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ISSN 1235-2241
ISBN 978-10-6974-1 (Paperback)
ISBN 978-10-6975-8 (PDF)

Unigrafia Oy
Helsinki 2011

University of Helsinki
Department of Economics and Management
Publication Nr. 50, Agricultural Policy, 122 p.

**Impact of agricultural market liberalization food security in developing countries: a comparative study of Kenya and Zambia**

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**Abstract**. This research investigates the impact of agricultural market liberalization on food security in developing countries and it evaluates the supply perspective of food security. This research theme is applied on the agricultural sector in Kenya and in Zambia by studying the role policies played in the maize sub-sector. An evaluation of selected policies introduced at the beginning of the 1980s is made, as well as an assessment of whether those policies influenced maize output. A theoretical model of agricultural production is then formulated to reflect cereal production in a developing country setting.

This study begins with a review of the general framework and the aims of the structural adjustment programs and proceeds to their application in the maize sub-sector in Kenya and Zambia. A literature review of the supply and demand synthesis of food security is presented with examples from various developing countries. Contrary to previous studies on food security, this study assesses two countries with divergent economic orientations. Agricultural sector response to economic and institutional policies in different settings is also evaluated. Finally, a dynamic time series econometric model is applied to assess the effects of policy on maize output.

The empirical findings suggest a weak policy influence on maize output, but the precipitation and acreage variables stand out as core determinants of maize output. The policy dimension of acreage and how markets influence it is not discussed at length in this study. Due to weak land rights and tenure structures in these countries, the direct impact of policy change on land markets cannot be precisely measured. Recurring government intervention during the structural policy implementation period impeded efficient functioning of input and output markets, particularly in Zambia. Input and output prices of maize and fertilizer responded more strongly in Kenya than in Zambia, where the state often ceded to public pressure by revoking pertinent policy measures. These policy interpretations are based on the response of policy variables which are more responsive in Kenya than in Zambia. According to the obtained regression results, agricultural markets in general, and the maize sub-sector in particular, responded more positively to

implemented policies in Kenya, than in Zambia, which supported a more socialist economic system.

It is observed in these results that in order for policies to be effective, sector and regional dimensions need to be considered. The regional and sector dimensions were not taken into account in the formulation and implementation of structural adjustment policies in the 1980s. It can be noted that countries with vibrant economic structures and institutions fared better than those which had a firm, socially founded system.

**Keywords**: agricultural policies, food security, maize sub-sector, market liberalization, structural adjustment programs, Kenya, Zambia

# Acknowledgements

I would like to thank the many people who, in various ways, have contributed to this research. First of all, I extend my deep appreciation to Professor Jukka Kola for his willingness to serve as my supervisor, thus opening the door to the Finnish 'scene'. Professor Kola has been a key player in the formulation and supervision of this research. Second, I would like to thank Professor John Sumelius, who accepted to serve as my second supervisor, for his unrelenting support, particularly in providing the requisite guidance in econometrics. In working with them, I have learned to become more resilient, patient and disciplined. Without their encouragement, support and guidance, I would not have been writing these words until much later. I also owe them a twofold debt: for putting up with the many mangled and, sometimes, lousy scripts, and for the willingness to write the numerous recommendations for funding.

I would like to thank Kaisa Kartunnen for her encouragement and comments. Kaisa availed herself for discussions, which always rallied my academic spirit. In the many occasions when I wallowed in the desert of confusion, she motivated me. For this I remain deeply grateful. Many colleagues and staff, at the Department of Economics and Management, have made my stay in Viikki a memorable one. Antti Simola, Antti Unnaslahti and Nina Hyytiä are among the first people I met during my first days in Helsinki. We have worked together as a team under the stewardship of Professor Kola.

I would like to thank all my colleagues and members of SARG, a research group in the Department of Economics and Management. I enjoyed the resourceful and thought-provoking discussions we had together on a wide range of issues. Tuulikki Parviainen, an office colleague, gave me encouraging words. The Department of Economics and Management also provided me with a good working environment. The efficient department staff complemented the quiet and ideal research atmosphere. I would like to particularly thank Outi Pajunen for her assistance and support. She is one of the nicest people I have had to work with in Viikki.

Several foundations have generously contributed to this research. I wish to thank them for believing in my work. The Finnish Cultural Foundation (2008 &2009), Ella & Georg Ehrnrooth Foundation (2007), Tiura Foundation (2007), and the University of Helsinki Funds (2006, 2007 & 2010) all generously supported my research. Without their financial support, I would still be laboring to finish it. I am also indebted to the Nordic Africa Institute (NAI), which funded two separate study trips to Uppsala, Sweden. The library staff there was wonderfully helpful in tracking down sources and material. It would be hard not to mention the United Nations University -WIDER for the three-month internship that provided me with the time and impetus to give this research a facelift.

I thank my dissertation pre-examiners, Professor Tapani Köppä and Professor Demetris Psaltopoulus, who both read my thesis and issued printing permission. They gave thoughtful and insightful comments that added value to my work. I wish to thank Professor Jyrki Niemi for the honor to serve as my opponent.

I am grateful to my good friend, Maria McCoy, New York, for being generous with her time in making language corrections for no reward beyond the satisfaction of a job well done. Maria read and suggested grammatical corrections for the entire manuscript. I also wish to thank Ella Alin for her willingness to draft a translation of the research abstract into Finnish.

I thank my beloved wife, Jackline Mosinya, for her love, encouragement and unwavering support during the entire research writing process. She patiently bore the brunt of my absence for months on end, but still remained strong. During the long absence, my wife took excellent care of our son, Christian Nyairo. I recognize my parents, Johnson Nyairo and Elizabeth Kemunto, who afforded me the love, support and encouragement during this long road. My father always reminded me that hard work is the cornerstone of success while my mother provided the best love a mother could offer. My deep gratitude to my siblings; Gichaba, Lilian, Bosire, Franklin, Dorothy, and Karen, who were, in immeasurable ways, an inspiration for taking this academic route. They were always a phone call away. However, nothing will not have come to be were it not for GOD who provided me with the energy, resilience and sound mind in the formulation and progression of the research.

Vantaa, May 2011
Newton Morara Nyairo

# Contents

# Acronyms

| | |
|---|---|
| **AoA** | Agreement on Agriculture |
| **AERC** | African Economic Research Consortium |
| **ASAL** | Arid and semi-arid lands |
| **CBS** | Central Bureau of Statistics |
| **CSO** | Central Statistical Office |
| **EAC** | East African Community |
| **EU** | European Union |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FPRZ** | Food Policy Research Zambia |
| **GATT** | General Agreement on Tariffs and Trade |
| **GDP** | Gross Domestic Product |
| **IMF** | International Monetary Fund |
| **KCPB** | Kenya Cereals and Produce Board |
| **Ksh** | Kenyan Shilling |
| **KFA** | Kenya Farmers Association |
| **KGGU** | Kenya Grain Growers Union |
| **KIPPRA** | Kenya Institute for Public Policy Research Analysis |
| **LDC** | Least Developed Country |
| **LM** | Lagrange Multiplier |
| **MACO** | Ministry of Agriculture and Cooperatives |
| **MDG** | Millennium Development Goals |
| **NAMBOARD** | National Maize Board |
| **NGO** | Non-governmental Organization |
| **NLS** | Non-linear least squares |
| **PHS** | Post Harvest Survey |
| **SADC** | Southern African Development Community |
| **SAL** | Structural Development Loans |
| **SAP** | Structural Adjustment Programs |
| **SDR** | Special Drawing Rights |
| **SSA** | Sub-Saharan Africa |
| **UNDP** | United Nations Development Program |
| **US** | United States of America |
| **WB** | World Bank |
| **WFS** | World Food Summit |
| **WHO** | World Health Organization |
| **WIDER** | World Institute for Development Economics Research |
| **WTO** | World Trade Organization |
| **ZCCM** | Zambia Consolidated Copper Mines |
| **ZK** | Zambian Kwacha |

# 1. Introduction

## 1.1 Background

The threat of food insecurity in developing countries remains a daunting policy challenge several decades after the introduction of agricultural market and economic liberalization. For Kenya and Zambia, this challenge is further compounded by an unsustainable increase in agricultural productivity, poor price and cost incentives, and incoherent policies in the agricultural sector. Ironically, the sector fulfills two central roles in the overall economy. First, agricultural exports constitute an essential source of foreign exchange earnings and a basis for government revenue. Secondly, a sizable portion of staple agricultural output is consumed domestically while the surplus is exported. The critical role faced by the government in shoring the agricultural sector echoes Theodore Schultz's Nobel Prize acceptance speech in 1979 in which he underlined the potential of agriculture, in low-income countries, to produce enough food for the then growing population, and to improve the incomes and welfare of the people (Schultz, 1979).

The pre-reform period in Kenya and Zambia, as in many other developing countries, was rife with government intervention in markets, and strict controls over the pricing and marketing of agricultural commodities. In the face of the control of domestic and external economic activities, serious economic imbalances began to pile up in developing country economies (Thomas, 2006). Economic growth rates were stagnating or in the negative (Mohan et. al., 2000). Reforming the structural economic and political policies was deemed a recipe for correcting the existing economic bottlenecks and for reversing the rapid decline and economic instability characterized by weakening macroeconomic indicators (Mohan et al., 2000). The slow economic growth evident in the 1980s and the 1990s, which marked a stark contrast to the moderate rates of growth experienced in the 1960s and 1970s, was mainly a result of imprudent economic management. In part, weak national economic policies and structural weaknesses also contributed to the economic free fall (Mohan et al. 2000).

It is against this economic backdrop that the World Bank (WB) and the International Monetary Fund (IMF) initiated structural adjustment[1] programs (SAP) in developing countries. These policies favored functional liberal markets and institutional reforms aimed at spurring stronger growth. The unfolding market era was preceded by institutional barriers to the exchange rate system, domestic interest rates and an economic system entirely dependent on state control. The wide-ranging reform policy proposals were important to the agricultural

[1] *Structural adjustment was the process by which the IMF and the World Bank based their lending to underdeveloped economies, on certain conditions, pre-determined by these institutions (Mohan et al., 2000).*

sector and the economy at large. Reforming the agricultural sector was presumed critical in the economy given the sector's contribution to the Gross National Product (GDP). For instance, import and export sectors of inputs and outputs were subject to greater reform. Previously, governments had an upper hand in external trade through the issuance of import and export licenses. Publicly financed marketing enterprises[2] participated in the procurement of inputs and the purchasing of agricultural outputs. The procurement of agricultural inputs and the marketing of tradable agricultural outputs overseen by these publicly financed enterprises impeded market functioning. Their functioning was a liability to the national treasury. The essence of reforms was to remove policies which were impeding the role of markets and decelerating economic progress. The core of the structural reorientation was deemed essential in restructuring domestic and cross border marketing (Edwards, 1993; Mohan et al, 2000).

### 1.1.1 Agricultural sector liberalization and maize supply

The agricultural reforms introduced in the 1980s aimed at reducing or eliminating the existing bias against agriculture and to open the sector to market forces. It was presumed that these steps would promote the role of private sector activity and lead to increased agricultural production through competitive markets. The implementation of these reforms required the removal of price disincentives for farmers and the reduction of government intervention in the sector. Removing such impediments was presumed to generate sufficient supply response and to lead to well-functioning markets (Kheralla et al., 2000; Christiaensen & Demery, 2007). Overall, the reforms undertaken included the removal of price controls, closure of state-owned enterprises that monopolized maize (agricultural) trade and changing the foreign exchange market to provide greater incentives for export (Kheralla et al., 2000).

In Kenya and Zambia, government intervention was rampant in maize marketing, as well as in fertilizer marketing. Agricultural support subsidies for inputs, credit, and transport cost were useful in promoting the agricultural sector and rural incomes. The introduction of agricultural market reforms required governments to reduce control over export markets and to remove subsidies. Universal fertilizer subsidies which were common during the pre-reform period still lingered long after most of the other recommended reforms were in place. The implementation of economic liberalization policies was anchored on the notion that deregulation and unfettered market competition would result in the ‘right’ input prices, and higher producer prices for farmers, spurring them to increase efficiency, increase production,

[2] *These publicly financed enterprises are also referred to as parastatals. They were mandated by the government to administer services which favored government policies pertaining to the functioning of the agricultural sector and markets.*

and make investments to raise land and labor productivity (Havnevik et al., 2007). The proposed reforms included the following types of measures:

a. Liberalizing input and output prices through the elimination of subsidies on agricultural inputs such as fertilizer and credits. The goal was to align domestic prices to international ones and to bring to an end to pan-territorial pricing.
b. Encouraging private sector activity by removing regulatory controls in input and output markets, thereby lifting restrictions of internal movement on food crop commodities. Trade-prohibitive measures such as delivery quotas, licensing arrangements, restrictions, and other regulatory arrangements were considered costly.
c. Restructuring public enterprises and restricting marketing boards to activities such as providing market information and maintaining food stocks (Kheralla et al., 2002).

This research investigates the impacts of agricultural reform policies affecting maize production and the corresponding response trends in both Kenya and Zambia. The foregoing policy reforms are analyzed in regard to maize market liberalization, the deregulation of essential production inputs, and associated marketing institutions. Maize, which is the featured cereal in this study, is widely consumed in both Kenya and in Zambia and it is a source of income for many rural producers. In both countries, the political economy of maize production is an important one, given its likely contribution to food security. By studying maize production and its response to agricultural reforms, this research provides an understanding of staple cereal response, particularly how the policies influenced the cereal sector, and traces those effects to the state of food security through maize production trends in Kenya and Zambia. In addition to the challenges of economic growth, overall food supply constraints continue to beleaguer these economies. In analyzing agricultural sector growth dynamics, the issues of development economics within the African context, which will innately arise, represent an important segment of the overarching theme of this research. The implementation of World Bank policies in the foregoing countries has led to a chorus of questions regarding the role of such reforms in the agricultural sector and staple food supply. The effectiveness of the stated policy intervention in the agricultural sector and support programs financed by the World Bank and the donor community receive mixed assessment in terms of the results. This study analyzes existing research and literature on maize supply responses to agricultural reform policies. The World Food Summit of 1996 defined food security as existing ‘when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life’ (FAO, 2003). This definition also entails both the physical and economic access to food that meets their dietary needs as well as their food preferences. Despite competing views over food security in the liberalization debate, the literature affirms that food supply is highly dependent on the growth in the agricultural supply of the main food crops. The supply of the main staple crops such as maize and wheat is a critical factor in enabling access to cereals by households for their own consumption.

### 1.1.2 Maize supply and government implementation of economic reforms

Market liberalization has its beginnings in structural adjustment programs (SAP), which were favored to provide an economic remedy to developing countries. The reforms targeted the removal of structural policies and institutions which were seen as impeding economic growth. Creating enabling institutions, and re-engineering the agricultural sector, was an important step in dealing with slow growth and rising poverty. Economic crises and overall stagnation were common indicators of economic distress evident during the late 1970s and afterwards in the 1980s. For instance, between 1978 and 1980, Kenya faced the first serious economic crisis since its independence; the country's balance of payments was in serious deficit (Mosley, 1986). The rise in oil prices and the decline in the value of most raw commodities, representing a large portion of the exports of developing countries, exacerbated the already worsening domestic economic conditions. Many governments were consequently pushed to the arms of the IMF, and later the WB or other bilateral donors, for loans. Kenya and Zambia, in fulfilling conditions attached to granted credits, had to devalue their currencies against international currencies and the special drawing rights[3] (SDR).

The government's role in dispensing public goods and services and ensuring their equitable distribution cannot be underestimated. Government entrenchment in market regulation cannot entirely be removed, but can be improved in order to facilitate market functioning. Agricultural market restructuring is pivotal in facilitating growth within the sector and in enhancing wider economic growth. The agricultural reforms introduced sought to reduce, not entirely remove, government participation in the economy, as stated in the Berg report[4] or subsequent WB directives, regarding institutional reforms during the 1980s. The report bestowed upon the government the mandate of implementing overall reform, but it was perceived as being against government participation in reform. The policies coming down from the World Bank emphasized the presence of the private sector in input and output markets. The role of the private sector was deemed important in facilitating market participation.

Reforms were important policy instruments in streamlining price signal barriers between producers and product markets. Output response to price signals had the potential of reversing balance-of-payments imbalances on condition of increased exports. The economic instruments embodied in reforms were integral in the reversal of the downward economic spiral accompanying the underperformance of the economies of Kenya and Zambia. The deterioration of the main economic indicators in Zambia had led to unprecedented economic

*[3] The SDR is an international reserve currency, created by the IMF in 1969 to supplement existing reserves of member countries. The SDR are allocated to member countries in proportion to their IMF quotas.*

*[4] The Berg report refers to the report published by the World Bank in 1981 and written by Eliot Berg. The report was entitled "Accelerated Development in Sub-Saharan Africa"*

decline in the period from the mid-1970s to mid-1987 (Young & Loxley, 1990). The ensuing economic collapse is associated with the sharp fall in the export price of copper, the country's main export commodity. Subsequent collapse in the country's terms of trade evidenced its dependence on a single commodity, whose terms of trade fell by more than 77 percent between 1973 and 1984 (Young & Loxley, 1990). This rapid decline resulted in a fall in the value of 'real imports' and an increase in the external debt. Young & Loxley (1990) conclude that the overvalued exchange rate hurt agriculture and domestic food producers. In the case of Zambia, the fall in exports weakened the country's food security pillars - the possibility to import or to produce sufficient food domestically - which were directly subverted.

