. Do they provide any technical and financial support to the farmers?

g. What is their pricing policy?
    i. How do they determine prices paid to suppliers,
    ii. Do they strive for some price stability throughout the year? If they do, what kind of strategy have they adopted to ensure this?

h. What geographical areas does the tomato come from, and about what share of tomatoes comes from each geographical area?
    i. What types of farmers operate in each geographical area.

i. Any other information related to their procurement of tomatoes? What are future directions in their procurement systems?

APPENDIX 2.

Full Wholesale Tomato Price Prediction Regression Results

Chicago, United States

Table A2.1. Model Summary, Chicago Wholesale Prices

R	0.97
R Square	0.93
Adjusted R Square	0.93
Std. Error of the Estimate	1.59

Table A2.2. Table of Regression Coefficients, Chicago Wholesale Prices

	Unstandardized Coefficients		Standardized Coefficients
	B	Std. Error	Beta
(Constant)	.182	.233	
February	.559**	.270	.024
March	.407	.253	.020
April	.342	.256	.016
May	-.004	.261	.000
June	.220	.259	.010
July	.187	.260	.009
August	.296	.259	.014
September	.719***	.268	.031
October	.362	.269	.016
November	.748***	.269	.033
December	.082	.267	.004
Lagged Price	.963***	.009	.961
Time	3.42×10^{-5}	.000	.002

* Significant at 10% level ** significant at 5% level and *** significant at 1% level

Taipei, Taiwan

Table A2.3. Model Summary, Taipei Wholesale Prices

R	0.95
R Square	0.90
Adjusted R Square	0.90
Std. Error of the Estimate	5.00

Table A2.4. Table of Regression Coefficients, Taipei Wholesale Prices

	Unstandardized Coefficients		Standardized Coefficients
Model	B	Std. Error	Beta
(Constant)	1.231*	.680	
January	-.329	.769	-.006
February	.047	.820	.001
March	-.081	.745	-.001
April	-.576	.779	-.010
May	-.093	.757	-.002
June	1.170	.759	.020
July	3.028***	.747	.055
August	1.781**	.782	.030
September	2.133*	.778	.037
October	1.897**	.786	.033
December	-.185	.776	-.003
Lagged Price	.906***	.013	.900
Time	.001**	.000	.022

* Significant at 10% level ** significant at 5% level and *** significant at 1% level

San José, Costa Rica

Table A2.5. Model Summary, San José Wholesale Prices

R	0.91
R Square	0.83
Adjusted R Square	0.82
Std. Error of the Estimate	1070.44

Table A2.6. Table of Regression Coefficients, San José Wholesale Prices

Model	Unstandardized Coefficients		Standardized Coefficients
	B	Std. Error	Beta
(Constant)	316.138**	129.635	
January	418.809***	150.452	.045
February	134.524	150.612	.014
March	26.345	148.332	.003
April	-17.782	151.951	-.002
May	40.363	148.812	.004
June	-1.849	149.239	.000
July	440.510***	147.068	.048
September	-16.398	149.666	-.002
October	321.367**	147.163	.035
November	282.215*	153.656	.029
December	513.136***	159.495	.051
Lagged Price	.853***	.015	.853
time	.504***	.103	.067

* Significant at 10% level ** significant at 5% level and *** significant at 1% level

Colombo, Sri Lanka

A2.7. Model Summary, Colombo Wholesale Prices

R	0.94
R Square	0.88
Adjusted R Square	0.87
Std. Error of the Estimate	6.44

A2.8. Table of Regression Coefficients, Colombo Wholesale Prices

	Unstandardized Coefficients		Standardized Coefficients
Model	B	Std. Error	Beta
(Constant)	3.243*	1.931	
January	-5.210***	1.575	-.072
February	-2.576*	1.488	-.040
March	-3.886***	1.487	-.061
April	-2.613	1.620	-.035
May	-2.133	1.495	-.033
June	-1.672	1.470	-.026
July	-3.466**	1.477	-.054
August	-4.219***	1.490	-.068
September	-3.034**	1.485	-.048
October	-2.945*	1.506	-.045
December	.577	1.608	.008
Lagged Price	.907***	.018	.905
time	.003	.002	.026

* Significant at 10% level ** significant at 5% level and *** significant at 1% level

Lusaka Soweto, Zambia

A2.9. Model Summary, Lusaka Soweto Wholesale Prices

R	0.88
R Square	0.77
Adjusted R Square	0.76
Std. Error of the Estimate	276.33

A2.10. Table of Regression Coefficients, Lusaka Soweto Wholesale Prices

Model	Unstandardized Coefficients		Standardized Coefficients
	B	Std. Error	Beta
(Constant)	112.199	92.666	
January	41.117	88.021	.021
February	119.905	86.057	.066
April	-58.348	86.267	-.032
May	-42.367	83.220	-.024
June	-169.110*	87.347	-.096
July	-147.502	98.478	-.070
August	-255.630**	117.103	-.097
September	-24.250	102.941	-.010
October	-36.607	97.354	-.016
November	-65.515	100.404	-.027
December	-144.626	110.876	-.058
Lagged Price	.736***	.051	.736
time	1.200***	.408	.126

* Significant at 10% level ** significant at 5% level and *** significant at 1% level

APPENDIX 3.

Graphs of Price Prediction Residuals

Figure A3.1. Price Prediction Residuals for Daily Wholesale Tomato Prices in Chicago, USA (January 2000 –October 2007)

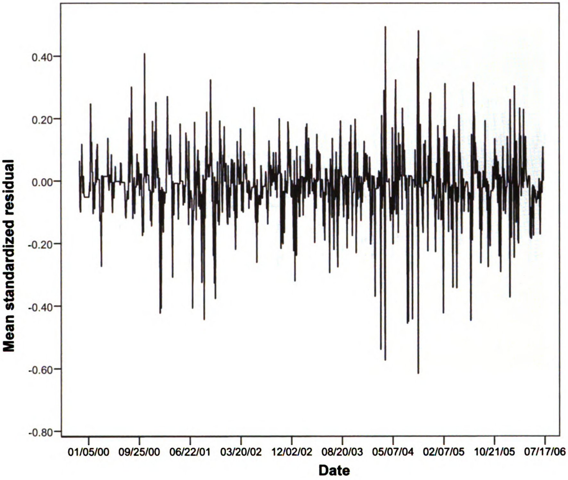


Figure A3.2. Price Prediction Residuals for Daily Wholesale Tomato Prices in Taipei, Taiwan (January 2000 –November 2007)

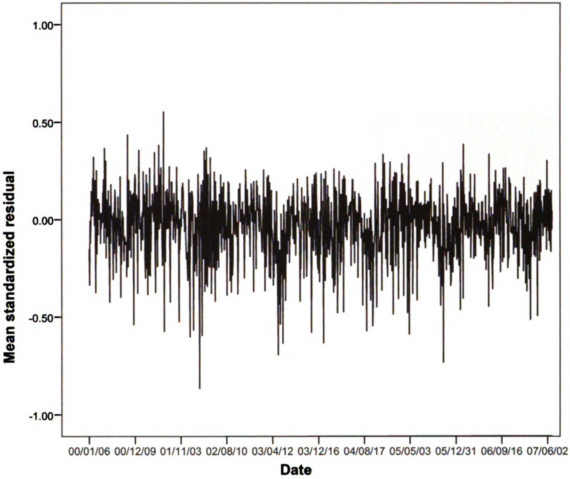


Figure A3.3. Price Prediction Residuals for Daily Wholesale Tomato Prices in San José, Costa Rica (January 2000 –October 2007)

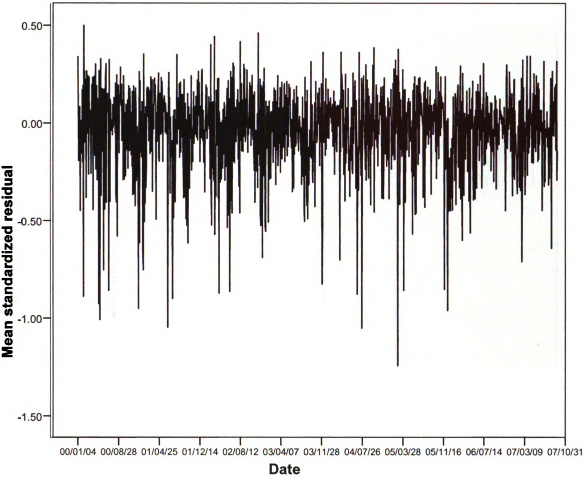


Figure A3.4. Price Prediction Residuals for Daily Wholesale Tomato Prices in Colombo, Sri Lanka (January 2004 –October 2007)

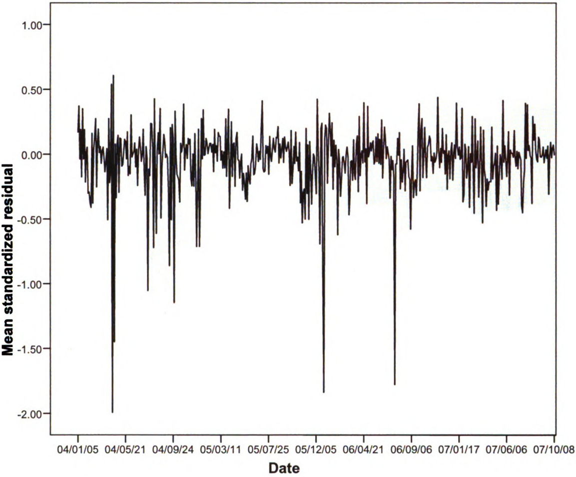
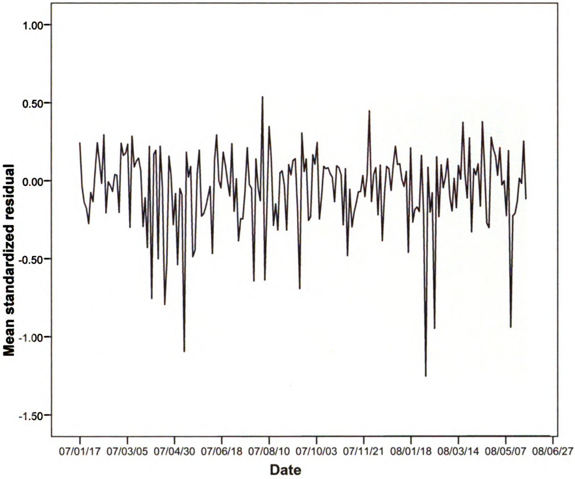


Figure A3.5. Price Prediction Residuals for Daily Wholesale Tomato Prices in Lusaka Soweto, Zambia (January 2007 – July 2008)



APPENDIX 4.

Tomato Survey Instrument

Strictly Confidential

Food Security Research Project
Tomato Grower Survey 2008

Informed Consent Form for Food Security Cooperative Agreement Surveys in Africa

This survey is part of a team effort between Food Security Research Project and Central Statistical Office aimed at collecting information to be used to make recommendations to the Government of Zambia regarding investments and policies that would best support efficient production and marketing of fresh fruits and vegetables by farmers and other stakeholders in order to increaser small farmer incomes and availability of high quality produce for urban consumers at competitive prices.. Your help in answering these questions is very much appreciated. Your responses will be kept COMPLETELY CONFIDENTIAL to the maximum extent allowable by law. If you choose to participate, you may refuse to answer certain questions, or you may stop participating at any time. Your responses will be summed together with those of roughly 150 other households in Lusaka West and Manyika area of Chongwe district, and general averages from analysis will be reported. You indicate your voluntary consent by participating in this interview: may we begin? If you have questions about this survey, you may contact the Director, CSO headquarters in Lusaka. If you have any questions for Michigan State University about this survey, you may contact Dr. Peter Vasilenko at 517 355 2180.

IDENTIFICATION PARTICULARS

1.	Province	PROV	
2.	District	DIST	
3.	Household Number	HH	
4.	Residential Area, Locality, or Village Name	RESIDE	
5.	Residential Address (house number and/or street name) or Section Number	ADDRESS	
6.	Landmarks near house (to help find same household in event of revisit)	LNDMRK	
7.	Name of Household Head	HHNAME	
8.	Sex of Household Head	1 = Male, 2 = Female	HHSEX

9.	Name of Main Respondent (if different from head) **RESNAME**						
10.	**RESPONSE** STATUS 1=Complete 2=Refusal 3=Non-contact	**RESTATUS**					
11.	ASSIGNMENT RECORD	CODE			Day/	Mon/	Year
	a. Name of Enumerator **ENUNAME**			Date completed			08
	b. Name of Supervisor **SUPNAME**			Date checked			08
	c. Name of Data Entrant **DATNAME**			Date entered			08

SECTION 1 - DEMOGRAPHICS

1.1 *We would like to ask you a few questions about all the individuals residing with you that you consider to be members of this household*

	How many ____ currently reside in this household? ***(respondent must include him/herself)***	What is the highest level of formal education attained among _______ ? ***(Indicate number of years completed)***	How many _____ are currently attending school?	How many ______ engaged in INFORMAL BUSINESS activities over the past 12 months?	How much in TOTAL did these _____ earn from these informal business activities over the past 12 months? (ZKW)	How many ______ held SALARIED JOBS over the past 12 months?	How much in TOTAL did these _____ earn from these salaried jobs over the past 12 months? (ZKW)
GROUP	**NUMBER**	**EDUCATION**	**SCHOOL**	**NBUSINESS**	**VBUSINESS**	**NSALARY**	**VSALARY**
Children and babies < 6 years old			------				
School-aged children (age 6-18)							
Adults aged 19-65							
Adults above age 65			------				

SECTION 2 - PERMANENT LABORERS EMPLOYED ON THE FARM

2.1 Over the past 12 months, have you engaged any PERMANENT WORKERS on your farm at any time? **PERMWORK** [ ]

1=yes 2=no (SKIP TO NEXT SECTION)

Worker Gender	How many ____ have you engaged as permanent workers on your farm?	On average, how many months over the past 12 were these workers engaged on your farm?	How much do you pay ______ in CASH?			What is the approximate value of any in-kind payments you make to ______ ? (e.g., daily meals)			Considering ALL your farm activities, about what percent of ______'s time is spent on tomato production tasks?
			Payment (ZKW)	Frequency 1=per month 2=per year 3=other, specify	Unit 1=per person 2=total over all	Payment (ZKW)	Frequency 1=per month 2=per year 3=other, specify	Unit 1=per person 2=total over all	
GENDER	**NUMBER**	**MONTHS**	**PMT**	**FREQ**	**UNIT**	**PMT2**	**FREQ2**	**UNIT2**	**PERCENT**
1=male workers									
2=female workers									

SECTION 3 - HARVEST AND SALES OF CROPS OTHER THAN TOMATO

3.1 We would now like to ask you about the range of crops that you produced over the past 12 months

Crop		Since April of 2007, did you HARVEST this crop? 1=yes 2=no	What TOTAL quantity did you harvest?		Since April of 2007, did you SELL this crop? 1=yes 2=no	What TOTAL quantity did you sell?		What did you EARN from these sales?		
			Quantity	Unit		Quantity	Unit	ZKW	Unit 1=per unit sold 2=total earnings	
CROP		**CRPHARV**	**CRPQT**	**CRPUNIT**	**CRPSELL**	**CRPQT2**	**CRPUNIT2**	**CRPVAL**	**CRPUNIT3**	**Unit Codes** 1=90kg bag 2=50kg bag 3=25kg bag 4=10kg bag 5=20lt tin 6=90kg bag unshelled 7=50kg bag unshelled 8=25kg bag unshelled 9=10 kg bag unshelled 10=20lt tin unshelled 11=5lt gallon 12=Meda 13=bunches 14=muchumbu 15=ka B.P. 16=crates 17=tonnes 18=boxes 19=number
Field Crops										
1	Maize									
2	Sorghum									
3	Rice									
4	Millet									
5	Sunflower									
6	Groundnuts									
7	Soyabeans									
8	Seed cotton									
9	Irish potato									
10	Virginia tobacco									
11	Burley tobacco									
12	Mixed beans									
13	Bambara nuts									
14	Cowpeas									
15	Velvet beans									
16	Coffee									
17	Sweet potato									
18	Cassava									
19	Kenaf									
20	Cashew nut									
22	Paprika									

Fruits and Vegetables										20=kilogram 21=heads 22=cobs
32	Cabbage									
33	Rape									
34	Spinach									
35	Tomato									
36	Onion									
37	Okra									
38	Eggplant									
39	Pumpkin									
40	Chilies									
41	Chomoli									
42	Cauliflower									
43	Carrots									
44	Lettuce									
45	Green beans									
46	Green maize									
48	Tangerines									
23	Oranges									
24	Bananas									
25	Pineapple									
26	Guavas									
27	Paw Paws									
28	Avocado									
29	Watermelon									
30	Mangoes									

SECTION 4 - PLANTING AND HARVEST PATTERN OF TOMATO

4.1 We would now like to ask you some questions about when you have PLANTED and SOLD tomato over each of the past twelve months

Planting month		Did you PREPARE TOMATO SEEDBEDS this month? (1=yes, 2=no)	Did you PLANT TOMATO SEEDLINGS this month? (1=yes, 2=no)	In total, how many FIELDS did you plant with these seeds and/or seedlings?	Did you SELL tomato this month? (1=yes, 2=no)
PLANTMTH		**SEEDBED**	**SEEDLING**	**NFIELDS**	**SELLTOM**
1	Jan 2007				
2	Feb				
3	Mar				
4	Apr				
5	May				
6	June				
7	July				
8	Aug				
9	Sep				
10	Oct				
11	Nov				
12	Dec				
13	Jan 2008				
14	Feb				
15	Mar				