## 1.2 The aims of the study

This study investigates the influence of market reform on food security[5] through the maize sub-sector in Kenya and Zambia. The study focuses on staple food supply and its role in ensuring national self-sufficiency by concentrating on maize, commonly produced and consumed in both Kenya and Zambia. Secondly, the study seeks to ascertain the contribution of policy influence on supply-side food security and whether this influence is similar or different across these countries.

Justification for the study is based on the greater emphasis on agriculture as the main sector responsible in providing economic livelihood for a large portion of the population in Kenya and Zambia. In these countries, the link between agricultural supply, marketing, distribution and food security remains relevant overall.

The main thrust of the research assesses how reforms impinged on maize markets and subsequently affected maize production trends through input and output markets. In the investigation the following sub-elements are discussed in depth:

1. The effects of agricultural reforms and the resulting response in maize output, as well as the effect on agricultural markets in both Kenya and Zambia.
2. The study elaborates how maize output responded to policy and non-policy variables during the post-reform period. In effect, the study assesses how maize producers and consumers gained from the structural market changes.
3. The subsequent role of policy changes and a comparative analysis of how policies may be deemed responsible in maize output in Kenya and Zambia.

[5] *The definition of food security is a flexible one, but mainly based on the supply, demand and income dimensions.*

The hypothesis in this study suggests that agricultural market reforms deeply influenced maize output, including the supply of other commonly consumed cereals. As a result there was a decline in available maize for consumption. The hypothesis claims further that agricultural sector reforms reduced access to the necessary inputs (mainly fertilizer and hybrid seeds), which in turn constrained total agricultural output. The investigation of the foregoing hypothesis is based on price theory, upon which classical agricultural production is presumed. Price policies are assumed integral in: income distribution, agricultural investment and in the general allocation of farm resources. The optimizing behavior of producers in a market system is an underlying principle in neoclassical production economics.

In investigating this hypothesis, a study of maize, the main cereal consumed in eastern and southern Africa, is presented. The closest maize substitutes are also included in the estimated equations as explanatory variables. The policy interpretation of agricultural market reforms will be inferred from the prices of maize and its substitutes, as well as through input prices. The assumption of structural change in times series estimations is important in drawing conclusions whether maize output, hence available food supply, responded to the agricultural reforms introduced during the 1980s. Maize supply fluctuations are assumed to dictate wide ranging pillars of food security through its effects on stocks and producer incomes. Available supply in markets often influences the final price consumers are willing to pay in markets.

The hypothesis is investigated in the following steps:

1) A theoretical framework of supply equations that represent agricultural production in general is introduced. The framework mainly considers cereal production (especially maize production) in a developing country setting.

2) The ensuing econometric model elaborates on a dynamic cereal crop supply analysis, which consists of dynamic supply equations, which account for rational expectations.

3) The dynamic estimations consider a structure of the factors affecting total output. These estimations also take into account important factors which affect total output of cereals; inputs, acreage, policies, and weather conditions. Analysis of the foregoing factors and their subsequent roles in the production process will be useful in interpreting the econometric model.

4) An econometric model is introduced and applied to data sets from Kenya and Zambia to evaluate how the effect of selected explanatory variables influence maize output. The interpretation of the parameter estimates is crucial in drawing policy inferences. The supply trends are analyzed in relation to output and input within the agricultural sector.

The stated methodological approach provides a logical investigation of the effects on food security of agricultural market liberalization. This approach validates an investigation of the introduction of agricultural reforms and their influence on the agricultural sector, in particular maize production. Agricultural production, marketing and distribution of major cereals were a target of institutional reforms because they remained pivotal in influencing the agricultural sector mainly through policy instruments such as prices and direct agricultural policies.

This study investigates how those changes affected the supply of maize, as well as other main food crops. Specific country experiences are considered with regard to the agricultural supply of the main staple food crops. Maize production has expanded to become one of the most important food crops for both urban and rural consumers in most of eastern and southern Africa. Its consumption in the region can be compared to the importance of rice and wheat in Asia (Byerlee & Eicher, 1997). The crop's yield potential and ease of processing and marketing is of significant value for urban and rural consumers. Recent progress in production systems; processing and marketing, maize has gained influence as the main food crop in Africa.

This study contributes to tackling a crucial aspect of food insecurity at a national level. There are insufficient studies that provide policy makers with insight into the effects of market reforms. Literature on market liberalization groups sub-Saharan African countries, or developing countries, into a single category (Dawson, 2005; Edwards, 1993; Ghai & Smith, 1987; Jenkins, 2001; Litchfield, 2003). However, the different political, economic, and social environments potentially influence policy developments. Each country applies policies according to prevailing economic, social and political conditions. Studying countries in a group only produces outcomes that are inadequate due to lack of comprehensive individual country analysis. Often, successful policy recommendations are a product of a comprehensive evaluation of the issue under consideration. In a diverse economy, a thorough assessment of the economic environment is integral to successful policy adoption.

This research is organized as follows: Chapter 2 provides the agricultural background in Kenya and Zambia, including a general analysis of their overall economies. This includes the major characteristics of food supply dynamics prevalent before and after the introduction of agricultural and economic reforms. Chapter 3 introduces a review of the literature on the link between agriculture and food security. Further critical review of the role of markets in the food security dynamics in general, and in the countries of the study in particular, is elicited. Food security measurement approaches are also covered and a direct critique of these measurements is made. Finally, major conclusions from the existing literature on agricultural policies, market trends and how both affect food security are drawn. Chapter 4 begins with a theoretical model of agricultural production and markets and proceeds to introduce the link between international and domestic markets, particularly in developing countries. An

extended model of cereal production is introduced, with direct reference to staple food production in Kenya and Zambia. An analysis of the adaptive expectation hypothesis is concurrently presented. Chapter 5 considers the research method, major data collection constraints, and their likely effect on the study results. Chapter 6 and chapter 7 consider the empirical application of a time series econometric model and results, respectively while Chapter 8 provides concluding remarks.

# 2. Country Profiles

## 2.1 Zambia: Country background

At the time of its independence in 1964, Zambia enjoyed relatively high standards of living, with a per capita gross national product (GNP) of $500. The annual rate of inflation was then only 5 percent per annum. The country had a low incidence of malnutrition, hunger or health-related challenges (Muyatwa, 2001). The level of prosperity was mainly derived from copper; the country's major export commodity and the source of government revenue. After 1960, in the years 1961-1963, the GDP started to decline. Between 1965 and 1970, real GDP grew by 83 percent per year, or at 8.2 percent per capita. The average per capita GDP grew to $424 in 1970, compared to $176 in 1964 (GZ, 1969). Nearly half of all the growth was due to favorable terms of trade supported by the high copper prices prevailing in world markets. During the subsequent years in which the copper economy began crumbling, this economic prosperity could not be sustained. The 1970s witnessed declining real employment, rising inflation, and gradual impoverishment. Inflation also grew close to 200 percent between 1992 and 1994 (see **Figure 2**).

In Zambia, the state-owned buyer of domestic food crops, the National Maize Board (NAMBOARD), undermined producer benefits from higher farm gate prices. This was reflected in the stagnation of maize production and performance at below its potential level (Young & Loxley, 1990). Physical infrastructural limitations undermined the local trading system, hindering cereal distribution from surplus to deficit areas. These infrastructural barriers raised marketing costs and hindered distribution of cereals beyond the producing areas. However, conventional marketing practice would suggest that reduced transaction costs permit domestic trade and contribute to growth in the export sector, representing diversification away from the narrow range of primary commodities (Morrissey & Filatotchev, 2000). Policies favored those sectors which contributed the most to the economy and excluded agriculture, thereby weakening it over the years and contributing to an insufficient supply of agricultural commodities.

Two striking factors make Zambia's food production and consumption challenges unique when compared to other economies in the SSA region. First, the economy's heavy dependence on copper as the main commodity for government revenue rendered the country more vulnerable to external shocks and fluctuations. Secondly, large numbers of people reside in urban areas, more than any other country in the region. At the turn of the century, urban dwellers made up about 50 percent of the country's population (Muyatwa, 2001). The main attraction for rural-urban migration was the demand for labor in the mining towns, particularly in the Copper Belt region. This demographic imbalance augured negatively for agricultural production by creating dependence on food imports as the main source of meeting domestic demand, particularly for urban dwellers. The sudden decline in copper foreign exchange earnings beginning in the 1970s undermined a sustained food import strategy. Domestic agricultural production capacity could not fill the import dependence gap created by the sharp fall in foreign exchange earnings. In addition to the fall in food import potential, there was a surge in urban unemployment, due to mine closures. Existing agricultural potential does not imply a one-way causality between agricultural supply and food security; rather, it emphasizes the importance of agriculture in meeting the basic food needs of rural households.

In agricultural markets, small-scale and large-scale producers did not respond as expected to market incentives and opportunities, due to the unattractive prices that their production would bring. Their agricultural revenue compared poorly with the rising cost of inputs and consumer goods. Although this was offset for a period by easily available credit, only part of which was recovered, market incentives in the long run were not in favor of producers. Besides economic factors, severe weather conditions during some crop seasons worsened the performance of agricultural producers. In practice, a farmer's welfare is a function of relative price movements and absolute farm level prices (Tomek, 1985). This implies that improving the terms of trade of farm products, that is, an increase in the average prices of farm products relative to the products and services, tends to benefit rural producers. The reverse, unless accompanied by offsetting improvements in productivity, can be a disincentive to producers. Increasing agricultural productivity then is an essential means of raising agricultural sector efficiency, market activity and incomes. The challenges that have beleaguered Zambia's agricultural sector are pegged to precise policy prescriptions. For a long period of time, the sector had been abandoned in favor of the mining industry, whose performance before its decline triggered a drawdown of agricultural labor and declining agricultural investment. The non-agricultural sector then remained an important domestic market for staple food produced by the agricultural sector.

Zambia's GDP growth trend captured in **Figure 1** depicts the dependence on the mineral sector, mainly on copper production, which in turn relied on the international market conditions. The growth trend reflects the volatility of copper prices over a period of many

years. The volatile copper prices combined with high rates of inflation, as depicted in **Figure 3**, rendered the Zambian economy constantly vulnerable to external shocks. The collapse of copper prices in the mid-1970s and a subsequent hostile economic environment pushed policymakers to change course in order to keep the economy afloat. These economic events were subsequently followed by poorly managed government interventions in the economy. The interventions included overvaluing the local currency, the Zambian Kwacha (ZM), trade protectionism, government ownership of the major economic enterprises and complete control over agricultural and food markets (Pletcher, 2000). This was later followed by heavy borrowing from the IMF and from other donor sources in an effort to keep the economy afloat.

Ensuing economic crises precipitated a change in political leadership, most of the changes offering a promise of better national economic management. This characteristic is common in *rentier* states in which governments depend on markets and industries with a political identity, as opposed to mass parties or strong bureaucracies. Zambia's *rentier* economy was a stumbling block to the wave of reforms introduced in the country in the early 1980s. Government officials and renters relied on the huge rents obtained through inefficiency, corruption, and an emphasis on consumption, rather than investment. However, the strong economic crisis of the 1980s empowered lending countries to insist on reforms as a condition for additional loans. In some cases, economic implosion led to a natural collapse of rents and rent-seeking activities (Pletcher, 2000).

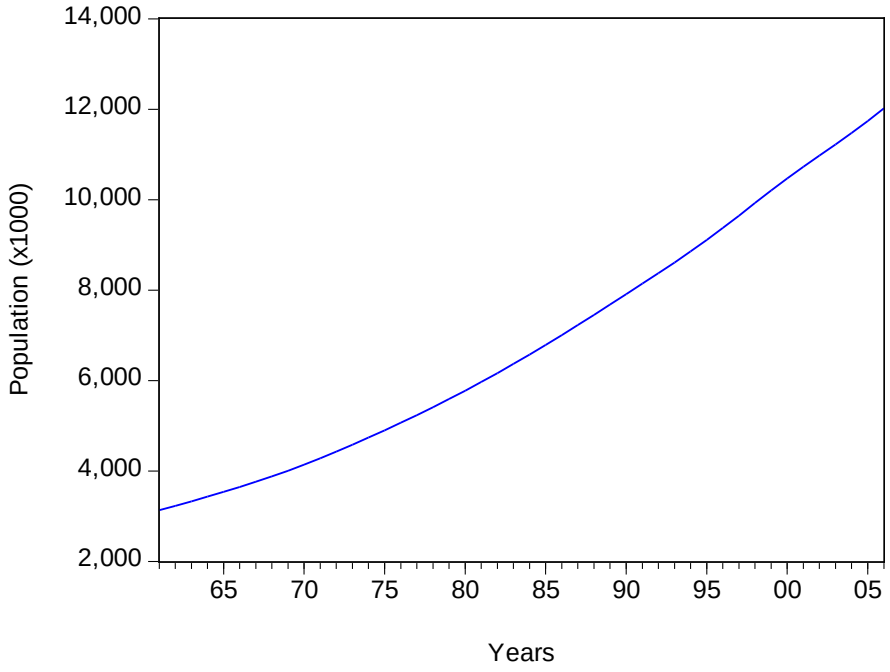


Figure 2. Population growth trend: 1961-2005

At the time it became independent, Zambia had a population slightly over three million people, but that figure trebled after a period of thirty years. This rapid rise in the overall growth rate implied greater demand and increased access to available food, as well as to other resources. As food security is measured over time, continuous study of the dynamic factors affecting it are necessary in ensuring sustainability. For instance, if the rate of population growth rises faster than the rate of agricultural and economic growth, food insecurity is likely to set in.

### 2.1.1 Agricultural economy of Zambia

Maize is the main cereal produced in Zambia, second only in importance in economic value copper, and receives the highest level of government intervention. It accounts for 65 percent of per capita consumption in the country, and its status makes it more valuable than copper both socially and politically (Muyatwa, 2001). It is produced by 80 percent of farmers in large, medium, and small scales in several parts of the country. The main producing areas in Zambia are Lusaka, the Copper Belt, and the Southern and Eastern provinces. Due to its importance, politically and socially, maize remains a privileged cereal in comparison to other crops, which is measured by government interest in its production and marketing. Government production campaigns led to a rise in the country's production capacity. Maize

production rose nearly fourfold from the early 1960s to the late 1980s (Byerlee & Eicher, 1997). The rapid increase in output was commensurate to the amount of support the maize sector received, relative to other crops. In the case of maize, there has been an increase in the development of better maize breeds, which are more resistant and higher yielding per capita.

The exclusion of agriculture from the country's national economic planning during the copper boom was reinforced by the political weakness of the rural regions' influence in lobbying for government investment in agriculture. This trend marginalized most rural farmers and their interests, given their dispersion and lack of organizational mobilization (Pletcher, 1986). The resulting agricultural policy bias contributed to the undervaluation of agricultural output, and diminished the agricultural to non-agricultural terms of trade. The non-agricultural sector, particularly the mining sector, benefited from government intervention during periods of crisis. For instance, in the mid-1970s the price of copper had lost three quarters of its 1960 real value (Wood, 1990). The free fall in its price triggered a surge in government deficits, a sharp drop in foreign currency earnings, as well as severe balance-of-payment difficulties. These macro-economic indicators directly reflected the challenges faced by not only the mining sector, but also in the entire economy.

The poor performance of the economy, and its dependence on a declining export sector eroded sustainable food import potential (Wood, 1990). Financial difficulties threatened to disrupt food imports, bringing the country to the verge of civil unrest and threatening political stability. Ensuing budget deficits drove Zambia to excessive borrowing from the IMF and from the donor community. A cohort of these loans, however, was taken out against the mining industry – an action that weakened the economy. The agricultural sector, upon which domestic food demand depended, suffered as a result of the weak export earnings caused by the downward spiral of copper prices. This fall during the 1970s and 1980s reinvigorated the search for economic diversification from the copper industry. Greater investment in agriculture was one such option given abundant labor and arable land. Most importantly, it could reduce dependence on food imports which was expensive to maintain. The relatively good soil and above average rainfalls in the country are good indicators of the existing potential. The peak of the copper price crisis at the end of the 1970s exerted great pressure on agricultural stability. At the macro level, economic growth began to let up due to a poor business environment. These economic developments contributed to a decline in per capita income by around 5 percent annually, between 1974 and 1985 (Rakner, 1990). In the 1980s, the same macro-economic factors contributed to the country’s defaulting loans and weakened overall effective demand.

Faced with a weak economy that had resulted from a debilitated export sector, the government’s shift to the agricultural sector, particularly in maize production, is evident in the rise in total agricultural output. The table in **Appendix 2** provides quantitative production

levels of the various agricultural commodities. In these figures, the growth in agricultural productivity (measured in average aggregate yields) is generally trended upwards. The expansion in output was driven by an increase in acreage; an indication that the increasing yields resulted from extensive production. Government investment in maize research and the search for better high-yielding seed varieties continued with increased government support. A significant percentage of the government of Zambia's budget outlay went to maize subsidies. The private sector's contribution to maize research, or agricultural research, remained weak, particularly due to the dominance of the public sector. Private sector interest in the agricultural sector was perceived to be profit-seeking. However, in a country such as Zambia where farmers are unable to afford royalties for new varieties of inputs, there would have been little incentive for the private sector to invest in agricultural research.