Enumerator:

The sales do NOT have to be linked to a planting recorded in the table. For example, sales during Jan 2007 would be linked to earlier plantings not listed in this table. You STILL NEED TO RECORD those sales

4.2 Field Identification

Planting month	Field #	What AREA did you plant to tomato in this field? Qt	Area Unit 1=acre 2=ha 3=lima 4=m^2	Prior to planting tomato, for how many months had this field been WITHOUT TOMATO?	What PRINCIPAL TOMATO VARIETY did you plant in this field?	For HOW MANY MONTHS did you harvest this field? ➔ **instructions at right**	***Enumerator***: Was this field chosen for detailed data collection? 1=yes 2=no
PLANT MTH	**FNUM**	**AREA 1**	**AUNIT**	**WOUT**	**VARIETY**	**NMONTHS**	**CHOSEN**

VARIETY Codes

1=Aphate	7=Novelle
2=Flora Dade	8=Rodade
3=Heinz	9=Star 9010
4=Money Maker	10=Star 9030
5=Nemonadine	11=Tengeru
6=Nemoneta	12=Others, specify

Enumerator: After completing this table, use this approach to choose which fields to cover in the rest of the interview:

1) ***If the household had only <u>one planting month</u> and planted one or two fields,, then choose ALL FIELDS***
2) ***If the household had only <u>one planting month</u> and planted more than two fields, then choose the TWO FIELDS WITH THE LONGEST HARVEST PERIODS.***
3) ***If the household had <u>two planting months</u>, then choose the fields that had the LONGEST HARVEST PERIOD from each month; this means that you will choose two fields***
4) ***If the household had <u>more than two planting months</u>, then:***
   a. ***choose one planting month for rainy season production and one planting month for dry season production, and***
   b. ***as in option 2, choose the fields that had the LONGEST HARVEST PERIOD from each chosen month; again, this means that you will choose two fields***

Once you have made your choices, indicate these fields by entering "1" in the final (shaded) column for those fields; enter "2"in that column for all other fields.

Now write the field number and planted variety for each chosen field here:

FIELD # ***VARIETY***

Then EXPLAIN to the respondent that the rest of the interview will focus on those fields and planting months.

SECTION 5 - PRODUCTION DETAILS

5.1 We would now like to ask you detailed questions about the management practices you used on some of your tomato fields.

PHASE 1 - SEED BED PREPARATION OR DIRECT TRANSPLANTING

Phase	Field # ***Enumerator: enter all chosen field numbers***	Variety planted ***Enumerator: enter the varieties planted on each field***	Did you plant seed, seedlings, or both? 1=seed only → Planted Seed Table 2=seedlings only →next Table (Planted Seedlings), then skip to Phase 2) 3=seed and seedlings → complete whole section
PHASE	**FNUM**	**VARIETY**	**WHATPLANT**
1			

Variety Codes (SDVAR)

1=Aphate	7=Novelle
2=Flora Dade	8=Rodade
3=Heinz	9=Star 9010
4=Money Maker	10=Star 9030
5=Nemonadine	11=Tengeru
6=Nemoneta	12=Others, specify

Enumerator:

1) ***Enter values for all chosen fields in FNUM;***
2) ***Enter the names of the varieties planted in all chosen fields in VARIETY***
3) ***Then complete WHATPLANT and the rest of this section (Phase 1) for the FIRST CHOSEN FIELD***
4) ***Then come back to this table and complete the whole section for the SECOND CHOSEN FIELD***
5) ***Then move on to the next section (Phase 2)***

5.2 Planted Seedlings

Phase	Field #	Please list the varieties that you planted AS SEEDLINGS on this field	How many seedlings did you plant?	How much did the seedlings cost?	
				ZKW	Unit 1=unit cost 2=total cost
PHASE	**FNUM**	**VARSDLNG**	**NSDLNG**	**VALUE**	**UNIT**
1					

Variety Codes (SDVAR)	
1=Aphate	7=Novelle
2=Flora Dade	8=Rodade
3=Heinz	9=Star 9010
4=Money Maker	10=Star 9030
5=Nemonadine	11=Tengeru
6=Nemoneta	12=Others, specify

Enumerator: If the field had ONLY SEEDLINGS, the skip to the next section (Phase 2)

5.3 Planted Seed

Phase	Field #	Please list all varieties that you planted AS SEED on this field	What quantity of seed did you plant?		How much did the seed cost?		
			Quantity	Unit	ZKW	Quantity	Unit
PHASE	**FNUM**	**VARSEED**	**SDQT**	**UNIT1**	**VALUE**	**SDQT2**	**UNIT2**
1							

Weight & Volume UNIT codes	
1=gram (g) 2=kilogram (kg) 3=milliliter (ml) 4. liter (l) Other, specify	***Enumerator: If the farmer used less than the full package of seed, use this space to calculate the value of the seed ACTUALLY USED.***

5.4 Use of Mulch in Seed bed

Phase	Field #	Did you use mulching grass in your tomato seedbed? 1=yes 2=no	Did you have to pay for the mulching grass? 1=yes 2=no	If you had to pay, how much did the mulching grass cost?	Did you use any piecework labor in this operation (gathering of the mulch grass)? 1=yes 2=no	If yes, what total value did you pay to this piecework labor?	Please indicate the TOTAL value of any other costs you incurred in your seedbed preparation and planting operations.
PHASE	**FNUM**	**MLCH**	**MLCHPAY**	**MLCHCST**	**MLCHLAB**	**MLCHLABCST**	**OTHERCOST**
1							

PHASE 2 - FIELD PREPARATION

*5.5 Enumerator: 1) Indicate the number of fields prepared during the period you are discussing: ________________. **2) Then write the variety of seed that was planted on each field (first column in table below). 3) Then fill out all tables in this section for ONE FIELD AT A TIME. 4) After completing all tables for the first field, come back to this table and complete all tables for the second field.***

Phase	Field number	What variety did you plant in this field? ***Enumerator: Write the NAME of the variety***	What is the AREA of the field? ***Enumerator: enter area of the field as recorded in the field identification table on page #6***		Did you install a DRIP LINE in the field? 1=yes 2=no	If yes, did you pay to have it installed? 1=yes, paid 2=no	If you paid, what was the total cost of installation? ***(Enumerator: do NOT include cost of the drip line itself)***	Did you apply any lime to the field? 1=yes 2=no	If yes, how much did you apply?		How much did the lime cost?	
			Qt	Unit 1=acre 2=ha 3=lima 4=m					Quantity	Unit 1= gram 2=kilogram Other, specify	ZKW	Unit 1=unit cost 2=total cost
PHASE	**FNUM**	**VARIETY**	**FAREA1**	**FAREA2**	**FDRIP**	**FDRIP2**	**FDRIPCOST**	**FLIME**	**FLIMEQ**	**FLIMEU**	**FLIMEV**	**FLIMEU2**
2												

5.6 Ploughing, Disking, Ridging

Phase	Field Number	Operation	How did you conduct this operation?		If you rented a tractor or paid for animal traction services, what did you pay? (TOTAL COST IN ZKW)		If you used your own tractor, what was the fuel cost for this specific operation?	Did you use any family labor on these operations? 1=yes 2=no	Did you use any piecework labor on these operations? 1=yes 2=no	If yes, what was the TOTAL COST of the piecework labor?
			Main method 0=did not conduct this operation 1=Own tractor 2=Rented tractor	Secondary method 3=Own AT 4=Rented AT 5=Hand hoe	Main method	Secondary method				
PHASE	**FNUM**	**OPERATION**	**MAINOP**	**SECONDOP**	**COST1**	**COST2**	**COSTFUEL**	**FAMLABOR**	**HRDLABOR**	**COST LABOR**
2		1=Ripping								
		2=Ploughing								
		3=Disking								
		4=Ridging								
		1=Ripping								
		2=Ploughing								
		3=Disking								
		4=Ridging								

5.7 Irrigation prior to transplanting

Phase	Field #	Did you irrigate your field prior to transplanting? 1=yes 2=no	If yes, how many times did you irrigate?	If you used a diesel or petrol pump, about how much did EACH IRRIGATION cost you in fuel?	
				# of liters	Cost/liter (ZKW)
PHASE	**FNUM**	**IRRIG**	**IRRNUM**	**LITER**	**COSTLIT**
2					

5.8 Electricity Irrigation Costs over the whole tomato production period

Field Number	Do you use an electrical pump for your agricultural irrigation operations? 1=yes 2=no	If you used an electrical pump, on average how much does the electricity for ALL your agricultural irrigation operations cost you per month?	What proportion of this electricity irrigation cost would you approximate for tomato production each month?
		Cost (ZKW)	Cost (ZKW)
FNUM	**ELECT**	**ELECT1**	**ELECT2**