The tight agricultural market in Zambia set the stage for sharp increases in the prices of food commodities in the 1980s. The background to this commodity trend was established by underlying demand and supply interactions, which put pressure on available resources, leading to short-run price increases. When copper prices were higher and world market demand was stronger, Zambia could afford food imports more easily. A combination of these factors put pressure on global prices, particularly declining production of cereals and other commonly consumed foodstuffs. Most Zambians are small landholders, with an average acreage of around 5 hectares, using fewer external resources and consuming most of their produce. Others have therefore argued that, given this form of production, any market incentives yield little effect on the policy efforts to raise productivity. Much of the government investment in seeds and other newer technologies ended up benefiting a select group of larger scale farmers who were endowed with the potential to acquire and apply the technologies. Smaller scale producers, who represent the majority of agricultural producers, remain disadvantaged overall. However, yield increases among these producers are not uncommon; government promotion and delivery of inputs, mainly seeds and fertilizers, have contributed to an improvement in yields.

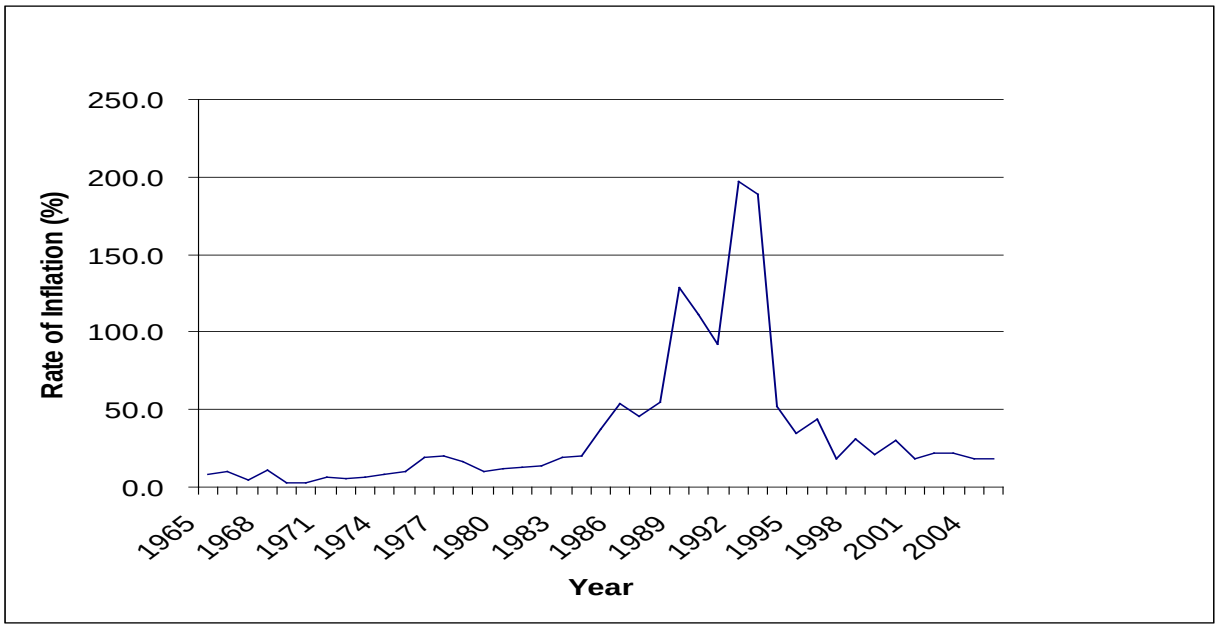


Figure 3. Annual inflation rate (CPI): 1965-2005

**Figure 3** shows trends in the rate of inflation in Zambia during the 1990s. The runaway inflation indicates the extent of the economic decline of the 1990s. Even with their decline towards the end of the 1990s, the rates were high enough to decisively discourage foreign investors and to weaken effective demand. The prolonged peak in the rate of inflation during the 1990s implies a painful transition to a free market economy. The subsequent fall in the rate of inflation shows that the Zambian economy significantly recovered from the structural economic policies that were adopted in the 1990s as a recipe for economic stability.

Following a post-independence decade of robust growth, per capita income started to fall in the mid-1970, with the collapse of copper prices. Slow and low economic growth persisted until the introduction of structural adjustment programs in the 1980s. During this period the growth rates of the GDP was low, and at times negative (see **Figure 1**). Some of the recommended reforms entailed the removal of government support from the agricultural sector, lifting exchange rate controls, and reducing food subsidies. Subsequent, for the most part partial, implementation of these reforms, particularly those affecting the agricultural sector, was met with strong public resistance. The political will to adopt those policies was further weakened, and the opposition, in the case of Zambia, was expressed through urban unrest. Urban residents depended on wage incomes for purchase of maize and maize products in markets, therefore the removal of food price subsidies threatened their survival. The rising inflation rate between 1987 and 1995 eroded consumer purchasing power and pushed many people into abject poverty. Fierce opposition to reforms did not deter the government from initiating radical market-oriented measures in the 1990s as a means of attracting foreign

investment (Rakner, 1990). The aggressive policy path consisted of embarking on a privatization program before it became embroiled in the difficulties related to the privatization of the mining conglomerate, Zambia Consolidated Copper Mines (ZCCM) (Loxley & Young, 1990). Even in the face of these bold macro-economic steps, the country continued to tilt towards economic collapse.

Throughout the 1990s, after the takeover of a new government with a commitment to reform, challenges still abounded in Zambia's agricultural sector. The development of a dynamic agricultural sector through major institutional reforms had not been achieved as was earlier anticipated. The macro-economic problems that beset the country during the late 1970s and 1980s were held in check. However, stringent structural challenges still hindered sustainable economic growth and threatened the attainment of overall food security. Domestic food production (supply), particularly maize and related cereals, continued to fall short of demand. Poor economic growth rates and a weak export sector did not warrant an open check for food imports. Government implementation of recommended policies failed to lead to the intended outcomes due to weak institutional support. These macroeconomic stabilization and market reforms became burdensome because they were not accompanied by a disciplined governing environment.

### 2.1.2 Poverty and food insecurity in Zambia

Zambia is one of the most impoverished and indebted countries in Africa. Evidence from household surveys and poverty assessments conducted during the 1990s show that between 70 percent and 80 percent of the population fell below the national poverty line (GRZ, 2001; World Bank, 2008). In terms of income distribution, Zambia is one of the most unequal countries - the Gini index in 1996 was 50.8, a high value by international standards (World Bank, 2008). This reflects a society in which the top 10 percent of the population receives over half of the per capita income, while the bottom 10 percent receives only 0.5 percent (GRZ, 2001). These poverty indicators suggest an economic environment that is conducive to widespread poverty and a hindrance to the fight against food insecurity.

Zambia's economic development programs have been financed through bi-lateral and multi-lateral support. The weak internal growth-generating potential constrains a growth rate capable of decelerating poverty and a bloating external debt. The regressive nature of inflation shown in **Figure 3** is a macroeconomic indicator which, between 1991 and 1994, depressed demand and pushed many households deeper into poverty. For the agricultural sector, a substantial rise in the price level also had direct implications on access to essential production inputs, mainly fertilizers. Such an inflationary trend begets adverse effects on access to food, particularly for lower income to poor rural and urban households. Rising

poverty and income inequality make it difficult for the state to redress increasing income disparity. The existence of low or stagnant industrial wages, especially in the non-agricultural sector, while food prices are on the rise, decreases consumer effective demand. Although Cardoso (1992) argues that consumers below the poverty line are unlikely to feel the effects of inflation because of their negligible cash holdings, many urban residents will certainly feel the economic pinch of incessant inflation. Inflation can potentially wipe out the savings of the middle class and lead to a rise in the general level of poverty. That in turn deepens the income inequality, increases poverty, and leads to economic collapse if left unchecked.

The upsurge in grass root development support schemes (mainly on rural communities) that the World Bank introduced and supervised in the 1980s and 1990s, in the agricultural sector, were intended to improve the economic bargaining power of the weak agricultural economies of poor countries vis-à-vis developed country trading partners. The world economic recession, which intensified in the 1980s, eroded any existing economic gains. The debt-crisis that followed exposed the vulnerability of the agricultural sector and that of rural livelihoods. In the 1980s the World Bank and the donor aid community coordinated a development aid package directed at the agricultural sector in rural communities, mainly supporting maize production. The World Bank coordination was aimed at ensuring the consistency between the donor aid policies and programs and the recipient nation's overall and sector development objectives. In response to the growing pressures and opportunities, the World Bank underwent a major change of outlook and assumed a greater role, due to its changing economic development paradigm. In Zambia, the role of the state still remained large, even with the intervention of the World Bank and the donor community. The differing views between the donor community and the recipient governments failed to reach a compromise around donor implementation demands.

Agricultural policies are important in the development of the Zambia's agricultural economy, particularly in the maize sub-sector. As a predominantly rural economy, but with a declining urban population and sustained growth in the dominance of the agricultural sector in the GDP as well as in the share of total labor force, policies have the potential to influence agricultural productivity and spur employment. With regard to agricultural employment, net immigration in the 1990s reversed from rural-urban to urban-rural in 2000 (World Bank, 2008). The changing demographics are indicative of the dearth of employment opportunities in towns and cities and the stagnation of the, largely urban, copper mining industry, triggered by declining copper revenue. Statistics indicate that the percentage of the rural population is 65 percent of the total population (World Bank, 2008). The surge in the proportion of the rural population implies either an increase in agricultural activity, or exerting pressure on existing resources. The increase in agricultural value added from around 13 percent in 1987 to around 20.7 percent between 2003 and 2005 may be explained by the urban-rural migration. However, a lasting contribution of agriculture to the food supply requires medium-term

programs that raise the incomes of the poor, as well as maintaining other safety nets, including food aid, to protect the chronic and transitory poor (World Bank, 2008).

The loans obtained by the Zambian government from the World Bank have consistently been contingent upon fiscal and monetary discipline and have wider macroeconomic ramifications. The austerity measures introduced by the International Monetary Fund and World Bank as stabilization instruments during the structural adjustment era, spurred a reduction in real incomes and triggered short-run unemployment. The implementation of these measures stirred discontent among policy makers and the public; they were deemed too harsh and unsuitable to enhancing development. Drastic government spending cuts and the raising of taxes are among the most unpopular tools often utilized. The World Bank sought to influence the investment environment and to deepen markets by discouraging the state from market micro-management. The recognition of the role of the private sector, in cooperation with the government, was construed to be crucial in forging more beneficial market liberalization.

Agricultural policies after the end of the copper boom period were characterized by widespread government control. Two highly visible measures were: First, the expansion of price controls to cover basic consumer goods, in addition to staple crops (Commander, 1998). Government control also covered certain production inputs such as fertilizer and fuel. Policies during this period can be said to have been steered towards protecting consumption levels, while sacrificing investment. Over the period of 1975-1980, investment declined by 11 percent. In light of this policy approach, export diversification was promoted by the government as a formal agenda and the government embraced the agricultural sector because of the availability of land conducive to agricultural production. As a land-locked country, labor-intensive manufacturing for export would not be attractive (Commander, 1998). Maize growing was an activity in which the government began to heavily subsidize in order to encourage production.

## 2.2 Kenya: Country background

Kenya's economy grew rapidly during the 1960s and 1970s with a growth rate approaching 4 percent annually (Mwega & Nyangito, 2005). In later years, after the 1980s, severe structural constraints prevented the economy from attaining earlier levels of growth (Mwega & Nyangito, 2005). The slow growth was largely attributed to a global recession in the 1980s, which was further worsened by a surge in oil prices during the same period. Reliance on cheaply priced raw commodity exports as a source of foreign exchange resulted in slowing economic growth and weak foreign exchange earnings. The economy failed to diversify to other sources of economic growth such as light industries as an alternative to sustainable economic expansion.

With regard to maize in the economy and in its contribution to food security, Kenya witnessed a remarkable surge in the role of maize as the most important cereal. The maize crop, which was well suited to a variety of weather conditions in the country, quickly became a dominant crop. The initial spread and importance of maize in the economy may be attributed to several factors. First, maize yielded higher returns than indigenous cereals, such as sorghum and millet, and it was easier to process and to market, particularly as an export crop. The emergence of a state-directed marketing enterprise system was in response to the rise in value and importance of the maize cereal. Maize cultivation among large-scale and smallholder cultivation quickly spread. The role of the state in sealing the resourcefulness of maize in Kenya was solidified by its investment in maize hybrid seed research. Radical transformation in cereal production followed suite, a major element of which was the introduction of different maize hybrids. These production techniques continued to improve since their inception during the colonial period. Successive hybrid combinations, widespread even among smallholders, contributed to a yield revolution.

The deregulation and privatization of the maize marketing system and privatizing were strongly resisted in Kenya during the reform era of the 1980s (Hubbard, 2003: 148-169). Large-scale maize commercial purchases and sales remained confined to the National Cereals and Produce Board (NCPB), a government corporation with a monopoly share in cereals trading. The NCPB was charged with stabilizing producer and consumer prices by maintaining buffer stocks and increasing those stocks through imports (Hubbard, 2003). Through market intervention, producer prices were fixed within a certain band while consumer prices were also set at favorable levels. It was then a government prerogative to maintain consumer prices at affordable levels. The NCPB was accorded the role of ensuring food security, mostly through the wide-ranging monopoly status in cereals trading. In practice, the parastatal's trading behavior did not allow other private enterprises to trade in maize (Hubbard, 2003). These government efforts did not help in shoring the level of access to cereals by a majority of households. Farmer impoverishment continued despite public efforts to lower real purchasing prices and to improve their general welfare.

### 2.2.1 The role of maize in food security

According to available estimates Kenya's population was around 30 million in the year 2000. Given the size of its population, agricultural production remains an important sector in the economy of Kenya. Overall, agriculture provides at least 24 percent of GDP and over 75 percent of total direct employment (UNDP, 2005). Of this contribution, the maize sub-sector is important within agriculture and it is widely consumed by a majority of rural and urban households. Its production can be divided between large-scale and small-scale production and has rapidly become a major cash and staple crop. In the last few years, both large-scale and

small-scale producers have adopted a higher quantity of hybrid seeds, and year-to-year output changes were uncommon.

Agricultural land area in Kenya is classified broadly into three categories: high, medium, and low potential, based mainly on the amount of received rainfall. The high potential area receives an annual average rainfall of 857mm or more and covers about 13 percent of the total land area. The medium potential areas receive an annual average rainfall of 735mm to 857mm and cover about 7 percent of the total land area. The low potential areas receive an annual average rainfall of 612mm or less and cover roughly 80 percent of the total land area. Within these different land classifications, agriculture takes place in the higher potential areas and serves as the main source of employment and foreign income for the country as a whole. Maize production is common in the medium to high potential areas, and overall national output tends to follow annual rainfall patterns.

Agricultural policies have revolved around increasing overall agricultural productivity and income growth among the bottom poor who rely on agriculture. However, the production of maize and other crops has experienced declining returns during some years due to harsh weather conditions, or insufficient rains during the growth season. Production trends have been exacerbated by periodic droughts, floods and diseases that contribute to the need for emergency food supplies. Current statistics suggest that the number of people affected by chronic food insecurity - based on dietary energy supply - exceeds 10 million, with a majority of the affected population residing in the well-endowed parts of the country (GoK, 2007). The maize sub-sector is an important stakeholder in the fortification of domestic food supply and in strengthening other food security entitlements. However, several constraints hamper the attainment of its capacity production level. A wide range of physical and bio-physical factors continue to deter the realization of the sector's potential:

i. Poor soil fertility and over-cultivation exhausts the soil nutrients;
ii. Inappropriate legal and regulatory framework impede agricultural productivity growth and the development of agro-industries;
iii. Unaffordable fertilizer farm-gate prices due to high transportation costs, brought about by other factors, such as high energy costs. Rising energy costs translate to higher fertilizer production costs, as well as transportation costs during delivery to final consumers;
iv. In Kenya, droughts have become more prolonged, more regular, and have contributed to the loss of forest cover in many parts of East Africa.

The government has a national food and nutrition policy that exists only in theory, lacking effective practical application. The weak regulation of institutions impedes the meaningful implementation of policies that support food and nutrition security. Government expenditure

has continued to rise, often leading to recurring fiscal deficits. The development of comprehensive food and nutrition security policies depends on the performance of the agricultural sector.

The role of the national food and nutrition policy is to provide an over-arching policy framework that covers all of the dimensions of food and nutrition security. Such a framework is also meant to address the link between food security and poverty reduction. Rising levels of poverty in Kenya have resulted in extensive food security ramifications nationwide. A majority of the poor, who reside in rural areas, rely on agriculture for their basic needs and livelihood. Often declining per capita agricultural production is the most likely cause of poverty among this portion of the population. The urban poor are also another segment of the population who are constantly vulnerable, particularly given the rising cost of living.

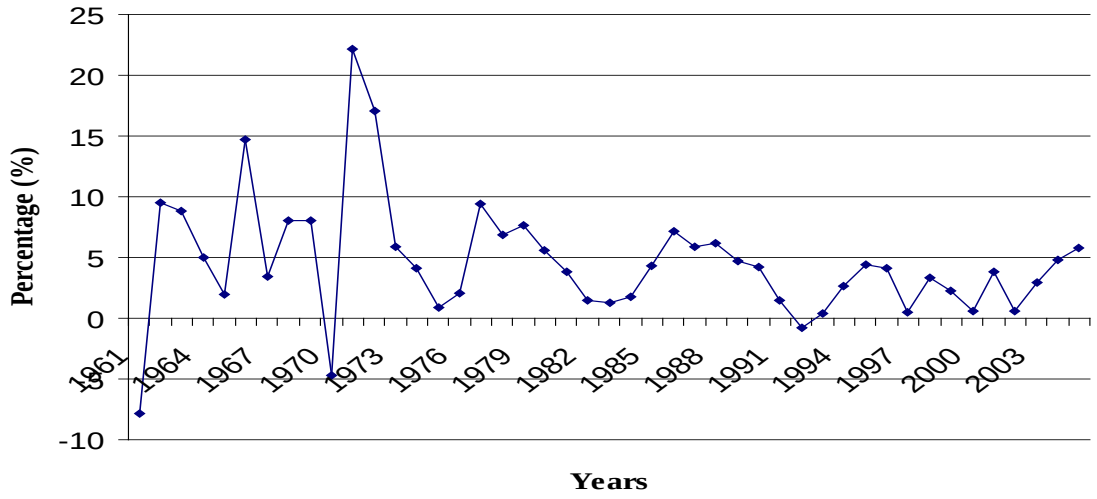


Figure 4. Kenya's annual GDP growth rate: 1961-2005

The history of Kenya's economic policy can be divided into two phases. The first phase represents policies that support government control and participation in foreign exchange, investment, and production, during the years of 1963 through 1980. The second phase covers the era of reduced government influence in markets, and the rise in the role of private individuals and market forces in agricultural production and investment - mostly during the 1980s and after (Mwega & Nyangito, 2005). During the second phase, markets began to gradually assume an expansive role in economic interactions. Even if markets were far from complete, their surge was in stark contrast to the deliberative economy of the 1960s and 1970s.

The implementation of structural adjustment policies and the promotion of agricultural markets did not begin until the mid-1980s. The key trade policy component of reform

programs was the liberalization of international trade through exchange rate reforms, the reduction or removal of cross-border taxes, the curbing of government intervention in trade, and the creation of legal safeguards permitting the free flow of commodities, both internally and externally. The removal of interlocking government arrangements in agricultural commodity markets was an important pre-condition for the increase market mechanisms. The deregulation of prices and other import controls was economically important in that it allowed the interaction of supply and demand for both inputs and outputs. In that regard, the non-agricultural sector was no exception to such liberalization. However, the weight of agriculture in the economy, ranging from between 20 percent to 40 percent of the overall aggregate GDP, made the influence of markets crucial in sustainable economic growth.

Agricultural production in Kenya can be divided into large and small-scale farming. Small-scale farming, in terms of real agricultural output, represents about 70 percent of aggregate production, while large-scale farms, estates, represent the rest (GoK, 2007). Small to medium-sized farms produce a variety of crops and are always located in rural areas deficient in physical infrastructure, with limited access to financial services, and an inexistent extension service system. Large scale producers, however, often have access to technology, whose adoption permits the enjoyment of scale economies in production. This genre of farmers exhibits some degree of versatility to market changes, particularly export markets. They also enjoy a range of privileges to which their small scale counterparts have difficulty gaining access. Financial institutions were more willing to extend loans or other financial services to large-scale farmers than to small-scale ones. However, in Kenya, they only represent about 30 percent of the total agricultural output.

The interaction between prevailing production trends and a rise in population implies an increase in food demand. Clear government policy favoring sufficient food supply is one way to promote the development of agriculture, through raising output commensurate with the demand for food. A rapidly rising population exerts pressure on available resources, particularly on cereals, which are important for consumption. **Figure 5** below depicts the trend in Kenya's population growth between 1950 and 2004. The charting of this trend makes it evident that the population growth has continued to rise. Other statistics also suggest that the population growth rate has not been matched with similar or higher food production growth rates. In practice, sustaining such a rapid rate of population growth requires considerable amounts of food resources from domestic, as well as external sources. However, viewed differently, a rising population growth rate can be economically beneficial through its contribution to the labor force of agriculture and other industries. In Kenya, unskilled labor is an important component of the small-scale production, which characterizes the majority of agricultural production. However, an unsustainable rise in the population exerts undue pressure on existing resources, particularly food resources needed to meet the rising demand.

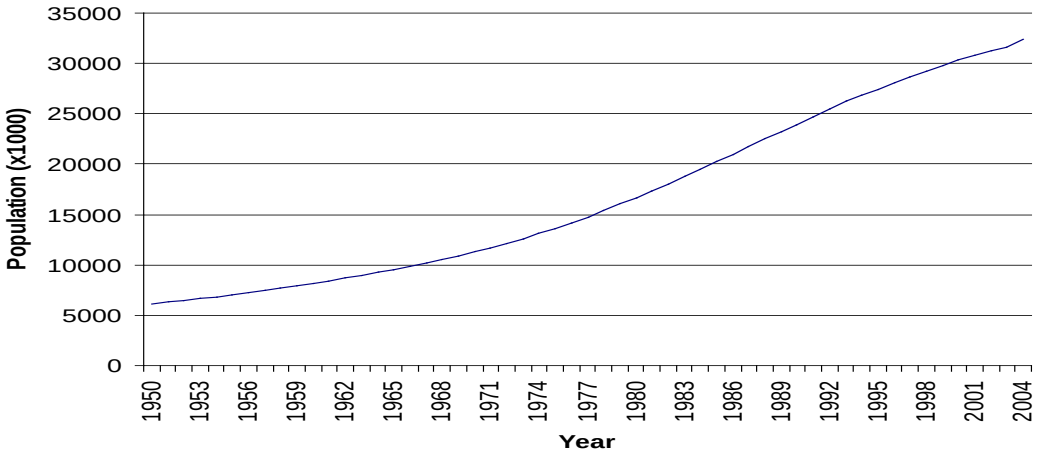


Figure 5. Kenyan population growth trend: 1950-2004

The transformation of global markets has changed the agricultural supply chain and resulted in a surge in non-traditional agricultural exports (GoK, 2007). This trend is characterized by a rise in horticultural production, particularly flowers and vegetables. These commodities have contributed to improving the country's balance of payments by increasing total export earnings and reducing revenue fluctuations which have characterized traditional agricultural commodities. The consistent rise in the demand of these newer commodities, in destination markets, has been a driving force in motivating some producers to opt out of the traditional exports. In Kenya, revenue earnings from the non-traditional crops have continued to rise (GOK, 2007). The rise in the production of high value horticultural commodities in Kenya is driven by the demand from destination markets, mainly in Western Europe. Marketed horticultural product value increased from Ksh 38,838.1 million in 2005 to Ksh 43,120.8 million in 2006 (GOK, 2007). The globalization of markets has fanned the changing supply and demand trends in the producing and receiving countries for these products. These flourishing niche markets are potentially important per-capita income multiplier components of agriculture. However, their effects on income are difficult to measure, due to the small size of the horticultural sub-sector and its uneven distribution in the economy. The economic contribution of the horticultural sector is not evenly distributed in the economy, as the economically vulnerable and the poor agricultural producers lack the means to enter into these niche markets.

Table 1. Marketed production of cereals at current prices: 2002-2006

| **Cereals** | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| **Maize** | 4,451.4 | 3,336.5 | 6,880.5 | 6,342.4 | 7,170.2 |
| **Wheat** | 987.5 | 1,375.3 | 1,864.0 | 2,232.3 | 2,073.4 |
| **Others** | 959.4 | 964.5 | 2,055.3 | 3,329.5 | 3,843.2 |
| **Total** | 6,398.3 | 5,676.3 | 10,799.8 | 11,904.2 | 13,086.7 |

Source: Government of Kenya (GoK)

The quantity of harvested supply continues to steadily rise following rather favorable weather conditions. This trend contributes to a rise in the average marketed value. This trend does not clearly provide any indication of average consumption; rather, it provides the average value of maize compared to other cereals.

The overall cash value of marketed production at current prices is clearly on the rise. The increase is arguably due to growth in the prices of the individual cereals as well as the quantity of marketed cereals. However, in terms of cash value, horticultural products show a much faster rise.

Table 2. Marketed volume of horticultural products: 2002-2006

| **Commodities** | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| **Cut flowers** | 14,791.0 | 16,496 | 18,720.0 | 22,896.8 | 23,560.6 |
| **Vegetables** | 10,470.0 | 10,591.0 | 12,891.4 | 13,891.4 | 17,822.9 |
| **Fruits** | 1,461.0 | 1,753.0 | 1,803.0 | 2,049.9 | 1,737.3 |
| **Total** | 26,722.0 | 28,840.0 | 32,591.0 | 38,838.1 | 43,120.8 |

Source: Government of Kenya (GoK)

**Table 2** depicts the volume of marketed horticultural products in Kenya. It is evident that there is a marked increase in the volume of horticultural products in the country. This trend, however, does not give any indication of who gains from this increasing volume. It can be inferred from the statistics that the demand for these products is certainly expanding in destination markets due to a flourishing supply chain network.

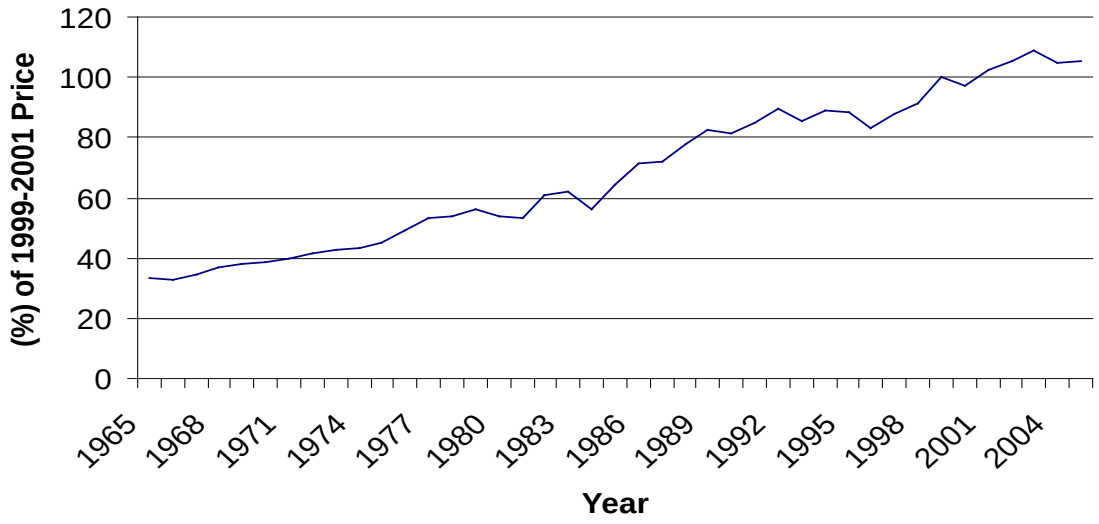


Figure 6. Kenya's Food Production Index: 1965-2005

The food production index in **Figure 6** depicts a rising trend in food production on aggregate, but it is not necessarily indicative of the overall access to food supply in country. One of the explanations for persistent food insecurity, in spite of the trend in **Figure 6,** is that a portion of the domestically produced food is exported to external markets. Alternatively, the level of demand supersedes the supply of food produced domestically. The rate of population growth has continued to grow much faster than the growth of food production. In **Figure 5** illustrates how the population growth in real numbers increases much more dramatically after the 1970s, and suggests that the pressure to meet the demand for food and other resources rises sharply.

### 2.2.2 The collapse of government supported marketing activities

State marketing institutions formed an essential part of agricultural production and distribution in Kenya, including the procurement and delivery of inputs. State participation in agricultural marketing characterized the pre-reform era during which public institutions functioned at the behest of state directives. The management of these public enterprises was unsustainable as their operations hemorrhaged the state treasury; a large portion of the state budget was dedicated in keeping them running. Continued state financing became increasingly unprofitable and unsustainable in the long run. In the 1980s, the pre-condition of

a reduction in government expenditure required by the World Bank and the donor community before providing aid, implied drastic cuts in budgeted support for all public corporations. These publicly financed enterprises had recorded a varied amount of recurring large losses, some of which were due to poor management and corruption. Consumer and producer-guaranteed markets had become too costly to maintain.

The participation of public enterprise in the cereals trade had led to investments in storage and in other forms of simple infrastructure in order to make possible the collection of targeted commodities, particularly cereals. The construction of cereal depots was necessary in the collection of agricultural output in specific regions of the country where surplus production for the market was warranted. However, little investment was made in the transportation sector, critical to timely market access. The extent of infrastructural investment undertaken in the transportation sector was limited to the facilitation of commodity collection. Once the state withdrew its support, as part of the institutional restructuring, the private sector attempted to take over input and output marketing operations. While a gap still remained in marketing expansion, domestic maize production and trade continued to rise towards the end of the 1980s, except during periods of prolonged drought spells when productions declined (Hubbard, 2003). In subsequent years, maize export tendering was introduced in response to donor pressure. For the NCPB, this implied a move away from its exclusive monopoly of the export of cereals.

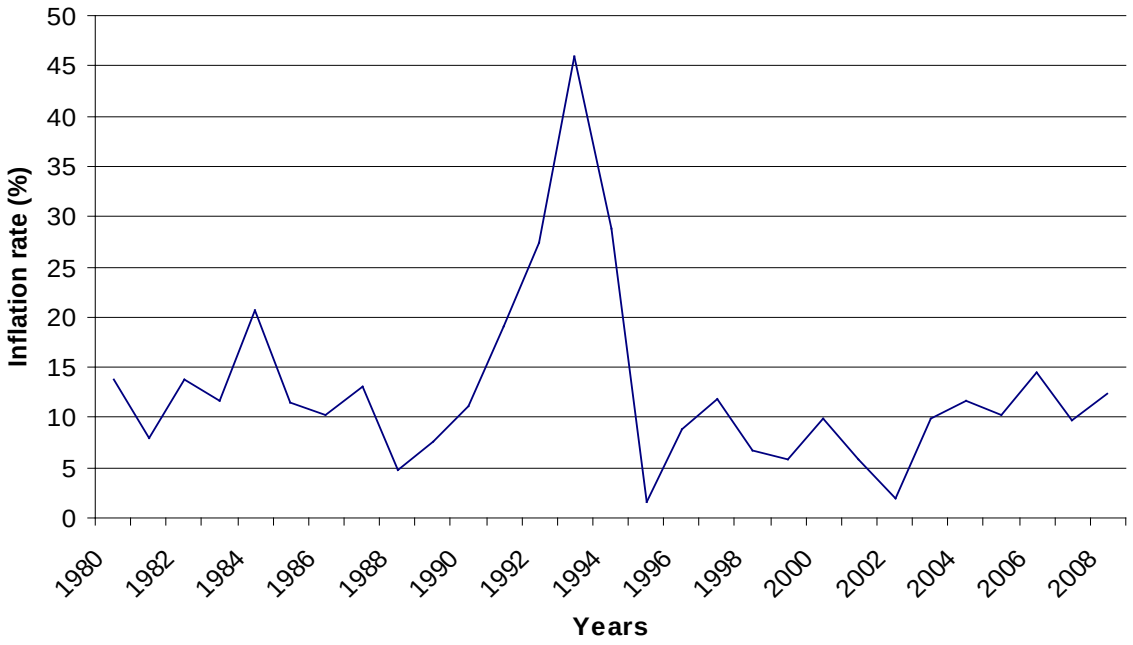


Figure 7. Annual inflation rate: 1991-2005

The collapse of the economy was also accompanied by the weakening of the macro-economy. **Figure 7** provides the rate of inflation, a major macro-economic indicator, which can give an indication of the stability of the economy. While the rate of inflation was rather low compared to that of Zambia, it was nonetheless high enough to affect economic activity and savings in the country. The trend in the rate of inflation is also reflective of the economy's response to structural changes.

### 2.2.3 Factors determining agricultural growth and food security in Kenya

As an agricultural economy, Kenya's food security draws mostly from the agricultural sector through staple food production. The non-agricultural sector also contributes immensely to the state of food security through incomes, but mostly for urban dwelling households. This group of consumers derives its food from earned incomes. Rural dwellers in Kenya consume food obtained directly from their own farms and sell the surplus in markets. Markets are important clearing centers for agricultural commodities and facilitate exchange between producers. Incomes and other in-kind livelihood entitlements represent the consumption items typically not included in market value calculations. Nevertheless, agricultural production in the rural sector is dependent on other important variables pertinent to the agricultural sector in general. For example, access to available labor is an essential factor in the agricultural sector. However, other variables beyond access to a large labor pool are pivotal in determining productivity. The availability of arable land is one of the most important factors that determine the level of output, besides the abundantly available labor.

The main requirements for tropical agricultural production are generally good soils and favorable natural conditions, such as regular rains and well-balanced temperatures throughout the year. These combined factors affect commodity yields, but they do not in themselves guarantee higher yields. An additional factor influential in overall agricultural performance is the implementation of a variety of inputs in production and marketing services. The use of adaptive technologies in the production of high yielding crops is particularly applicable in large-scale agricultural production, but remains unexploited in agricultural production in Kenya. The introduction and use of inexpensive sprinkler pumps is crucial in small-scale irrigation particularly in the arid and semi-arid lands (ASAL), where soils are not conducive to agriculture (FAO, 1997). Rainfall is extremely scarce during most of the year in some regions of Kenya; therefore irrigation technologies would be suitable land reclamation tools. Well-managed land reclamation programs can be an important source for the expansion of the land area conducive to agricultural production.

Erratic natural conditions constitute a vulnerable aspect of the agricultural sector in Kenya. The occurrence of droughts, famines, and floods potentially reverses any agricultural

production gains by ruining existing commodity stocks, particularly the most essential cereals. A lack of adaptive capacity in response to changes in conventional variables is a common tendency in the arid portions of Kenya (FAO, 1997). The adoption of irrigation-related technological equipments in agriculture is substitutable to rain-fed agricultural production. Irrigation reclaims arid regions by expanding sustainable economic activities besides agriculture. The rearing of livestock in the arid regions of Kenya is a traditionally favorable economic activity that anchors the food security of these regions. Making water available through irrigation activities and the procurement of boreholes in search of water both represent a crucial lifeline for this activity. Known technologies used in mechanized agricultural production can be important in yield improvement and in broadening the producer income base. The dissemination of these technologies often contributes to positive agricultural pay-offs by increasing agricultural productivity. However, massive state or private-sector intervention and investment in the procurement of the necessary capital for making available the technology can also be a necessary facilitator. In many cases, agricultural extension and research have previously been provided by the state, although the private-sector can be an important partner in service delivery.