PHASE 3 - TRANSPLANTING TO FIRST HARVEST

***Enumerator:** After completing information on all fields for the previous section (Field Preparation), complete this section (Transplanting to First Harvest) in the same way as the first: complete all tables for the first field, then for the second, and so on.*

5.9 Piecework Labor from Transplanting to First Harvest

Phase	Field #	Operation	Did you carry out ______ during the period after transplanting up to your first harvest? 1=yes 2=no	If yes, did you engage any piecework labor for ______? 1=yes 2=no (Skip to next phase)	How did you pay people for this work? 1=per person per day 2=per line 3=per block 4=total cost for operation	If LBPAY=1 (paid per person per day):			If LBPAY=2 OR 3 (paid per line or per block):		If LBPAY=4 (made single total payment)
						# of people	# of days PER PERSON	Payment per person per day	# of lines or blocks	Payment per line or block	Total payment
PHASE	**FNUM**	**OPERATION**	**OPYES**	**OPLABOR**	**LBPAY**	**NPPL**	**NDAYS**	**VPPPD**	**NLB**	**VLB**	**VTOTAL**
3		1=Transplanting									
		2=Irrigating									
		3=Fert. Applications									
		4=Spraying									
		5=Weeding									
		6=Placement of poles									
		7=Pruning									
		1=Transplanting									
		2=Irrigating									
		3=Fert. Applications									

		4=Spraying									
		5=Weeding									
		6=Placement of poles									
		7=Pruning									

5.9.1 Transplanting and Irrigation

Phase	Field #	For HOW MANY WEEKS did your seed/seedlings remain in the seedbed?	Did you irrigate your field prior to first harvest? 1=yes 2=no	If yes, how many times did you irrigate your field during this phase?		If you used a diesel or petrol pump, about how much did EACH IRRIGATION cost you in fuel?	
				# of times	Frequency 1=day 2=week 3=month	Cost (ZKW)	Cost/liter (ZKW)
PHASE	**FNUM**	**WEEKS**	**IRRIG**	**NIRRIG**	**FIRRIG**	**NLITERS**	**COSTLITER**
3							

SECTION 6 - FERTILIZER AND CHEMICAL USE – PHASE ONE THROUGH TO PHASE FOUR

6.1 Fertilizer Use

Q1. Did you use any **FERTILIZER** in any of your tomato production phases? (1=yes,2=no) ==> if no, skip to question
____2___

List of basal fertilizers and top dressing fertilizers		
1=Ammon. Nitrate	10=Phosphorous Sulphate	13=Polyfeed
2=Ca basal	11=Mono Amm. Phosph. (MAP)	14=Processed manure/organic fert
3=Calcuim Ammon Nitrate (CAN)	7=Compound X	15=Potassium Nitrate
4=Compound D	8=Compound B	16=Single Super Phosphate (SSP)
5=Compound R	9= Compound T	17=TPS
6=Compound S	12=Multi K	18=Urea

Field #	Please list all the types of fertilizer that you used in your tomato production	What quantities of fertilizer did you use?				How much did the fertilizer cost you?		
		Quantity	Unit 1= gram 2=kilogram Other, specify	Freq 1=qt per application 2=total qt over all applications	**ONLY IF FERTREQ=1** How many applications did you make of this fertilizer?	ZKW	Quantity	Unit 1= gram 2=kilogram
FNUM	**FERTTYPE**	**FERTQT**	**FERTUNIT**	**FERTFREQ**	**NAPPFERT**	**FERTCOST**	**FERTQT2**	**FERTUNIT2**

6.2 Chemical use

Q2. Did you use any **CHEMICALS (PESTICIDES, FUNGICIDES, HERBICIDES or BACTERIALCIDES)** in your tomato production? (1=yes,2=no) ==> if no, skip to question **ASSETS**

Enumerator: If the respondent used only part of a packet or container, then record the cost of the whole packet in the cost column (CHMCOST) . Be sure to record the proper volume or weight of that full packet in CHMQT2.		
Coded list of pesticides, fungicides, herbicides and bacterialcides.		
1=Abamectin	21=Golan	41=Score
2=Acephate	22=Iprodione & Mancozeb	42=Seed plus
3=Agrifos 400	23=Iprodish	43=Streptop
4=Ardent	24=Keshet	44=Surf
5=Benomyl	25=Lyhalo	45=Tebuconazole
6=Bravo	26=Malathion	46=Temik/Sanacarb
7=Carbofuran	27=Malathion	47=Tendion
8=Chlorothanil	28=Mancozeb	48=Thionex
9=Chlorphyrifos	29=March	49=Trigaurd
10=Confidol (spear)	30=Metalaxyl & Mancozeb	50=Victory
11=Copper C.N.	31=Metamedaphos	51=Virrate
12=Copper oxy Chloride	32=Metaphos	52=Vydate
13=Cymoxanil & Mancozeb	33=Methomyl	53=Copper Flouride
14=Cypermenthlyn	34=Monocrotophos	54=Copper Count
15=Cyrux	35=Nimrod	55=0thers, specify
16=Deflule	36=Orius	
17=Dithane	37=Procymidone and Mancozeb	
18=Fastac	38=Pyrinex 480EC	
19=Folica	39=Ridomil	
20=Folpan	40=Rimon	

Field #	Please list all the types of CHEMICALS	In total, what quantities of each CHEMICAL did you use in your tomato production?	How much did the CHEMICAL cost you?

	that you used in your tomato production.							
		Qt	Unit 1=gram 2=kilogram 3=milliliter 4=liter	Frequency 1=qt per application 2=total qt over all applications	**ONLY IF CHMREQ=1:** How many applications did you make of this chemical?	ZKW	Qt	Unit 1=gram 2=kilogram 3=milliliter 4=liter
FNUM	**CHMTYPE**	**CHMTQT**	**CHMUNIT**	**CHMFREQ**	**NAPPCHM**	**CHMCOST**	**CHMQT2**	**CHMUNIT2**

SECTION 7 - ASSETS USED IN TOMATO PRODUCTION

71. We now want to ask you about the assets you use for tomato production

Asset	How many of these assets do you have? ***Enumerator: For the various pipes, please enter the meters of pipe they own, but in the case of aluminum pipes, enter the number of pipes***	Do you use this asset in your tomato production? 1=yes 2=no	What would it cost to buy this asset now, in new condition? (ZKW) ***Enumerator: Please indicate the unit cost of the item.***	What is the useful life of this asset in years? (from the time it is NEW to the end of its useful life)	How much do you spend every year to repair and maintain this asset? (ZKW)	Thinking about ALL the crops that you use this asset on, about how much of the time is it used in tomato production? 1=I use it ONLY on tomato 2=Tomato occupies MORE THAN HALF of its use 3=Tomato occupies ABOUT HALF of its use 4=Tomato occupies LESS THAN HALF of its use
ASSET (Examples)	**ANUM**	**AUSE**	**COSTNEW**	**USELIFE**	**REPAIR**	**STOMATO**
Hand hoe						
Shovel/spade						
Rake						
Garden fork						
Garden pick						
Digging rod (Mungwala)						
Axe						
Ox plough						
Ox cultivator						
Ox harrow						
Oxcart						
Chain (for Ox drawn implements)						
Yolk						
Tractor						
Disc plough						
Disc harrow						

Trailer						
Van/light truck						
Borehole						
Borehole pump						
Borehole pipes – Type 1 (……..inches)						
Borehole pipes – Type 2 (……...inches) Borehole pipes – Type 3 (………inches)						
Treadle pump						
Engine pump (Diesel or Petrol)						
Aluminum pipes - Type 1 (…….inches)						
Aluminum pipes – Type 2 (………inches)						
Aluminum pipes – Type 3 (………inches)						
Poly pipes - Type 1 (…….inches)						
Poly pipes – Type 2 (………inches)						
Poly pipes – Type 3 (………inches)						
PVC pipes - Type 1 (…….inches)						
PVC pipes – Type 2 (………inches)						
PVC pipes – Type 3 (………inches)						
Rubber for pipes (Malegeni)						
Well						
Drip liners						
Wooden box crates						
Plastic box crates						

Chemical Sprayer						
Cattle (For ox drawn implements)						
Wheel barrow						
Others, specify						

PHASE 4 -- FIRST HARVEST TO FINAL HARVEST

7.2 We would now like to talk to you about the quantities of tomato that you harvested and sold from the two fields we have been discussing

Enumerator: The table below allows the respondent to give their production and sales figures on a weekly or monthly basis, however they best recall it. You CAN take weekly responses for some months and monthly for others, but you should NOT fill in both weekly and monthly lines for a given month.
For example, the respondent might recall weekly production and sales figures for the first month, but thereafter recall only monthly figures. If that is the case, then fill out the lines for Phase 411-414 (weekly data for the first month), do NOT fill out the line for Phase 41 (Total Month 1), then fill out the lines for Phase 42 (Total Month 2), Phase 43 (Total Month 3), etc. (as relevant for the total number of months that the respondent harvested)
First Field

Field #	Time from 1st harvest	Phase	How often did you PICK during this period?		Production		Sales			Did you make ALL your tomato sales in SOWETO during this period? 1=yes 2=no	If not, please indicate how much you sold elsewhere, and the name of the market	
					How many crates did you HARVEST during this period?		Did you sell all that you harvested?	If not, how many crates did you sell?				
			# of times	Frequency 1=day 2=week 3=month	# Crates	Frequency 1=day 2=week 3=month	1=yes (➔SOWETO) 2=no	# Crates	Frequency 1=day 2=week 3=month		Total # of Crates sold elsewhere	Name of market (***Enumerator:*** write the name of the market)
FNUM	**PHASE**		**NPICK**	**FRQPICK**	**CRTPROD**	**PRODFRQ**	**SELL ALL**	**CRT SELL**	**SELL FRQ**	**SOWETO**	**CR TOTH**	**OMARKET**
	Week 1	411										
	Week 2	412										
	Week 3	413										

Field #	Time from 1st harvest	Phase	How often did you PICK during this period?		Production		Sales			Did you make ALL your tomato sales in SOWETO during this period? 1=yes 2=no	If not, please indicate how much you sold elsewhere, and the name of the market	
					How many crates did you HARVEST during this period?		Did you sell all that you harvested?	If not, how many crates did you sell?				
			# of times	Frequency 1=day 2=week 3=month	# Crates	Frequency 1=day 2=week 3=month	1=yes (➔SOWETO) 2=no	# Crates	Frequency 1=day 2=week 3=month		Total # of Crates sold elsewhere	Name of market (***Enumerator:*** write the name of the market)
FNUM	**PHASE**		**NPICK**	**FRQPICK**	**CRTPROD**	**PRODFRQ**	**SELL ALL**	**CRT SELL**	**SELL FRQ**	**SOWETO**	**CR TOTH**	**OMARKET**
	Week 4	414										
	Total Month 1	41										
	Week 1	421										
	Week 2	422										
	Week 3	423										
	Week 4	424										
	Total Month 2	42										
	Week 1	431										
	Week 2	432										
	Week 3	433										
	Week 4	434										
	Total Month 3	43										
	Week 1	441										
	Week 2	442										
	Week 3	443										
	Week 4	444										
	Total Month 4	44										
	Week 1	451										
	Week 2	452										
	Week 3	453										
	Week 4	454										
	Total Month 5	45										

Field #	Time from 1^{st} harvest	Phase	How often did you PICK during this period?		Production		Sales			Did you make ALL your tomato sales in SOWETO during this period? 1=yes 2=no	If not, please indicate how much you sold elsewhere, and the name of the market	
					How many crates did you HARVEST during this period?		Did you sell all that you harvested?	If not, how many crates did you sell?				
			# of times	Frequency 1=day 2=week 3=month	# Crates	Frequency 1=day 2=week 3=month	1=yes (➔SOWETO) 2=no	# Crates	Frequency 1=day 2=week 3=month		Total # of Crates sold elsewhere	Name of market (***Enumerator:*** write the name of the market)
FNUM	**PHASE**		**NPICK**	**FRQPICK**	**CRTPROD**	**PRODFRQ**	**SELL ALL**	**CRT SELL**	**SELL FRQ**	**SOWETO**	**CR TOTH**	**OMARK ET**
	Week 1	461										
	Week 2	462										
	Week 3	463										
	Week 4	464										
	Total Month 6	46										
	Week 1	471										
	Week 2	472										
	Week 3	473										
	Week 4	474										
	Total Month 7	47										
	Week 1	481										
	Week 2	482										
	Week 3	483										
	Week 4	484										
	Total Month 8	48										

Second Field

Field #	Time from 1st harvest	Phase	How often did you PICK during this period?		Production		Sales				Did you make ALL your tomato sales in SOWETO during this period?	If not, please indicate how much you sold elsewhere, and the name of the market	
					How many crates did you HARVEST during this period?			If not, how many crates did you sell?					
			# of times	Frequency 1=day 2=week 3=month	# Crates	Frequency 1=day 2=week 3=month	Did you sell all that you harvested? 1=yes (➔SOWETO) 2=no	# Crates	Frequency 1=day 2=week 3=month		1=yes 2=no	Total # of Crates sold elsewhere	Name of market (***Enumerator:*** write the name of the market)
FNUM	PHASE		NPICK	FRQ PICK	CRTPROD	PRODFRQ	SELLALL	CRT SELL	SELL FRQ		SOWETO	CR TOTH	OMARKET
	Week 1	411											
	Week 2	412											
	Week 3	413											
	Week 4	414											
	Total Month 1	41											
	Week 1	421											
	Week 2	422											
	Week 3	423											
	Week 4	424											
	Total Month 2	42											
	Week 1	431											
	Week 2	432											
	Week 3	433											
	Week 4	434											
	Total Month 3	43											
	Week 1	441											
	Week 2	442											

			How often did you PICK during this period?		Production		Sales				Did you make ALL your tomato sales in SOWETO during this period? 1=yes 2=no	If not, please indicate how much you sold elsewhere, and the name of the market	
					How many crates did you HARVEST during this period?			If not, how many crates did you sell?				
Field #	Time from 1st harvest	Phase	# of times	Frequency 1=day 2=week 3=month	# Crates	Frequency 1=day 2=week 3=month	Did you sell all that you harvested? 1=yes (➔SOWETO) 2=no	# Crates	Frequency 1=day 2=week 3=month		Total # of Crates sold elsewhere	Name of market (*Enumerator:* write the name of the market)
FNUM	**PHASE**		**NPICK**	**FRQ PICK**	**CRTPROD**	**PRODFRQ**	**SELLALL**	**CRT SELL**	**SELL FRQ**	**SOWETO**	**CR TOTH**	**OMARKET**
	Week 3	443										
	Week 4	444										
	Total Month 4	44										
	Week 1	451										
	Week 2	452										
	Week 3	453										
	Week 4	454										
	Total Month 5	45										
	Week 1	461										
	Week 2	462										
	Week 3	463										
	Week 4	464										
	Total Month 6	46										
	Week 1	471										
	Week 2	472										
	Week 3	473										
	Week 4	474										
	Total Month 7	47										

Field #	Time from 1^{st} harvest	Phase	How often did you PICK during this period?		Production		Sales				Did you make ALL your tomato sales in SOWETO during this period?	If not, please indicate how much you sold elsewhere, and the name of the market	
					How many crates did you HARVEST during this period?		Did you sell all that you harvested?	If not, how many crates did you sell?					
			# of times	Frequency 1=day 2=week 3=month	# Crates	Frequency 1=day 2=week 3=month	1=yes (➔SOWETO) 2=no	# Crates	Frequency 1=day 2=week 3=month		1=yes 2=no	Total # of Crates sold elsewhere	Name of market (***Enum erator:*** write the name of the market)
FNUM	**PHASE**		**NPICK**	**FRQ PICK**	**CRTPROD**	**PRODFRQ**	**SELLALL**	**CRT SELL**	**SELL FRQ**		**SOWET O**	**CR TOTH**	**OMAR KET**
	Week 1	481											
	Week 2	482											
	Week 3	483											
	Week 4	484											
	Total Month 8	48											

7.3 ***For the field just discussed, we would like to know approximately what quantity of tomato went to waste (you were unable to sell it due to poor quality) during each harvest month***

Field #	Time from 1^{st} harvest	Phase	About what % of your production did you either LEAVE IN THE FIELD due to poor	Please list the TOP TWO reasons for leaving your product in the field or for the wastage after it was harvested during the month	Were you ever unable to sell some of what you took to the market?	If yes, about what % of the amount that you took to the market were you UNABLE TO SELL due to poor	About what % of the amount that you took to the market received a BIG DISCOUNT due to poor quality?

			quality, went to waste after harvesting or you gave away to your farm workers?	1=excessive rain 2=not enough chemicals to control disease or pest problems 3=Unable to pick on time 4=Poor market quality =other, specify		1=yes 2=no, always sold all (➔ next month)	quality?	
FNUM	**PHASE**		**PCT1**	**REASON1**	**REASON2**	**NOSELL**	**PCT2**	**PCT3**
	Month 1	41						
	Month 2	42						
	Month 3	43						
	Month 4	44						
	Month 5	45						
	Month 6	46						
	Month 7	47						
	Month 8	48						
	Month 1	41						
	Month 2	42						
	Month 3	43						
	Month 4	44						
	Month 5	45						
	Month 6	46						
	Month 7	47						
	Month 8	48						