## 2.3 Agriculture, the economy, and food security in Kenya and Zambia

Kenya and Zambia exhibit some similarities in their economies, agricultural sectors, and food security regimes. Except for recent signs of recovery in Zambia's economy, its rate of economic expansion was relatively slow during the 1980s and 1990s, and macro-economic challenges, such as high inflation, unemployment and weak investment, persisted during the same period. Kenya’s food supply and food security challenges persisted during the reference period. In spite of moderate growth in overall production, a gap between supply and demand in accessing the main cereals was common. The pace of maize liberalization was slow and there was widespread institutional failure. The portion of prices received by maize farmers was significantly low; often undercut by the middlemen institutions such as the NCPB. Among the macroeconomic challenges exerting pressure, the rate of inflation was particularly critical. The rate of inflation, which remained high, was made worse by the fixed exchange rates preferred by the governments. In practice, rising inflation rates do not work well with fixed exchange rates. There is a tendency to incur a balance of payments deficit; fixed exchange rates are not sustainable during an inflationary period.

The economic mismanagement of the maize marketing schemes was strikingly similar. The stop-and-go approach for both domestic and external maize trade liberalization attempts provided sufficient room for corrupt government officials, often at the behest of the ruling government, to participate in maize trade with huge financial gains. The institutions which oversaw input and output markets were similar in both Kenya and Zambia. State monopoly of

the procurement of agricultural inputs and outputs impeded full entry of the private sector into the market. As a landlocked country without direct access to its own harbor, Zambia incurred heavy transportation cost and transferred these costs to the final consumer, agricultural producers.

The widespread consumption of maize by a majority of people in both countries makes a comparative analysis of maize supply relevant, particularly due to the fact that it is considered as a proxy for food security. Prior studies on food security have emphasized the weight of maize as a core determinant of food security (Jayne, 1997; Jayne, 1997 & 2002; Seshamani, 1998). While other variables are important indicators of food security in these countries, following the trend of a proxy food security measure provides an important indication of overall access to food. There are other remarkable demographic differences between the two countries which facilitate their respective food security conditions. The portion of the population that resides in urban areas, including small towns, is relatively higher in Zambia than it is in Kenya. The location and activity of the population influences a government's food security planning and strategies in any given period. The presence of a larger concentration of residents in towns and cities, as is the case in Zambia, might imply decreased agricultural activity.

Research and investment aimed at the development of maize hybrid varieties has been ongoing in Zambia since the 1960s, and these varieties were introduced to the smallholder sector during the 1970s (Kumar, 1994). The most common hybrid varieties in Zambia are ZH1, SR11, ZCA, SR52, and SR13. SR52 offers the most yield advantage over local varieties, particularly in its response to fertilizer, and commands 90 percent of the commercial seed market. The remaining 10 percent of the commercial market share is held by ZH1. However, both hybrids are long-duration varieties requiring 170 days to mature, which makes it critical to plant them early in the season.

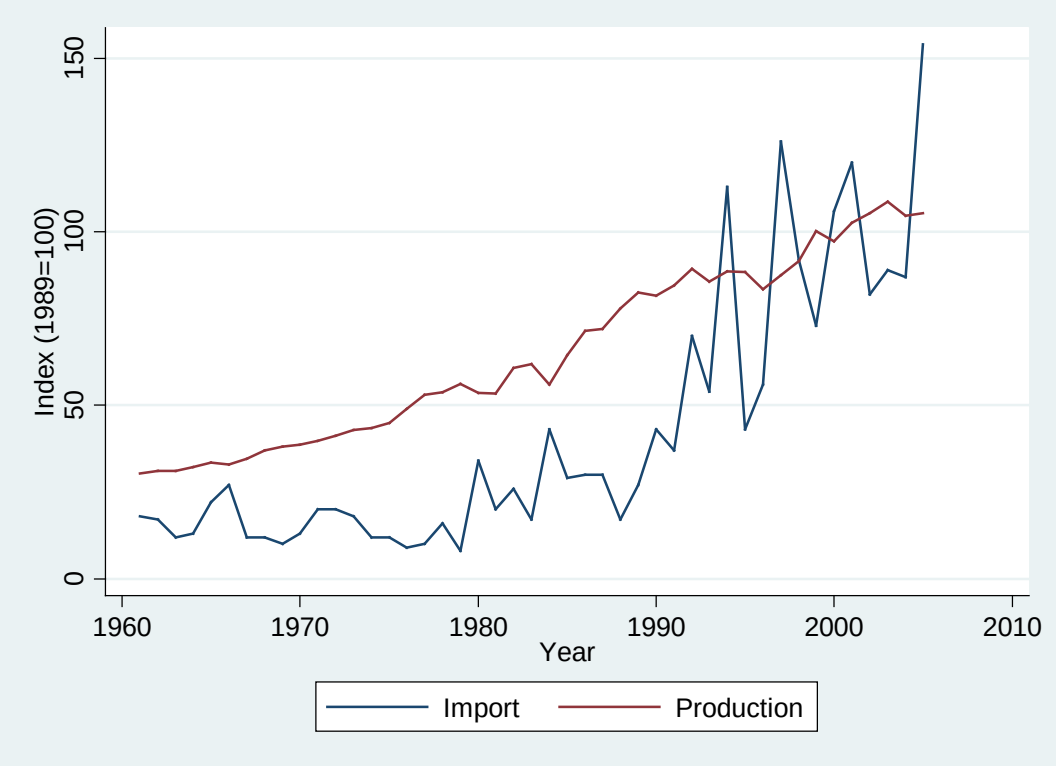


Figure 8. Agricultural production and import indices (Zambia): 1961-2005

It can be concluded from the **Figure 8** that Zambia is not a strong participant in cereals trade based upon it low trade turnover prior to early in the year 2000. It is clear from the maize production figure that the government of Zambia continued to face two policy challenges with regard to maize production. First, there was the need to maintain remunerative prices that would encourage farmers to continue producing enough for the market. Secondly, policy-makers were faced with the task of mitigating maize mealy prices, mainly for urban consumers. Reigning in prices also serves the interests of rural consumers who are net buyers of maize.

The role of cereals must be viewed against the overall trends in food production and consumption of the entire South-Eastern region of Africa. Kenya has moved from being a net exporter of cereals, particularly maize, to being a net importer. The surge in imports has always remained high during the drought seasons. In terms of population density and the proportion of arable land utilized, Kenya has maximized the percentage of cultivated land as a percentage of the estimated potential of arable land (Byerlee & Eicher, 1997). Intensive agricultural production techniques are considered essential in increasing the domestic cereal production and in meeting the domestic cereal demand. Reclaiming arid and semi-arid areas in order to increase production has not achieved any substantial yields. This trend has

remained cheaper than the cost of reclaiming arid land or acquiring the appropriate technology necessary for irrigation or storing water storage during periods of extreme drought.

The demand for cereal imports continues to be steady. In Zambia, the commercial demand for maize, and the resulting political pressure to improve the policy and organizational environment led to the reorganization of the state delivery of maize, an important political weapon for most Zambian administrations. Demonstrating a political interest in the rural and urban poor and their food demands was a valuable means for politicians to remain popular. Demand for maize in the urban areas of Zambia was a major catalyst for the replacement of traditional over-pollinated varieties with improved higher yields. After independence, maize development programs played an important role in solidifying political support, particularly for urban and rural residents who neglected during the colonial period. The government encouraged farmers to grow sufficient output in order to supply urban residents with cheap maize mealy, a form of maize.

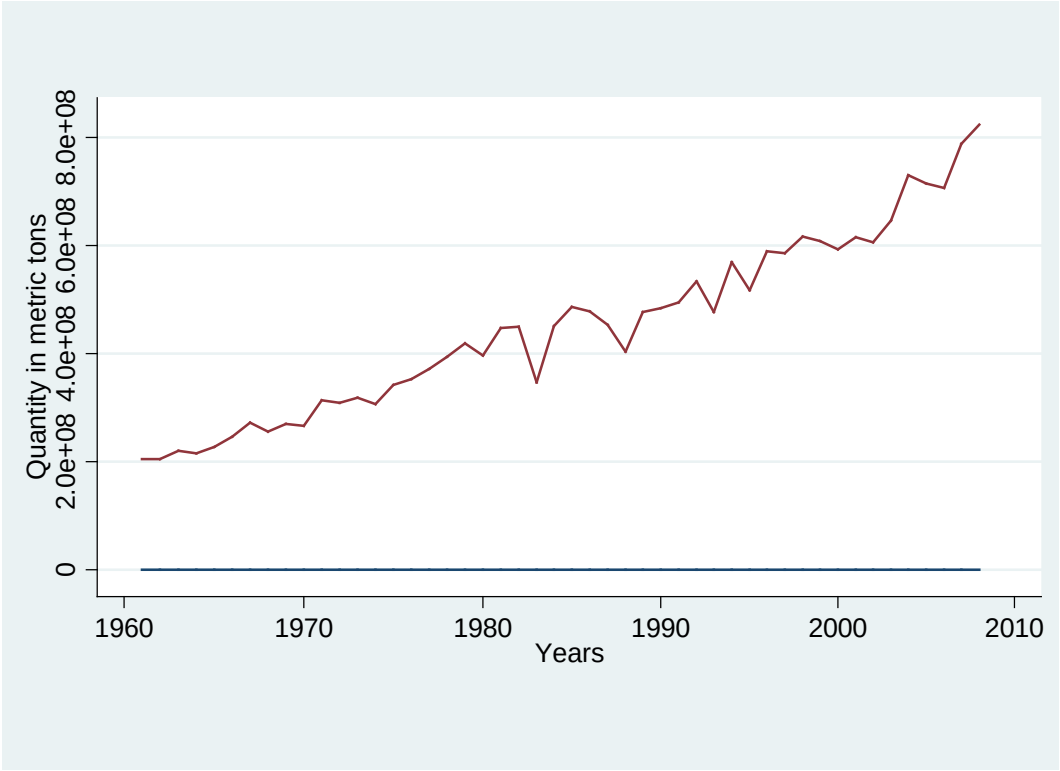


Figure 9. World Maize production: 1961-2008

Aggregate productions trend upwards, indicating that the global supply during the reference period is on the rise. The graph in **Figure 9** summarizes the global trend in maize production.

The rise in global production may not essentially be representative of individual country production trends. Instead, the global food markets, most commonly the demand for animal feed, is a particularly one of the important factors that drive production. These global conditions strongly affect domestic production and domestic prices overall.

# 3. Review and synthesis of the previous literature

## 3.1 Definition and measurement of food security

In this research the concept of food security is defined as access by all people at all times to adequate food to live an active life (World Bank, 1981). Although supply is the defining component within food security, there are other instrumental elements which complement it. Food security encompasses food availability through production, storage or imports as well as the access that people have through their purchasing power in markets (Nyariki & Wiggins, 1997). Markets play a critical role in this definition and it is through such framework that reforms enter maize supply markets. These markets serve as a source of food for consumers who do not rely on their own consumption, but may have the financial means to make purchases.

Food security is a multifaceted concept which has been defined in various ways (FAO, 2003). The most common definitions directly point to food supply based on domestic and global supply conditions. Domestic supply indicators, which are the main focus of this research, consist of availability, access and stability of food supplies during any given period. This study does not address the deeper issues of nutrition and health. Rather, it considers the role of imports in contributing to the total domestic food supply. Trade is an important nexus between the domestic food demand, particularly for cereals, and the world market supply of the commonly consumed agricultural food products, which are primarily cereals. Most countries follow a strategy of self-sufficiency in food supply through purchases from international food markets, and by fortifying domestic consumption when domestic production potential has been exhausted. Net food importing countries are often vulnerable to severe food deficiencies and widespread ill-health.

More conventional approaches to food security analysis and measurement rely on a set of objective measurements: target levels of consumption, such as those recommended by the World Health Organization (WHO). The most commonly used WHO targets are often measured in terms of food energy levels, usually by age range. Even with such measures, access to reliable and nutritionally adequate food supplies offers the most preferred means of overall food security (Maxwell & Slater, 2003). However, these approaches present two

practical problems. First, the concept of nutrition is not easily analyzed due to the variance in the age of the consumers. Individual nutritional requirements are a function of age, health, workload, environment and behavior. Calculating the average calorie intake for average adults and children can be complicated, given the variance in the range of activity patterns for each group. The question that then arises is: How qualified is the individual who makes value judgments for individuals, households or communities as a whole? Secondly, the measurement criteria overshadow the qualitative aspects of food security. Those qualitative issues consist of technical food quality, cultural acceptability and human dignity. In effect, this implies that nutritional adequacy is a necessary, but not sufficient, condition for food security.

In low-income countries, especially in sub-Saharan Africa, a wide range of other indicators explain food security. Improved agricultural production techniques are critical in increasing yields, irrespective of the size of land available for production, due to the declining land size in some countries. Access to modern technology has been suggested as an important contributing factor to overcoming these shortcomings and to reaching adequate yield targets (Maxwell & Slater, 2004). The use of suitable inputs such as fertilizers, hybrid seeds or conventional tractors contributes to the realization of better yields. Commercial, large-scale producers often have easier access to improved inputs and technologies that guarantee greater output. They also possess financial, marketing and extension services which in turn provide greater overall agricultural production and marketing leverage over their small-scale counterparts. An enabling agro-ecological background, changing macro-economic conditions, population growth trends and the performance of the non-agricultural sector are all important factors in facilitating, or obstructing overall yields. The export sectors in Kenya and Zambia typify a non-agricultural export regime that lacks oil and mineral ores exports, particularly in Kenya (Johnston, 1961; Eicher, 1990). Zambia's mineral exports in the 1960s and early 1970s typify this category of countries, but the unfavorable copper market conditions eroded foreign exchange earnings in succeeding years.

### 3.1.1 Literature review on the role of markets in food security

Markets are an essential channel through which surplus agricultural output can be disposed of based on existing supply and demand conditions. The functioning of domestic and international markets is crucial in facilitating exchange and strengthening food security by enabling those with the wherewithal to acquire food and inputs from markets. Efficient interaction between demand and supply of agricultural commodities requires the support of favorable institutional frameworks which ensure distribution. This in turn creates public confidence in the market institution as a clearing centre for a variety of goods and services, and guarantees reciprocal benefits for participating agents. One of the main factors which

support access to food is the ability to produce it or to purchase it locally in markets. The supply of such food is dependent on, among other factors, the producer's ability to use available resources efficiently.

The legislation of policy measures that tackle poverty and fortify food security in developing countries has been well underway. International conventions have provided important forum strategies that coordinate the building blocks that consolidate a common approach to overall human development. The launch of the Millennium Development Goals (MDG)[6] covers a range of concrete components with a direct link to food security, as well as those most likely to improve the sources of livelihood for many of the rural poor and food insecure households in developing countries. The World Food Summit of 1996 convened in response to widespread malnutrition and a growing concern over agriculture's potential to meet future food needs (FAO, 2003). The summit was preceded by the World Food Conference in 1974 which claimed every man's right to food security. The WTO Ministerial Declaration at the Doha Conference, the Doha Development Agenda (DDA), provided a mandate on a wide range of issues related to developing countries within the framework of agricultural trade. While the DDA has not made significant progress in the negotiation, implementation, and development of the issues discussed upon its initiation, there is great emphasis on food security and trade, the gateways to foreign exchange for developing countries. In developing countries, domestic food needs and the shortfall in domestic production, particularly net food importers, are on the government agenda. The adoption of policies which ease food insecurity and alleviate poverty, arguably, can be achieved through greater market access to developed country markets, mainly for agricultural products.

Tackling the food insecurity challenge in developing countries requires a multi-dimensional approach and problem-targeted policies. With regard to Kenya and Zambia, economies with large pockets of poverty in rural and urban regions, domestic agricultural production forms an important source of domestically consumed food. Arable land is available in plenty, particularly in Zambia, and it can be well exploited with greater access to inputs and enabling institutions. Cross-country studies in Sub-Saharan Africa reveal an increase in the number of people without sufficient access to food (Falcon & Naylor, 2005). Falcon & Naylor (2005) assert that the decline in food production and access can be linked to the pace of agricultural and economic development. Other studies suggest that the increased regional trade or

[6] *The launching of the Millennium Development Goals (MDG), a set of objectives adopted by UN members as a renewed commitment to human development, is an important step in the international awareness campaign. These goals are aimed at rallying the international community and providing an accountability mechanism for efforts to enable millions of people trapped in poverty improve their incomes and general livelihoods. These initiatives, while they are aimed at enhancing human development, deal closely with the variables capable of reducing poverty and raising incomes (UNDP, 2005).*

developing markets in general can be an important instrument in alleviating region demand (Weeks & Subasat, 1998; Deaton, 1999).

For some countries, weak non-agricultural exports, such as oil or mineral ores, and reliance on the agricultural sector for exports require favorable international markets with greater market access. Such conditions may then permit overall economic growth driven by agricultural exports, and not the manufacturing sector (Diao et. al, 2007). However, Diao et al. (2007) conclude in their research that land-locked countries face transportation barriers, a condition which undermines both agricultural and industrial export opportunities. In spite of its mineral and agricultural potential, Zambia has no direct ports of its own. The additional costs incurred in importing tend to be transferred to final consumers. Even though Diao et al. (2007) suggest that sometimes GDP per capita rates for coastal and land-locked countries are similar, this only presents an average and it may not be extended to individual countries. A related study also concludes that states where 80 percent of the population resides in rural areas tend to have a higher poverty ratio.

Some studies have analyzed the response of the agricultural sectors of developing countries to market reforms (Chiwele, 1999; Jayne, 1997; Orvis, 1997; Rakner, 2003; Seshamani, 1998). However, such attempts have not adequately considered the multi-faceted nature of the reforms and the many gaps that remain in regards to the political economy considerations within countries. While the common thread among such studies appeals to the lack of data, most of them concur on the importance of a productive agricultural sector in improving food production. Some empirical studies conclude that efficient local infrastructure, and the access to inputs or functional markets contribute significantly to food, cereal, and distribution. This synergy within agricultural production, given an organized and reliable local supply network, reduces production vagaries (Devereux, 2001). For instance, in the Western and Central regions of Kenya, agricultural production is higher than in most other parts of the country, particularly in the arid and semi-arid regions. In such a case, a flourishing infrastructural system would enable easier distribution of maize and other cereals in order to reach those consumers. A full-fledged communication and transportation infrastructure can mitigate transitory supply shortages (Devereux, 2001). Policy interventions enhance market fluidity and are effective in increasing agricultural supply. Effective policies can be an important instrument in supporting production and in making markets competitive by allowing prices to be determined by supply and demand forces. The literature supports the positive correlation between income poverty and food security (Litchfield, 2003; Thomas, 2006). Income poverty is a major deterrent to overall human development and the cause of the creation of a vicious poverty trap. Such a trap may be dependent on structural factors as well as the policies pursued within a given political economy framework.

### 3.1.2 Agricultural market liberalization and food security

The literature on agricultural market liberalization often classifies SSA countries as a collective group, irrespective of their differentiated political, social and economic environments and conditions (Umali-Deininger, 2001; Binswanger & Deininger, 1997; Ghai & Smith, 1987). These generalizations are based on country income groups that do not take into account the diverse politico-economic regimes. Duncan (1998) typifies such characterization by drawing an example from the Southern African Development Community (SADC)[7] member countries. In the SADC region, food security and food production strategies are harmonized into regional development policies represented by the regional block. The SADC policy document supports the view that achieving food security can be attained by reducing the relatively higher levels of poverty and income inequality. Macro-economic policies play a critical role in tackling poverty, and hence lead to an improvement in food security through even and sustainable economic growth. While such an approach may be deemed generally true, its application may have certain limitations given economic growth and development challenges. On a similar score, Duncan (1998) further asserts that trade integration can be beneficial, particularly through the removal of tariff and non-tariff trade barriers. The expansion of product markets can increase agricultural stocks for local and regional consumption by easing agricultural production asymmetry. This may be equated to the market reforms that the World Bank urged developing countries to embrace (Edwards, 1993).

It was generally assumed that agricultural trade liberalization would generate economic benefits that would be of aggregate spill over to the domestic economy. However, questions still remained on how the domestic economy would gain given existing macro-economic challenges, such as inflation, unemployment and ballooning debts in many low-income countries (Smith, 1997; Duncan, 1998). Most SSA economies are rife with the foregoing economic challenges, making economic crises of varying proportions common. The most important ingredients of reforms were the removal of the state's role in economic management. These reforms, both domestic and cross-border, were resisted by governments due to their perceived disruption of the economic status quo. In effect, the realignment of domestic agricultural trade with international market standards was uneven in many SSA countries, given the diversity of economic regimes represented. Smith (1997) cites an example from Malawi with regard to the production of food crops and the acquisition of inputs for production. The removal of the public sector from commercial-type activities was an important step towards liberalizing the agricultural sector in Malawi. However, the role of

[7] *Southern African Development Community is a regional organization in Southern Africa that is comprised of Angola, Botswana, the Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.*

the public sector in food security, through macro-economic stabilization, cannot be entirely ignored. The relationship between politics and agriculture, which differs by country, is a function of the public policy response to pressing issues within the rural sector (van Rooyen, 1998; Sigwele, 1999).

Economic growth and agricultural productivity were the main factors behind the World Bank-supported reforms. The entire donor community defended agricultural reforms due to the predominance of the agricultural sector and the potential benefits from foreign trade (Edwards, 1997). The similarity in the implementation of the economic reforms supports the 'one size fits all' approach favored within the WB and the donor community. Studies from Kenya indicate that the agricultural sector's contribution to the Gross Domestic Product declined between 1980 and 2001 from 32.8 percent to 25.9 percent, respectively (Thomas, 2006). Similar economic shocks were common in other countries, but they failed to correctly identify the direction of effective demand within the economy. Thomas' (2006) study generally attributes subsequent growth in the sector to the expansion of cultivated land, improved technology, and a fairly active extension system. Other uncontrollable economic factors are also responsible for poor agricultural production in Kenya in 1980, 1984, 1994 and 1999 (Hubbard, 2003).

The literature asserts that the idea of liberalized markets, in the World Bank’s point of view, was a default preference presumed to spur economic growth in developing countries, particularly in the agricultural sector. Often, the World Bank has been faulted for demonstrating frequent disparities between its rhetoric and action, particularly concerning food security (Falcon & Naylor, 2005). The World Bank’s reduction of its enormous agricultural funding for developing countries was in contrast to the initial leadership role it assumed during the 1980s. Underinvestment in rural agricultural infrastructure weakened the prosperity of the agricultural sector. The failure to provide production inputs and the timely delivery of outputs to the market contributed to the stagnation of the agricultural sector, thereby curtailing any benefits derived thereof. It is easy to conclude, and as the literature suggests, that food security is deeply embedded in the political economy of agricultural policy and the institutions surrounding its functioning.

## 3.2 Demand and supply considerations in food security

In the 1980s Amartya Sen (1981) caused a stir with his treatise on demand concerns, as opposed to only supply considerations, in overcoming the prevalence of food insecurity in developing countries. Prior to Sen's ideological argument, supply factors were considered the main source of food insecurity in many developing countries. Sen's position stressed the likelihood of food insecurity prevalence amid food availability. Averting such a situation

would require a greater access to entitlements, suggesting that food insecurity could be analyzed through a decline in people's entitlements across the different socio-economic groups. The main theme in his argument was that sufficient incomes, or effective demand, are integral in ensuring food security. Feleke et al. (1984) argue that, on the contrary, that government policies aimed at improving demand-enhancing components of food security may neglect other factors likely to induce the supply side of food security. Feleke et al. (1984) continue to suggest that facilitating policies, such as the influencing of prices in order to shore up demand, may have depressive effects on supply. This indirectly refers to the synergized role of demand and supply considerations in contributing to sufficient food security. The entitlements central to Sen's (1981) thesis can be influenced by public policies; similarly to the supply shifters in Feleke et al. (1984).

Attaining food security is an essential component of the rural livelihood of developing countries, of which Kenya and Zambia are no exception. Given the importance of farming in fulfilling rural food demand, mainstreaming agriculture is a major tool for reducing the restraints of the demand-side entitlements that Sen (1981) discusses. However, it is not the only means of working towards sufficient income security, which empowers households or individuals who have the financial wherewithal to attain effective demand (Ellis, 2000). However, some countries are not endowed with favorable soils which are conducive to food production. This implies that other forms of entitlements that guarantee effective demand are essential in ensuring access to food.

### 3.2.1 Staple food pricing policies

Food pricing policies are crucial for rural and urban consumers due to their influence over effective demand. The relatively low incomes in many developing countries and the food share of those incomes imply that changes in food prices significantly affect income allocations. The role of policies is relevant to both consumer and producer pricing (Byerlee & Sain, 1986). Byerlee & Sain (1986) showed how important policies augur well for consumers and producers alike. Their study investigates the claim of wheat producer price policy discrimination and assesses the impact it wrought on wheat producers in a typical developing country producing wheat. The conclusion drawn from the study supported the stated hypothesis that producer price discrimination enforced by policies potentially slowed down agricultural growth. The findings from that study supported the conclusion that consumer subsidies and trade policies influenced reductions in bread prices for urban consumers – the consumers who are most vulnerable to food insecurity.

A similar study in the sub-field of price policy demonstrated a policy bias against the agricultural sector in several countries, in which an attempt to give a rationale for government

action is made (Peterson, 1979). Peterson (1979) concluded that the government regulation of agricultural sector output, common in developing countries, was enforced in order to guarantee sufficient food reserves for domestic consumption. Agricultural sector regulation was supported for other reasons besides the interest in food security. Firstly, in low-income countries, where the agricultural sector is the main source of savings and income, agriculture is the main source of government revenue. Transferring revenue from the agricultural sector was carried out through price discrimination (Schultz, 1978). Schultz (1978) makes the claim that price discrimination against farmers was responsible for inadequate investment in agriculture and for the increased food imports to developing countries. Byerlee & Sain (1986) find that food subsidies were highest in those countries which were less dependent on agriculture for national incomes and government revenue.

Secondly, producer price incentives are important in formulating agricultural development strategies. Food pricing policy is a crucial government tool for controlling and regulating the agricultural sector. To utilize this policy tool, a government can enforce a price ceiling or a price floor. Price controls were widely applied in the agricultural sector in order to influence the marketing of a variety of agricultural products, particularly cereals (Norton et. al., 2006). However, in their study, Byerlee & Sain (1986) conclude that price discrimination against agricultural food production and the contradiction between producer and consumer interests in price setting policies was less widespread than suggested. Their conclusions are only derived from a study of one cereal; namely, wheat. Other cereals are likely to respond differently depending on their importance in consumption, the number of available substitutes and the prevailing conditions in international markets. However, the general trend of price policy intervention can have similar, but not identical, results with regard to producer or consumer response.

### 3.2.2 Cash crop pricing policies

Agricultural taxation in developing countries generally utilized agriculture as a resource base for strengthening industry. This was not an economically efficient means of resource transfer. Agricultural policy analysis of the impact on agriculture and agricultural incomes suggest that policies represented both 'direct' and 'indirect' taxes. Direct taxes consisted of taxes on exports, subsidies on agricultural imports, and the range of mechanisms used by policy makers to control producer prices. Indirect taxes consisted of those policies targeting other sectors of the economy, but had a significant impact on agriculture as well. Those policies which aggregately taxed agriculture often affected the real incomes, causing them to be lower than the real incomes they would have obtained under a free trade regime. In general, the formation and development of agricultural prices directly follow policy developments. In the agricultural policy history of a group of countries being studied by the World Bank study, it

is evident that the pursuit of import prohibitions, restrictive import licensing, and applied tariff policies raised the prices of farm inputs and other consumption items (Krueger, 1996). The direct impact on farmers was that they were required to purchase inputs and other items at prices that were higher than free market prices.

A study of agricultural pricing policy history in developing countries points to the ideology of industrialization as a key to growth and as an important factor determining initial agricultural policies. Within those policies, modernization was long held to be achieved through industrialization, a belief which provided the rationale for the bias against agriculture. The newly-independent countries inherited from their colonial predecessors agricultural marketing boards. Their easy availability made them convenient instruments for politicians. Economic realities started to impinge on politicians to overhaul marketing enterprises due to their inefficiency in input delivery from markets to final producers and in getting output to the market on time. The suppression of producer prices as politicians attempted to tax agriculture squeezed agricultural marketing boards. The prices that the boards could pay producers fell further below what was intended (Krueger, 1996).

The effect of this form of agricultural policy orientation was to induce producers to resort to more gainful outlets for their output, rather than selling it to marketing boards at throw-away prices. Confronted by severe cost increases, other countries resorted to lowering the prices paid to farmers to well below intended levels. Krueger (1996) argues that the low farm prices, combined with the farmer's supply response, contributed to 'foreign exchange shortages' as the supply of exportable commodities flagged and domestic consumption rose. That resulted in a rise in import license premiums, which increased the incentives for evasion of the trade regime. In a few instances where reform policies were confined to agricultural pricing policy, efforts to reform these policies were viewed as economy-wide reforms. In many countries, the reforms were short-lived as politicians reverted to the *ex ante status quo* as soon as the positive effects of reforms removed the urgency that had led to their implementation (Krueger, 1996).

Arguments have been made that government agricultural policy bias against producers in many developing countries depressed farm earnings and even caused harm to national and global welfare (Peterson, 1987; Schultz, 1978). In other cases, earnings from farming in many developing countries have been depressed by a pro-urban policy bias in own-country policies as well as the governments of richer countries favoring their farmers with import barriers and subsidies. Zambia is a case in point of those countries, which for political reasons supported a pro-urban policy. Rising protection inhibits trade and reduces agricultural production efficiency. The imposition of export taxes directly influences domestic prices, hence aggregate production**.** However, prior to liberalization, governments repeatedly raised

revenue by altering domestic commodity prices and through the direct taxation of agriculture (Norton et al., 2006).

Programs initiated by developing countries did not show any positive secular trend in the evolution of markets. The P.L. 480[8] and other government-to-government food aid programs provided low-priced, subsidized substitutes for home-produced products and exerted downward pressure on the prices of beneficiary countries. Peterson (1987) rightly argues that these programs, labeled as humanitarian, were avenues for the disposing of surpluses, accumulated through farm subsidies in developed countries, to developing countries. However, it is evident that the volume and composition of the trade of developing countries has evolved during the last several decades (Diakosavvas, 1991).

A glut of agricultural products in world markets further depresses agricultural product prices. The economic ripple effect goes on to affect foreign exchange earnings for agriculture-dependent countries. The circularity effect, over a given period of time, leads to far-reaching economic and social effects across country divides. Primary commodity markets continue to remain a source of controversy between countries and the policies they pursue. For many developing countries, this controversy arises from several levels. First, primary commodities contribute to a secular decline in the terms of trade. Secondly, they represent a structural condition of unequal exchange between countries, making them a major source of instability, and hence, financial vulnerability.

The conception of the WTO and its basis on trade as a producer-driven organization raises broad inconsistencies with regard to gains from trade by SSA countries (Morrissey & Filatotchev, 2000). Under international trade theory, comparative advantage confers countries with the benefits of specialization in production and trade. However the veracity of this trade theory is subject to question with regard to the trade gains of developing countries, given their the presumed advantage in agricultural production. The Prebisch-Singer hypothesis prevails with regard to the gains of trade of developing countries (Ram, 2004). Yet, absolute dependence on agriculture in the face of the deteriorating net terms of trade renders sub-Saharan Africa countries highly vulnerable to other macroeconomic shocks. Even though scores of these countries have attempted to shift toward manufactured exports, technical trade barriers have weakened their competitiveness in international markets. However, exports are not an unambiguous source of sustainable import potential. Morrissey & Filatotchev (2000) presents a few exceptions of countries that have gained competitiveness in the production of high-valued non-traditional crops. Even after joining the international trading system, developing countries have not earned clear gains or expanded their trade volumes, as trade theory may suggest.

[8] *Public Law 480 was a US government initiative aimed at providing food shipments to countries that lacked enough for their own consumption.*

### 3.2.3 Food security and macroeconomic challenges in SSA

Agriculture is the major sector in many countries in the SSA region. Important among those countries is Kenya. The rationality of farmers and their frequent response to market signals cannot be disputed. For instance, producer allocation of land to crops that they grow is dictated by policy instruments (Narayan & Shah, 1984). However, the response varied from target to target and according to the type of policies being applied. The elements of producer behavior range from those driven by the allocation of land to various crops, the risk taking entrepreneurship in uncertain environments of future prices and yields, as well as the application of inputs such as fertilizers, capital, and labor.

Narayana & Shah (1984) studied farm supply response in Kenya among small and large farm production. They have adopted the traditional Nerlovian model which consists of all the major crops produced by both large and small-scale producers. The time series approach utilized in the model emphasizes the role of agriculture and hence implies the invariable place of food security within it. In assessing the supply response of small and large-scale producers to policies, the research has disaggregated the contribution of each farming group's direct role in food security or its contribution to income generation.

In the research on food security and agricultural sector policies, particularly that conducted by the WB during the 1980s, there is a common emphasis on the effectiveness of macro-level policies introduced by the WB (World Bank, 1981). This particular investigation discusses how macro-economic challenges were compounded by less than sufficient economic growth, a competitive international commodity market, and rising poverty. With regard to the agricultural sector, the analysis reflects on the challenges of SSA countries' efforts to achieve sufficient growth in food crop production. Particular mention is made of the reduction of food calorie deficits and reducing food imports. However, the unanswered question is how developing countries, mainly those dependent on agriculture, may surmount these threats to their livelihood in the presence of an under-performing sector. Yet, wide claims suggest that liberalizing agriculture would spur substantial economic growth in the agricultural sector. Intertwined in the search for the solution for agriculture is the attainment of food security for the rural and urban population. Rural populations are at a much greater risk due to their dependence on agriculture for their food and their incomes.

## 3.3 Major conclusions of existing literature

A review of the literature on the theme of agricultural market reforms and agricultural supply, and their link to food security in Kenya and Zambia, as well as in sub-Saharan Africa, arrives at some striking conclusions. A handful of these studies have emphasized the effect of world

price stability on agricultural supply and the dependence upon the macro-environment (Subervie, 2008). The strong wave of economic liberalization, the volatile world agricultural prices, and the macro-economic environment have compounded existing shocks in demand and supply in agricultural economies, in particular. Subervie (2008) concludes that the rising shocks to supply predominantly affect agricultural commodities in countries that heavily depend on export revenues and domestic cereal supply. The logical conclusion of such outcome augurs negatively on both food supply and incomes, on which effective demand depends. These demand and supply shocks are hindered by poor domestic infrastructure, weak financial development, and higher price inflation which weaken producer risk-management capacity.