7.4 For the fields we just discussed, which statement best describes your sales behavior? ☐

1=I nearly always sold the tomatoes after every picking; I didn't wait for two pickings to sell
2=I typically collected two pickings, then sold them both at the same time
3=Other (Enumerator: please describe in space below)

First Field: ______________________________

____

Second field: ____

8.0 Harvesting and Marketing Costs – Field #1

We would now like to talk with you about the typical costs associated with picking and selling your tomatoes. First, we would like to ask you about the typical costs on the field that you were harvesting during ____________________________ (ENUMERATOR: indicate the months during which the respondent was harvesting the FIRST field)

Cost code	Type of cost	Cost of activity			
		Cost (ZMK)	Unit 1= per person, 2= per line 3= per block , 4= per day 5= per week, 6= per lima, 7= per acre, 8= per sales load 9= per crate (box) , 10= per trip 11= other, specify	Total number of units	Total cost **(COST*CTUNITS)**
COSTNU	**COSTYPE**	**COST**	**CUNIT**	**CTUNITS**	**COSTOTAL**
1	Picking				
2	Sorting				
3	Packing				
4	Picking/Sorting/Packing				
5	Loading				
6	Hired transport				
7	Own transport (Fuel cost)				
8	Loading and transporting				
9	Unloading				
10	Unloading and sales commission				
11	Sales Commission				
12	Other costs				

13					
14					
15					

8.1 Harvesting and Marketing Costs – Field #2

Now *we would like to ask you about the typical costs on the other field we have been discussing, the one that you were harvesting during*

(ENUMERATOR: indicate the months during which the respondent was harvesting the SECOND field)

Cost code	Type of cost	Cost of activity			
		Cost (ZMK)	Unit 1= per person, 2= per line 3= per block , 4= per day 5= per week, 6= per lima, 7= per acre, 8= per sales load 9= per crate (box) , 10= per trip 11= other, specify	Total number of units	Total cost **(COST*CTUNITS)**
COSTNU	**COSTYPE**	**COST**	**CUNIT**	**CTUNITS**	**COSTOTAL**
1	Picking				
2	Sorting				
3	Packing				
4	Picking/Sorting/Packing				
5	Loading				
6	Hired transport				
7	Own transport				
8	Loading and transporting				
9	Unloading				
10	Unloading and sales commission				
11	Sales Commission				
12	Other costs				
13					
14					
15					

APPENDIX 5.

Distribution of Sampled Farmers

Table A5.1. Distribution of Sampled Farmers

Area	Number of farmers identified	Number of farmers sampled	Number of farmers actually interviewed
Maali	31	16	8
Kangombe	21	9	8
Nchute	12	7	7
Kapilipili	74	35	35
Katoba	28	13	12
Kacheta	43	28	25
Kuma plot	11	6	5
Star cottage	15	7	2
Total	235	121	102

APPENDIX 6.

Baseline Distributions for the Random Variables Cost per Hectare and Yield

Figure A6.1. Distributions for Cost/Ha, Group 1

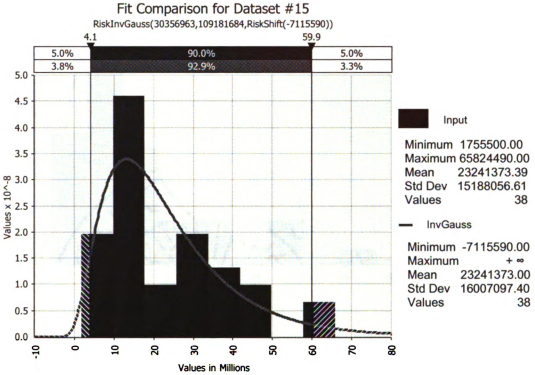


Figure A6.2. Distributions for Cost/Ha, Group 2

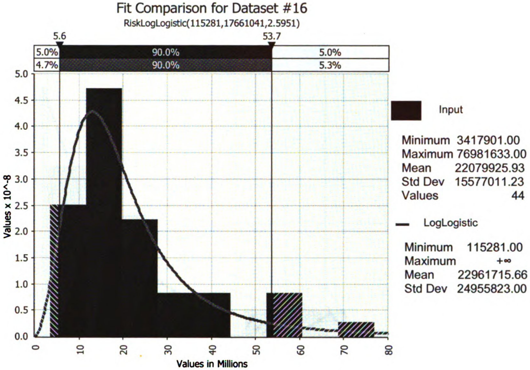


Figure A6.3. Distributions for Cost/Ha, Group 3

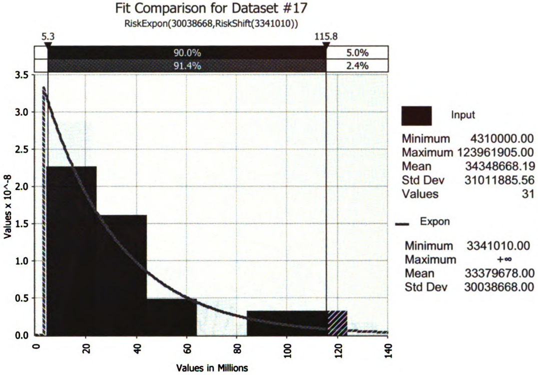


Figure A6.4. Distributions for Cost/Ha, Group 4

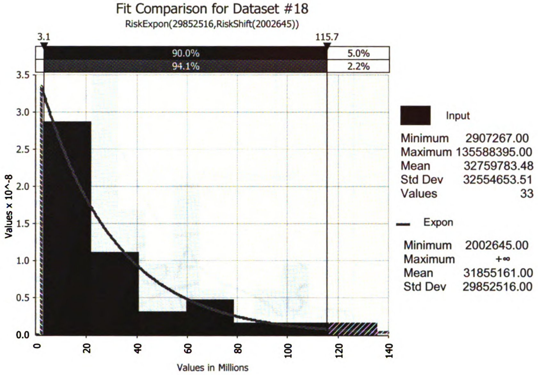
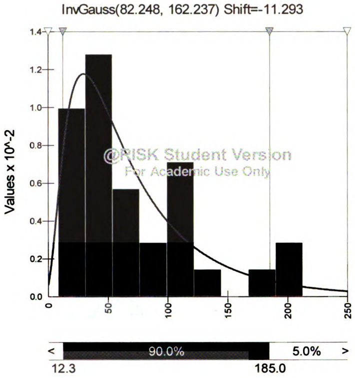


Figure A6.7. Distributions for Yield, Group 3



APPENDIX 7.

Histograms of Farmer Profits per Hectare under Different Scenarios

Figure A7.1. Baseline Scenario: Histograms of Farmer Profits per Hectare, Group 1

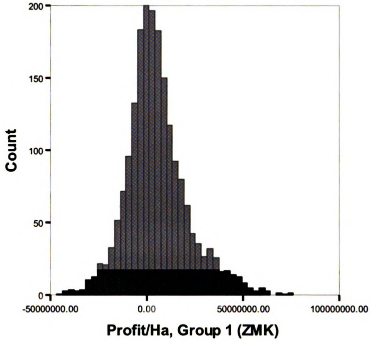


Figure A7.2. Baseline Scenario: Histograms of Farmer Profits per Hectare, Group 2

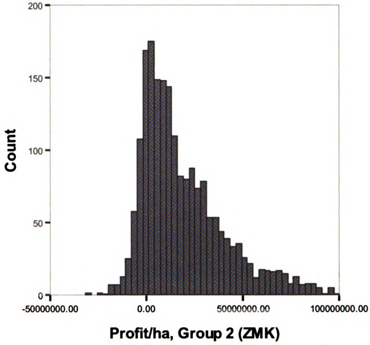


Figure A7.3. Baseline Scenario: Histograms of Farmer Profits per Hectare, Group 3

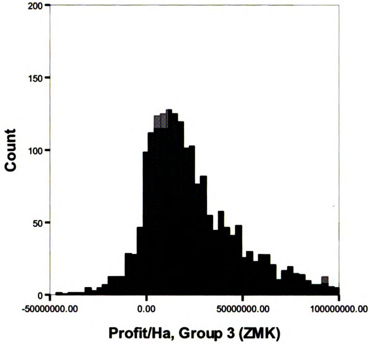


Figure A7.4. Baseline Scenario: Histograms of Farmer Profits per Hectare, Group 4

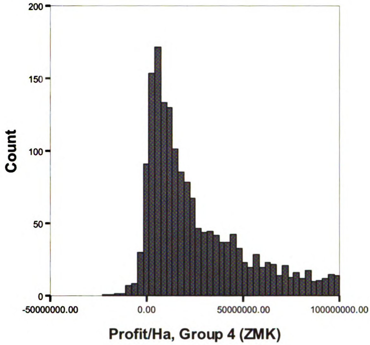


Figure A7.5. Increased Sales Frequency Scenario: Histograms of Farmer Profits per Hectare, Group 1