From these conclusions, some time series analyses underline a strengthening of the macro-economic factors that sustain producer capacity management, particularly at the micro-level. Byerlee & Sain (1986) cite that producer price incentives are not the only ones that constrain productivity growth. Rather, at times, low consumer prices are predominant in inducing a rapid rise in food grain imports, largely wheat, by most developing countries. The resulting long-run unfavorable price relationships faced by farmers in the LDCs in the long-run, say some economists, have the effect of reducing agricultural output from what it would otherwise have been, causing food shortages (Peterson, 1979).

Numerous recent studies on agricultural supply particularly focusing on Africa have reiterated the effects of government price policies, but they have not clearly discussed how they directly affect food security. There have been no studies undertaken which in fine detail the food security dynamics in these countries; rather, a large number of studies have focused on cross-country developments. Hence, conventional wisdom has come to suggest that (a) food insecurity can only be explained by poverty, and (b) agricultural trade reforms were favorable for the improvement of agricultural production in the range of countries where studies have been carried out. However, a lack of conclusive studies casts doubts on how the reforms favored agricultural supply in these countries.

The contribution of agricultural supply is clearly important in providing sufficient food for domestic consumption and surplus for the market. It is reasonable to believe that policy action tends to change farm prices over a somewhat longer duration than market induced changes. This causes the supply response in the former to be greater than in the latter (Peterson, 1979). Therefore, there is some danger of underestimating the response of farmers to policy-induced changes to prices if short-run, market-induced changes are used as a guide. A policy incentive which provides a balanced strategy of producer prices, improved technology, and associated distribution is essential for ensuring sufficient food for consumption. The *World Bank Report on Africa* (World bank, 1982), generated debate on the

extent to which African governments should focus on agricultural research and extension to promote change, or concentrate their efforts on maintaining reasonable prices.

This research seeks to bridge the gap between existing knowledge on the theme of agricultural trade reforms as generally considered in cross-country studies, as well as the results of those reforms in Kenya and Zambia. Conclusions from the countries in this study would provide new evidence on how agricultural reforms fared in individual countries such as in Kenya and in Zambia. Policy reports on food security provide little or uninformed links between food security and agricultural trade reforms, particularly through agricultural supply. Many such studies were conducted at the initial stages of the reform era; few comprehensive studies have been undertaken on the subject at the country level. A macro-level study is therefore a useful means of evaluating national food intervention programs and of assessing strategies that support overall production of sufficient food for consumption. Macro-economic policies influence food security through relative price changes of the basic staple foods and through real income change.

# 4. Theoretical Approach

## 4.1 Agricultural production and markets

The research hypothesis presented in Chapter 1 states that market reform negatively influenced agricultural supply. The research investigates this hypothesis by considering the production of maize, a source of food for many rural and urban households in Kenya and Zambia. As a cash crop as well as an internationally traded commodity, maize supply and demand conditions in international markets influence domestic market development. For instance, with open domestic markets, price changes in international markets affect local prices, hence production trends.

## 4.2 Link between international and domestic markets

The preferred definition of food security covers the supply and demand (effective demand) aspects of its attainment. The latter determinant is strengthened by a rise in incomes or through access to transfers (Ellis, 1992). Domestic production serves as the most reliable source of food consumption in agricultural economies. However, shortfalls in domestic supply are filled by food imports; whether it is through food aid, emergency food relief programs or direct commercial food imports from the international markets. Micro- and

macro-economic conditions influence domestic access to sufficient food. In years of good harvests, both Kenya and Zambia produce maize surpluses, enabling them to export maize. However, in years of poor harvests, when drought reduces the average harvest area, or when input bottlenecks have constricted output, the two countries are net importers of maize. Given the evident production volatility, trade serves an important tool for stabilizing national food supplies through the setting of prices and its ability to control them. The expansion of global agricultural markets, accompanied by deepening globalization, continues to influence domestic markets. Prices in global markets tend to be volatile and unstable. In part, this trend is spurred by widespread speculation in agricultural commodity markets, which consists of unique market instruments, such as spot and futures market and a wide range of speculative choices.

In theory, increasing agricultural productivity, particularly maize productivity, can be attained by applying existing agricultural technologies and other inputs in maize production. However, in theory, the application of new production inputs, as well as the diligent use of environmentally sustainable agriculture and efficient production techniques, can contribute significantly to sufficient agricultural supply as well. An effective institutional structure can be a strong pillar through which agricultural sector policies would intermediate and provide clear guidelines between the farm gate value of agricultural products and the market value. The organization of the domestic market depends on the effectiveness of the policy governing framework.

The price of internationally traded commodities, or their close substitutes, enters domestic markets through these commodities and affects their supply and demand thereof. At the international market level, agricultural economies do not have the market power to alter the prices of agricultural inputs, whose prices are easily transmitted to farmers. The fluctuation of input and output prices in international markets has a ripple effect throughout the input and output supply chain of the affected products. Derivative markets, where the product is traded, will respond accordingly to price signals. These changes often attract counter-cyclical policy measures as market correcting tools, particularly if agricultural market outcomes are deemed unfavorable for public welfare. The transmission and permeability of external shocks to the domestic sectors depend on how the internal market is connected to international markets, especially in regards to imports. For policy analysis, these conditioning factors provide the pathways for analyzing policy and taking action in response to a market crisis. Trade policies and macro-economic conditioning factors leverage producer and consumer prices.

In recent years global markets have been rendered more volatile by changing conditions as markets become more interconnected. Sharp increases in fuel prices are passed on to the costs of transporting commodities to destination markets, particularly from international ports. Rising energy prices are caused by changing supply and demand conditions, a fact that alters

transportation costs, particularly for those countries without access to international ports. Kenya and Zambia, net importers of energy products, are affected immensely as a result of these rising costs. Alternative environmentally friendly energy sources have been explored in recent years. In developed countries, there has been a marked increase in bio-fuel production, which relies on cereals. Bio-fuel production diverts cereals from human consumption to energy needs. This exerts upward pressure on prices due to decreased cereal supplies channeled to markets (von Braun, 2008). Agriculture's dependence on natural factors makes it vulnerable to droughts or other natural failures, particularly in traditional high production areas, and that puts pressure in supply. Consistent under-investment in agricultural production over the past several decades has negatively affected the supply of food, while population has continued to grow steadily.

### 4.2.1 Domestic and external markets links to food security

The prices of internationally traded commodities are transmitted to local markets through cross-border transactions. The prices of cereals traded in international markets are, in effect, determined in those markets. These supply and demand interactions have a strong bearing on domestic markets, which as a result reflect international conditions and prices. For instance, the price of fuel, which determines the cost of transportation of the agricultural inputs, is an influential factor. Market efficiency and integration in domestic markets tend to be undermined by the inadequate provision of public goods such as infrastructure, an inefficient flow of information, and the imperfect completion or missing institutions for risk management such as credit and insurance. Common market failures contributed to an inefficient and underperforming agricultural sector. Markets in landlocked countries, such as Zambia, are characterized by additional transportation costs, which give rise to apparent inefficiencies.

Global food prices influence government revenue and expenditure in a number of ways. The external market changes driven by the changing prices of food, fuel, or fertilizer affect government spending on subsidies. However, net food importing countries will be affected differently from net food exporting countries. Rising food prices imply a higher import bill for countries relying on trade for their food consumption. However, if industrial diversification is weak or non-existent, these downward-trending prices result in agricultural exports commanding insufficient foreign exchange earnings to finance non-food imports. Such a trend may cause a reduction in government spending on social programs, which serve the low-income sector of the population. These programs are important, particularly in poor economies where a majority of the people depends on social support from the government.

Domestic food crises are often a result of a number of factors, usually beyond demand supply interactions. Falling imports, due to price hikes in international markets or weak exports, debilitate the potential for supplying food to external markets from major producing countries. Developing countries which are net food and fuel importers experience declining terms of trade in the event of an increase in the prices of fuel and foodstuffs. The increasing variability in the prices of cereals makes food imports correspondingly unstable. This instability easily permeates domestic markets and is transmitted to the household level in the form of higher prices for net food purchasing households. The political sensitivity of urban food consumers to price hikes has been a common reason for political instability during price increases. During the early 1980s, when the government of Zambia removed food price subsidies, public pressure, coming primarily from urban consumers, pushed the government to rescind the removal of food price subsidies (Rakner, 2003).

Higher prices of food or other commodities in domestic markets, particularly for urban consumers, have notable effects. First, they decrease purchasing power for the consumers who rely on markets for food. A persistent rise in the price of food and other consumables tends to put upward pressure on wage rates. In the face of these price hikes, employees are compelled to renegotiate their salaries in order to maintain their purchasing power. Often, wages tend to be rigid, lagging behind commodity price increases

### 4.2.2 Agricultural production and markets

The level of agricultural output determination is intermediated by the cost of inputs, mainly capital, labor, fertilizers and hybrid seeds, as well as by prevailing prices. Input price levels that are within the reach of producers imply greater access to them. With regard to output prices, the more units of a commodity that are produced, the greater the returns with higher output prices. Higher prices, in the short run, can lead to the expansion of production – before markets reach equilibrium. Markets stabilize to long-run equilibrium when the expectations price settles to the new equilibrium price. The agricultural market outcome is mediated by technological developments and economic policies, as well as other non-market conditioning factors unique to the region under analysis. As final products reach their destinations, market behavior causes backward linkages that are recycled back to the producers. Less essential, but important nonetheless, is the policy environment in the production chain from production to consumption. This general abstraction is an essential basis for the production, marketing, and consumption of agricultural products.

Land, on the other hand, is a prime factor in agricultural production, but its physical properties are fixed. The fixity assumption could be eased by technology, which can facilitate an improvement in yields when the producer optimally utilizes it in production. Land is also

implicitly associated with labor, since the amount of cultivated land is dependent on available labor using predominantly simple production tools, or technology. Closely related to land is the concept of diminishing returns[9], which explains how combining the various factors of production could be critical in determining agricultural productivity. This essential economic principle reiterates the resource combinations of land, labor and capital. The underlying economic essence is that maximized levels of output are attained once their respective returns are measured to a scale that optimally combines resources.

At the beginning of the 1980s, the agricultural sector and other sectors of the economies of Kenya and Zambia experienced a sweeping wave of overall reform. These economy-wide shocks led to a gradual shift in the structural functioning of consumer and producer institutions. The initial controls placed on the prices of agricultural and non-agricultural commodities were lifted. The prices of agricultural and non-agricultural inputs, which until then had been subsidized, started being subjected to a competitive market environment. Subsidies, in particular, were considered to be a dispensable fiscal constraint as well as a hindrance to market development. The economic restructuring also entailed the cross-border lowering of tariffs and quotas, which were commonly applied to agricultural imports. This step was intended to increase imports and exports for all goods, but more particularly the export of agricultural products. The immediate rationale for the latter was that the exchange rates would be used to facilitate exchanges without any restraints and controls. The implementation of the suggested policy and structural changes affecting domestic markets influenced the functioning of domestic institutions. In order to implement the suggested policies, domestic markets had to be aligned to domestic agricultural institutions.

In theory, a production function describes the combination of several inputs to produce a certain level of output. Such a relationship can also apply in a general economic sense, or can particularly be postulated in an agricultural economy setting. In agricultural production, the generation of the determination of output with a combination of various input resources can negatively or positively influence the level of output. To optimize profits, producers combine inputs in adequate proportions and increase the scale of specialization and efficiency (Norton et al., 2006). While a production function typically refers to the generation of a particular type of output or the combination of some input in a general economic sense, it is possible to extend that postulation to the agricultural economy. With regard to output, changing the way input resources are used can either have a positive influence, or none at all, on the range of output. However, in order to optimize profits, better organization of how inputs are mixed is necessary in increasing the scale of specialization and efficiency (Norton et al., 2006).

[9] *The Law of Diminishing Returns underscores an important characteristic in production and the proportionality of factor combination for the attainment of a predetermined level of output.*

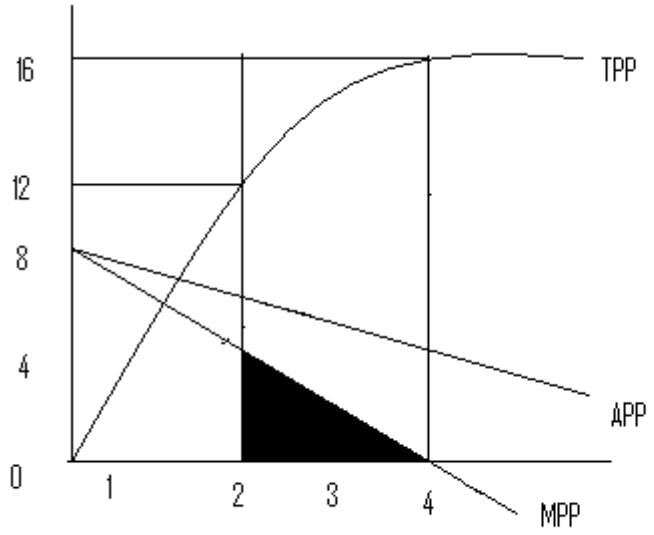


Figure 10. Illustration of the theory of diminishing returns

**Figure 10** illustrates the theory of diminishing returns and how it relates to agricultural production. The conceptual theory underscores the fact that as more units of an input are added to production, it reaches a point when lesser and lesser yields result. The total physical product (TPP) is assumed to begin declining. This concept represents the elasticity of production and entails a consideration of factor elasticity, which captures the response of one factor given an incremental variance on a variable factor. Elasticity in this case measures the percentage change in output in response to an infinitesimal percentage change in a factor given that all other factors are held fixed.

The theoretical concepts and market inter-linkages illustrated in **Figure 10** above would not be entirely complete without underscoring market harmonization. Market forces do not affect every aspect of a producer's decisions. However, given producer rationality, some of the producer choices are influenced by cultural, economic and political factors. For any given level of input use, a typical producer expects to attain a predetermined level of output. In general, however, demand considerations are important in determining how much output is delivered to markets and what range of inputs are expended to reach that level of output. Equilibrium price determination by markets, based on prevailing demand and supply, becomes an important signal for the producers. The self-replicating role of prices drives input markets and leads to an equilibrium markets price.

The concept of the equilibrium price is based on the general economic principle that quantity demanded equates quantity supplied; and in theory, this generates the final market price. Actual prices provide a close estimate of the prevailing equilibrium prices under competitive

markets. Imperfect market conditions, lack of information, market failure or other negative influences, may all induce the price to deviate from the equilibrium. Besides that, greater year-to-year fluctuations in the supply of agricultural commodities can depress the agricultural terms of trade and ultimately influence equilibrium price deviation (Tomek, 1985). In practice, average transaction costs - monthly, quarterly or annual-are equivalent to the equilibrium price.

A relationship between the level of variable input use and the price of the input and the output exists. In order to reach the optimal level, the marginal value product of the input would have to equal the price of the input. That optimum level of profit changes with the transformation in the price ratio between the input used and the output of the combination.

## 4.3 Review of dynamic cereal production research

The study of agricultural supply response to prices has continued to receive a great deal of emphasis in recent years and remains of interest to researchers (Henneberry & Tweeten, 1991). Price policies, in the study of agricultural supply, are one of the most frequently used tools in resource allocation. The price and supply of agricultural commodities are of particular importance in developing countries where a majority of the people reside in rural areas and spend a large share of their income on food.

In dynamic supply analysis, the effectiveness of policies affecting agricultural supply often depends on the elasticity of a product. This also occurs in developing countries, where agricultural supply serves a wider population base; the rural and urban populations. The latter type of consumers derives agricultural output through markets. Often, elasticity of supply varies between different products, and at times, in different regions of the country. Estimates vary according to the type of econometric model used, the definition of the price variable, and the type of data. This can imply that a single estimation of the elasticity of supply, while providing valuable information, can be undeniably incomplete in its value as a guide to policy makers.

A majority of the agricultural supply response studies have utilized the direct estimation of the supply function (Henneberry & Tweeten, 1991). A measure of supply, such as the quantity supplied, acreage planted, or area harvested, is generally specified as a function of own-price, related product prices, and non-price shift variables, particularly the weather and technology. The own-price supply response measures the percentage change in the quantity supplied, that is, the acreage planted or harvested, in response to a percentage change in the price of the product.

Marc Nerlove (1958) pioneered the area of dynamic supply analysis, particularly in the formulation of price expectations. Nerlove (1958), in his seminal research on dynamic analysis, considered the supply adjustment through time and the factors affecting both the speed and the magnitude of the adjustment. Nerlove's model has been extensively modified in subsequent supply response studies (Askari & Cummings, 1977). Nerlove's original model assumes that past prices govern normal expectations about the normal level of future prices, with the most recent past prices having a greater weight. In the Nerlovian model of adaptive expectations, producers are assumed to adjust their output slowly to the desired level because of their habits, technological constraints, adjustment costs, institutional rigidities, and overall caution.

### 4.3.1 Theoretical model of cereal production

Previous literature has investigated the role of product prices in agricultural production and land allocation. Eckstein (1984) considers an empirical model of agricultural supply based on a dynamic and stochastic framework in which farmers are presumed to maximize their present supply by choice of land allocation subject to dynamic and stochastic technology, as well as uncertainties triggered by price movements.