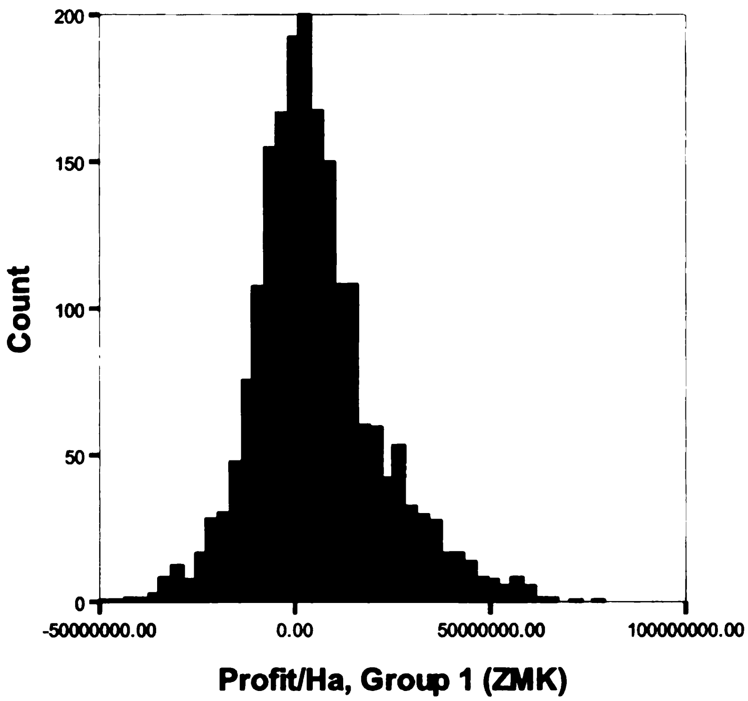


Figure A7.6. Increased Sales Frequency Scenario: Histograms of Farmer Profits per Hectare, Group 2

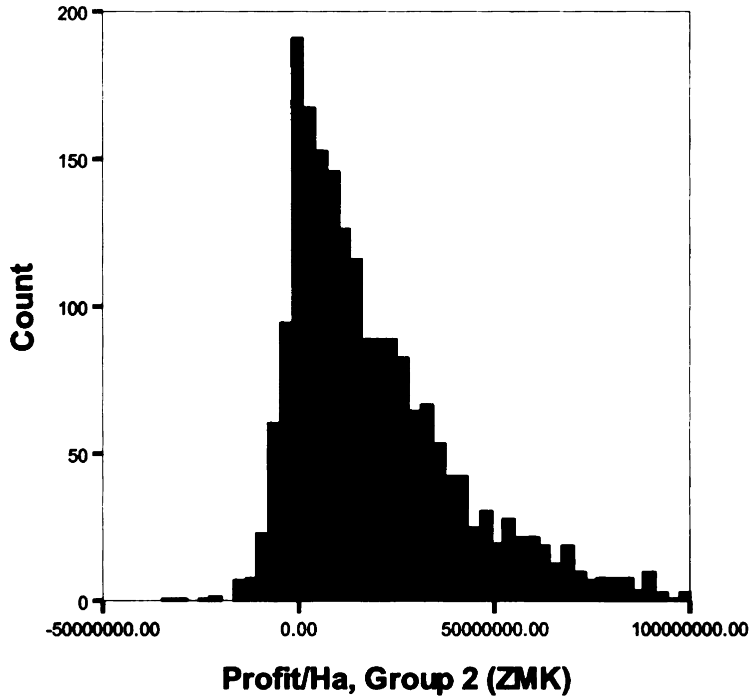


Figure A7.7. Increased Sales Frequency Scenario: Histograms of Farmer Profits per Hectare, Group 3

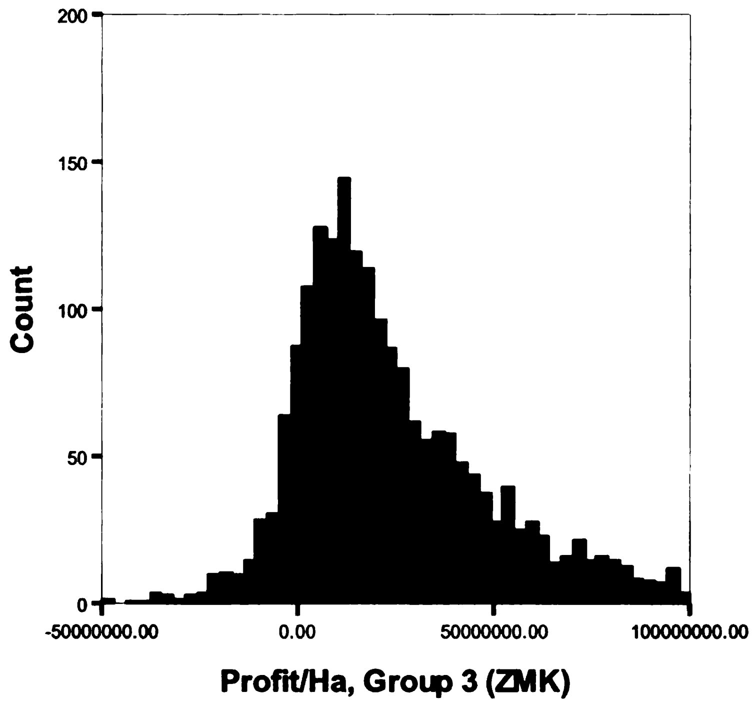


Figure A7.8. Increased Sales Frequency Scenario: Histograms of Farmer Profits per Hectare, Group 4

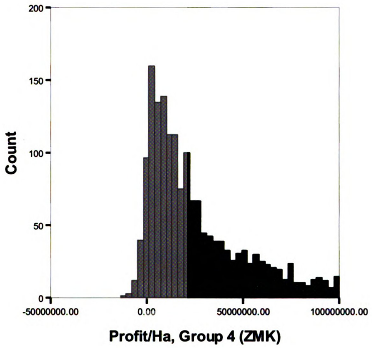


Figure A7.9. Supply Chain Improvements Scenario: Histograms of Farmer Profits per Hectare, Group 1

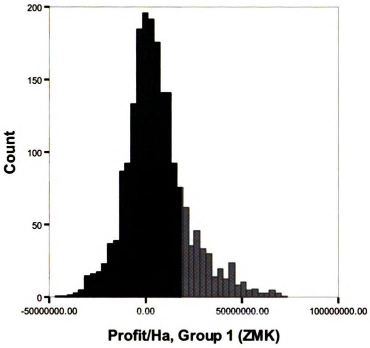


Figure A7.10. Supply Chain Improvements Scenario: Histograms of Farmer Profits per Hectare, Group 2

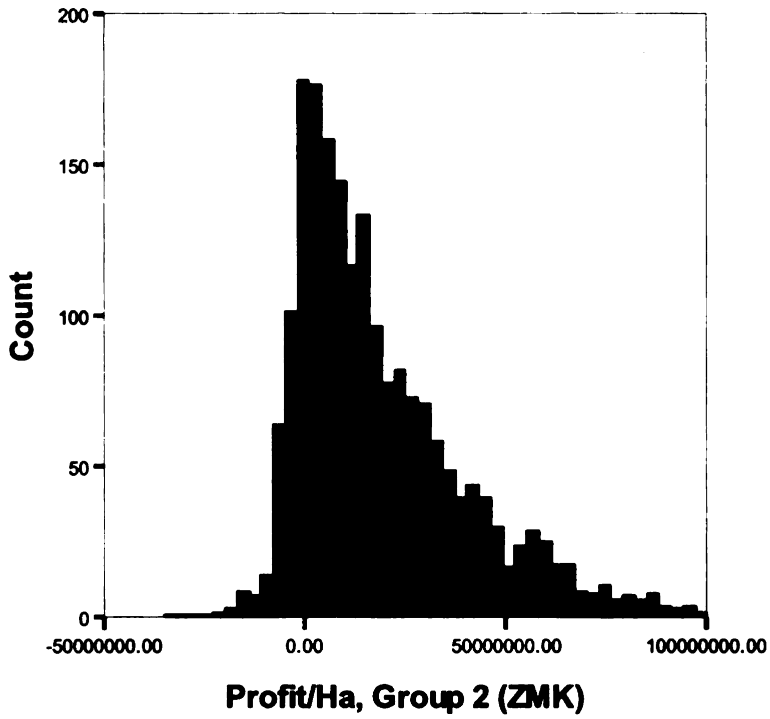


Figure A7.11. Supply Chain Improvements Scenario: Histograms of Farmer Profits per Hectare, Group 3

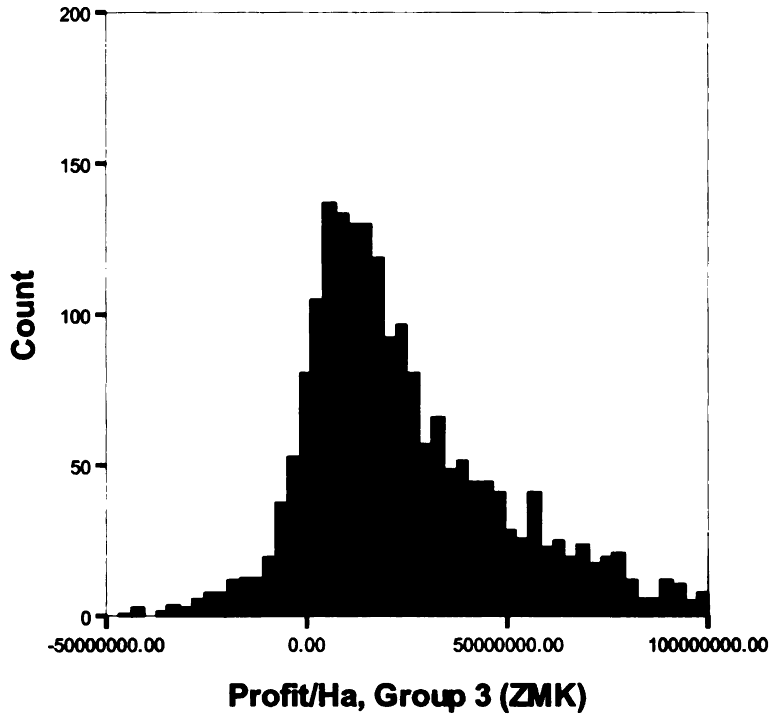


Figure A7.12. Supply Chain Improvements Scenario: Histograms of Farmer Profits per Hectare, Group 4

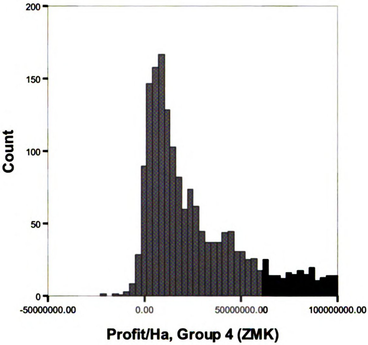


Figure A7.13. Scenario on Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 1

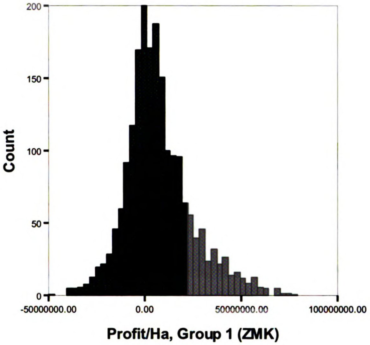


Figure A7.14. Scenario on Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 2

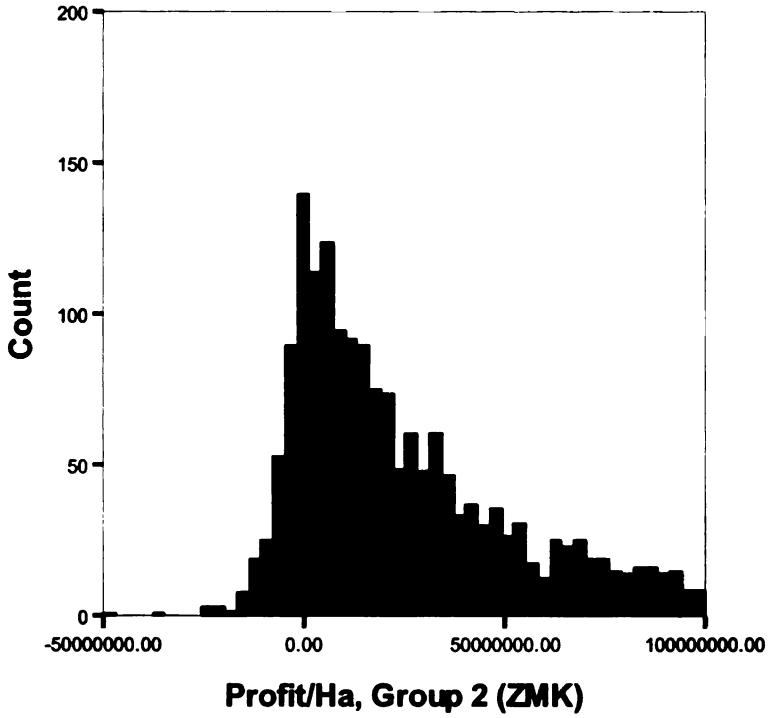


Figure A7.15. Scenario on Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 3

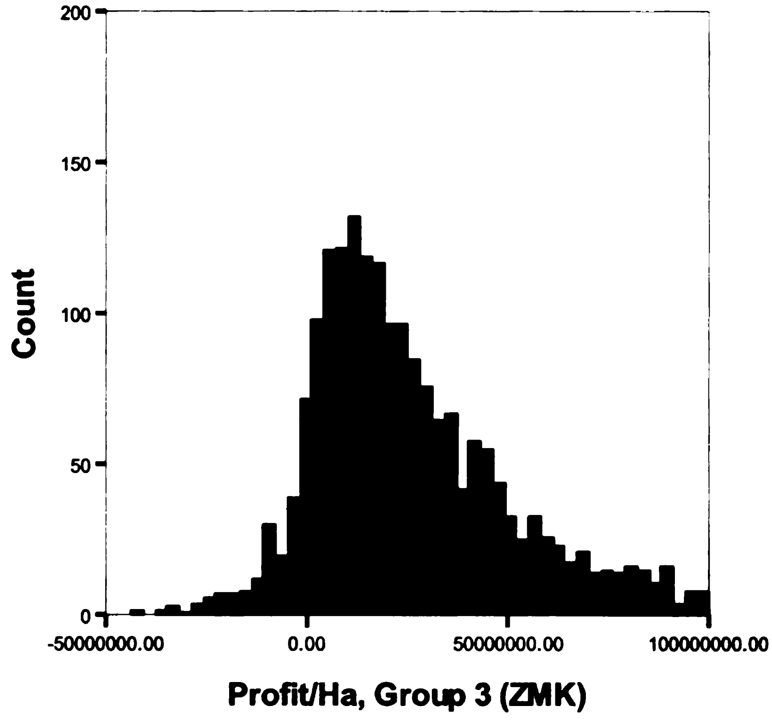


Figure A7.16. Scenario on Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 4

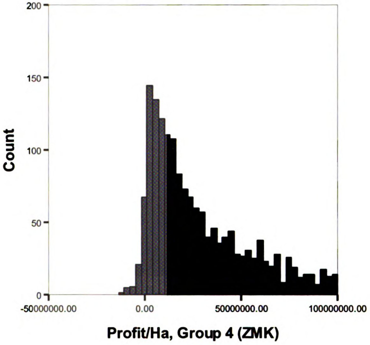


Figure A7.17. Scenario on Low Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 1

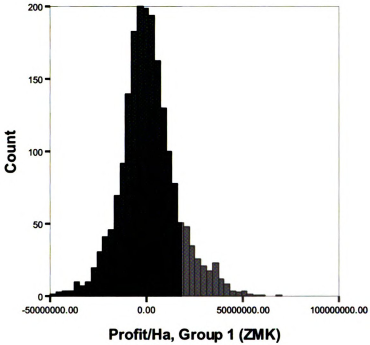


Figure A7.18. Scenario on Low Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 2

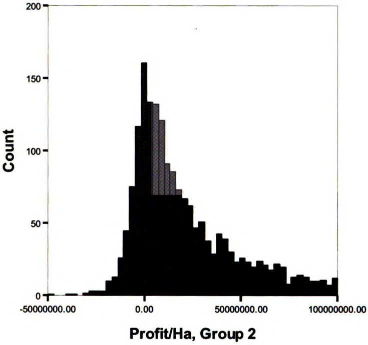


Figure A7.19. Scenario on Low Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 3

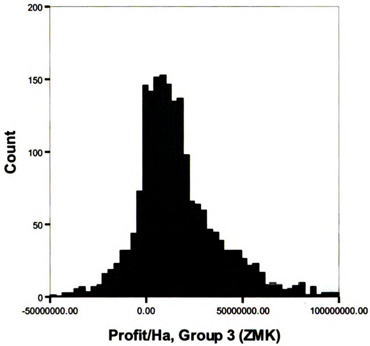
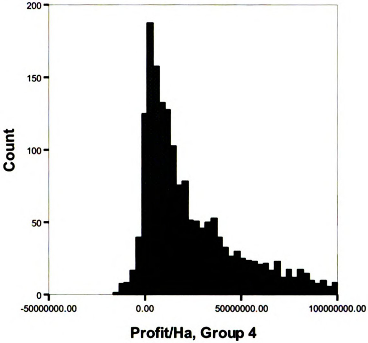


Figure A7.20. Scenario on Low Quality of Tomatoes Sold in the Market: Histograms of Farmer Profits per Hectare, Group 4



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