The consequences of product price movements are important and significant for a farmer's production decisions. The prices of inputs and outputs are mediated by markets, which in turn determine producer margins. Acreage often responds to corresponding output price movements. Eckstein (1984) has analyzed a stochastic dynamic optimization problem of a farmer endowed with land allocated between two crops. Eckstein's analysis uses a dynamic linear rational expectations modeling approach with time series observations.

The theoretical model analyzed below is adapted from Tegene et al. (1988) and it is based on the adaptive expectations hypothesis[10]. Eckstein (1984) has used a similar model to estimate the impact of product prices and land allocation. However, Tegene et al. (1988) consider the production of two types of crops; maize and another cash crop. The model encapsulates the Leontief (fixed proportions) technology conceptual approach by taking into account the combination of land and other non-land factor inputs. Both model features are typical of the agricultural sectors of developing countries. However, the model introduced below embodies the exogeneity effect of policies on agricultural output.

Maize production is made dynamic by allowing past land allocation to affect current levels of output. The price of maize during the preceding year is also assumed to influence current

[10] *The adaptive expectations hypothesis assumes that agents make errors in their expectations and that they revise them by a constant portion of the most recent error.*

year's acreage and output. Conversely, future production, driven by the adaptive expectations hypothesis, relies on current producer decisions and supported by the rational expectations of the production conditions in the future. Production decisions between the two crops are jointly made because of the capacity constraint, such as a limited amount of available land.

To develop a production model which captures the supply of maize, as well as an alternative crop, we consider the following definitions:

$X_{it}$ is the production of crop $i$ at time $t$ ;
$P_{it}$ is the producer price of crop $i$ at time $t$;
$A_{it}$ is the land allocated at time $t-1$ for the production of crop $i$ at time $t$;
$\bar{A}$ is the total available cultivated land at time $t$ ;
$0 < \beta < 1$ is the objective discount factor equivalent $\left(\frac{1}{1+r}\right)$
$E$ is the expectations operator, where $E_t(X) = E(X|\Omega_t)$ and $\Omega_t$ is the information set available for farmers at time $t$; and
$L$ is the lag operator defined by the property $L^k X_t = X_{t-k}$
Crop 1 represents maize and Crop 2 is tea or another cash crop

The key model assumptions in the theoretical approach are as follows: First, land is assumed to be an important factor in agricultural production and its resourcefulness is a direct function of producer efforts to maximize output based upon available inputs, such as fertilizer, improved seeds, or extension services. Second, the depletion of organic matter and the presence of pests during production are constraints that can be mitigated by a periodic (annual or bi-annual) change of the types of crops grown on the same piece of land, in the form of intercropping. Third, agricultural policies affect the supply of the stated commodities through inputs and outputs. Producer intervention in soil conservation is maintained by careful choice of applied fertilizer and other inputs that are not harmful to the organic matter of the existing so.

In extensive agricultural production, the area of arable land is the main supply shifter. However, this type of production is subject to physical and economic constraints, such as diminishing returns and the extent of expansion. While agricultural productivity can be improved by the application of modern production techniques, the absence of these techniques restricts the level of productivity. Applying improved agricultural technology has been considered crucial in raising output through the application of more intensive techniques. Other choice variables combined with the area of productive farmland, contribute decisively to augment productivity. This concept is consistent with agricultural producer theory, which often provides clues to the variables likely to be most important (Tomek, 1985).

A two period production cycle is assumed for the production of a staple cereal crop, in this case maize, and competing cash crops such that the maize planted in period $t-1$ is sold or consumed in period $t$. As a result of the fixed proportions production technology between land and non-land factors, the output of each activity can be related to the size of land utilized for that activity. This property is expressed as:

$$A_{1t} + A_{2t} = \overline{A}_t \tag{1}$$

$A_{1t}$ is the maize acreage
$A_{2t}$ is the acreage of competing crops
$\overline{A}_t$ is the total acreage

Tegene et al. (1988) suggests that the fixed proportions production technology between land and non-land inputs for each activity (Leontief technology), the output of each activity can be related to the land utilized. These production functions are quadratic for maize and linear for other crops in land use during time $t$ and both are stochastic:

$$X_{1t+1} = \left[d_0 - \frac{d_1}{2}\bar{A}_{1t} + d_2\left(\bar{A}_t - \right.\right.\left.\left.A_{1t-1}\right) + e_{1t}\right]A_{1t} \tag{2}$$

$$X_{2t+1} = [d_3 + e_{2t}]A_{2t} \tag{3}$$

$X_{1t}$ is the output of maize in period $t$;
$X_{2t}$ is the output of alternative crop in period $t$;
$e_{1t}$ is the zero mean random disturbance term for maize;
$e_{2t}$ is the zero mean random disturbance term for the other crop;
$d_2(\bar{A}_t - A_{1t-1})$ is the dynamic trend in land utilization

The average yields per unit of maize in period $t$ increases (decreases) when less (more) of other crops are harvested from the land during period $t-1$. The production parameter $d_2$ is positive if raising maize successively from the same land decreases its average yield per acre. All of the production parameters are expected to have positive signs, reflecting the effects of weather and crop diseases. The random component is assumed to be proportional to the acreage allocated to that activity.

The output from the production of the stated agricultural products is either consumed or the surplus marketed for producer income. The producers are assumed to obtain receipts from maize and other crop sales upon the delivery of output to markets and to incur expenses for the non-land factor inputs used in the production. Extension and marketing services also constitute an expense for the producer.

Following [1] through [3] and assuming the production of Crop 1 is subject to dynamic production constraints, its production can be expressed as follows:

$$X_{1t} = F^1(A_{1t}, A_{1t-1}, A_{1t-2}, \dots\dots; K, \bar{A}, Precip), \quad (4)$$

where $F_1^1 > 0$ , $F_2^1 > 0$ , $F_j^1 \leq 0$ , $K$ is a vector of other inputs applied to the land. The production function for crop 2 (wheat) is given simply by

$$X_{2t} = F^2(A_{2t}, ; K, \bar{A}, Precip), \quad (5)$$

where $F_1^2 > 0$, $F_2^2 > 0$,. The representative producer is expected to maximize his expected discounted profit in terms of the price of Crop 1 (maize) by choosing a contingency plan at each period $t$ for allocating his given area for the production of crops for time $t + 1$. Therefore the producer's objective is to maximize

$$E_{-1} \lim_{N\to\infty} \sum_{t=}^{N} \beta^t \left( X_{1t} + \frac{P_{2t}}{P_{1t}} X_{2t} \right) \quad (6)$$

The foregoing expectations equation is subject to the land constraint stated in (1) and the production functions in (4) and (5).

Agricultural policies enter equations (4) and (5) through variables associated with vector *K* (input prices; fertilizers, hybrid seeds, extension services, production tools). Agricultural production in Kenya and Zambia is done on a small scale, using pieces of land that are 5 hectares or less on average. The preference for fertilizer over other inputs is prevalent among most maize farmers given its contribution to yield increases and relative affordability. The use of a variety of seeds for planting is a common practice. The quality of the seeds used for planting is an important yield determinant. The use of fertilizers, particularly nitrogen ones, is widely common in maize production even if its environmental side effects have not been adequately studied. Nitrogen improves the soil's carbon level, which is critical in improving soil quality and fertility. In some studies, it is argued that N fertilizers help moderate the greenhouse effect on the environment by reducing atmospheric enrichment of carbon dioxide. However, the potential effect of fertilizers in the soil or the environment is beyond the scope of this research.

Labor, the main input in agricultural production in developing countries, is cheaply available in large quantities. Cheap labor is particularly essential during planting and harvesting periods. The cost of labor to producers is minimized by the abundance of family labor which reduces the direct cost to the producers. Small-scale farming, which dominates agricultural production in Kenya and Zambia, is characterized by low productivity. For a variety of crops, small-scale farming is integrated in a market-oriented production system. These semi-

subsistence farmers provide most of the food consumed, particularly in the rural regions of these countries, where purchasing power is limited by the levels of poverty. These producers often operate on low incomes and directly consume some of their products before supplying the remainder to the market. This preference is furthered by the small size of farms, which limits the use of advanced farm technology.

$P_{it}$ is the nominal price received from output $X_{it}$ $i = 1,2$ and $c_1'$ and $c_2'$ are the non-land costs of producing maize and other crops. The farmer's objective is to choose the $A_{it+j}$ in order to maximize output for production; both for consumption and for sale.

$$J = \max_{(A_{1t})_{t=0}^{\infty}} E \sum_{t=0}^{\infty} \beta^t \left\{(d_0 + e_{1t} - c_{it} + c_{2t})A_{1t} - \frac{d_1}{2}A_{1t}^2 + d_2\bar{A}A_{1t} - d_2\bar{A}_{1t-1}A_{1t} + P_{t+1}\bar{A}_t - P_{t+1}A_{1t} - c_{2t}\bar{A}_t\right\} \quad (7)$$

The foregoing equation constitutes the expectations operator conditional on information at $t-1$. $\{\quad\}$

The values of the stated variables are not known to farmers, but expectations about them are formed when land allocation decisions are made[11]. Known variables take precedence over the unknown variables whose logical relevance to the outcomes of the farmers' output is immeasurable.

The information set available to producers is broadly defined to include the past history of prices and production trends. Current and past economic variables, which are exogenous to the producer, are among the factors which contribute to an individual producer's decisions on the level of output. Even the past policies affecting production, which are likely to recur in the future, become influential in the determination of the types of production that a producer engages in.

The time domain is the period over which the equation is supposed to hold. The largest possible time domain that might be conceptually appropriate is from $t - \infty$. In the present framework, that domain projects a backward-looking solution for the equation. The side condition preferred is $t - 1$.

[11] *For the sake of analysis, it will be assumed that expectations formation in developing countries tend to be overshadowed by direct government interference in farmer's decision making or indirectly through policies which in turn influence their production decisions.*

# 5. Data Analysis of the Agricultural Economy

## 5.1 Kenyan maize production data

The model in Chapter 4 represents a theoretical framework that captures cereal production and provides a potential framework for its analysis. In Kenya, maize is a cereal whose contribution to consumption and income is important and an anchor to food security. The presented general theoretical approach is assumed to encapsulate the production of maize, a common cereal food in most households. The market and social value of this staple crop vary widely, depending on the region of the country and prevailing ecological conditions. The process of producing and marketing of maize is different in the two countries as reflected in its consumption patterns. These consumption traits are compounded by maize's increasing cash value, which makes it susceptible to respond to market forces, input prices, as well as the prices of other substitute.

Most of the data sets were obtained from the Central Bureau of Statistics (CBS) and are comprised of agricultural sector as well as general economic data as published in the *Annual Statistical Abstracts* for various years. The data was already organized into various booklets according to sector, and this structure facilitated its extraction and eventual use for the estimation process. It also facilitated the disaggregation of sectors into smaller sub-divisions for estimations and general qualitative analysis of the entire sector. The national statistical office was the main depository of the economic data. A larger portion of this data was also obtained from online digital depositories. In order to make the data usable, further conversions to metric units were made. Other conversions from monthly to annually were made in order to annualize the observations selected for each of the selected variables.

There are several variables that, in practice, can be considered important in influencing maize output. Maize production is labor intensive, taking into account its calculation in production. Labor utilized in maize production consists of family and off-farm labor, but insufficient observations were available to warrant its inclusion as an explanatory variable. To avoid measurement inconsistencies, the labor input was removed from the estimations. Hired labor with pecuniary value is a marginal portion of maize production in Kenya. The aim of the research is to focus more on the policy dimension, given the selected estimation approach of making comparisons during the pre- and post-liberation periods, which represent a policy shift. In practice, a policy shifts may influence labor movements, but may not be easily discernible.

Inorganic fertilizer and pesticides are also crucial maize production inputs. Pesticides are used on a regular basis for pest control and they are readily available domestically. However,

the price of fertilizer is the only readily available data with sufficient observations. Various quantities of chemical fertilizer are documented, but for the purposes of the research fertilizer price observations are preferred in order to draw policy conclusions. Policies can be measured through input price trends due to the integral role that inputs play in maize production. In theory, producers are bound to respond to input prices as they tend to react easily to policy changes. A dearth of data on prices of other input, such as hybrid seeds prevents their consideration in the estimations. The widespread use of fertilizer suggests its critical role in production and the correlation of policies to its availability. End-consumer prices are essential in ensuring producer potential to utilize the input for their production. The state's interest in agricultural production facilitated the extension of subsidies in order to enable farmers' access to fertilizer and other inputs essential to farming. The rationale for providing input subsidies varied from country to country. The cost of acquiring the fertilizer depended on access to international markets as well as domestic distributional networks.

As an explanatory variable for maize output, precipitation plays a strong role in tropical agricultural production. Maize production, as in agricultural production in general, relies on sufficient rainfall throughout the life cycle of the maize plant. With respect to the timing of the rains, eventual maize yields respond well if both the first rains and the second rains arrive on schedule. The historical rainfall data was obtained from the *Climatic Research Unit* of the University of East Anglia based on recorded country precipitation statistics. In addition to sufficient precipitation, areas favored with good soils and little moisture stress respond well with better yields than those less endowed with such soil qualities. In effect, precipitation as a factor is not single-handedly responsible for raising maize output; other factors work in synergy with it in leading to aggregate output. Therefore, the justification for using precipitation data is supported by availability and its practical contribution to maize output.

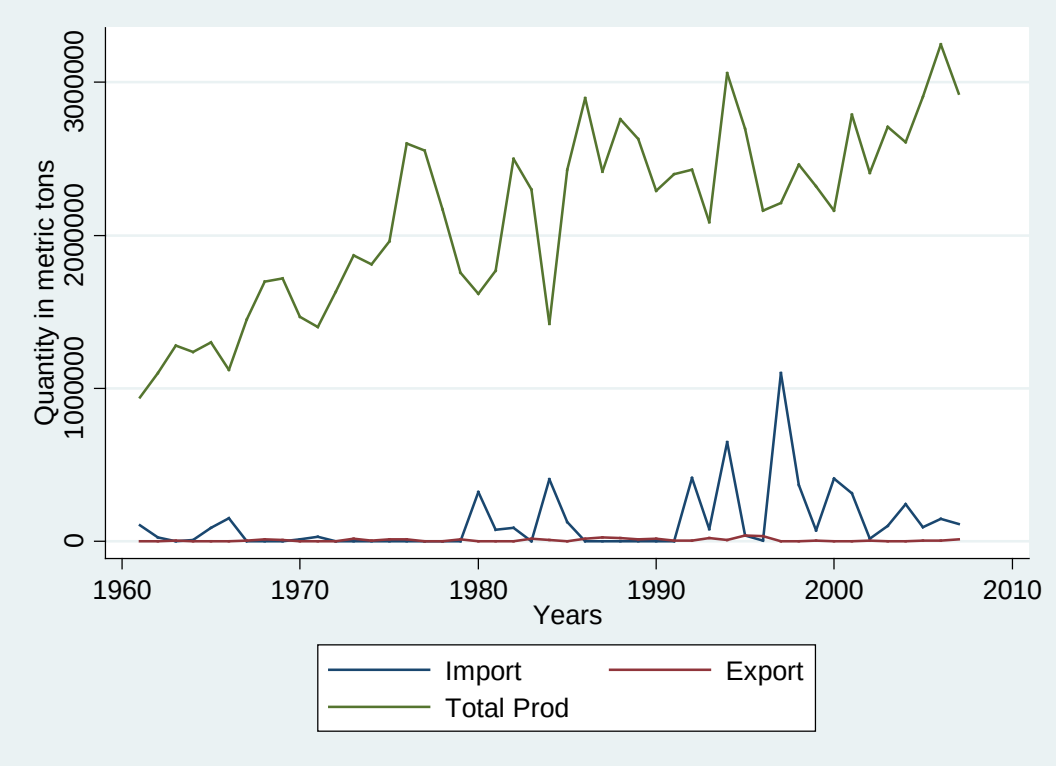


Figure 11. Volume of food imports and exports (Kenya): 1960-2008

The model in Chapter 4 suitably represents Kenyan agriculture and captures the most important factors that influence maize production. As the main cereal consumed in the country, most of which is produced domestically, policies guiding its markets can be economically meaningful. **Figure 11** shows how import volumes, which are trended upwards, compare with food exports. The continued rise in food imports raises the question as to why there is a rise in the imports when the country has arable soils capable of producing sufficient food for domestic consumption. Exports, as captured in official statistics, seem to be either constant or trending downwards. This might imply that there is increased cross-border smuggling or that wastage occurs due to poor storage facilities. The factors that influence maize output may be classified into policy and non-policy categories. While prices and markets are important indicators of how producers will respond these factors, other non-policy considerations are important in driving output. Some of the factors are specific to each region, depending on whether it is a traditional maize or cassava growing area.

This research mainly utilizes agricultural sector data sets, as well as general national accounts data consisting of non-agricultural sector macro-economic indicators. The data selection accounts for the linkages between the agricultural and non-agricultural sectors. Non-agricultural data sets are also important in evaluating the policy impact of agricultural supply trends. The relationship between output and input price, as well as their effect on overall

GDP contributes significantly to the type of available agricultural data. Aggregated non-agricultural economic data constitute annualized exchange rates, trade balance statistics, and labor statistics.

For developing countries, the system of recording agricultural production data is in the process of evolving. In recent years, however, governments, private institutions, and a few international organizations have invested in data collection and storage. International agencies, such as the USAID, participated every year in carrying out the agricultural census in Kenya. The long-run trends in how data is valued shows consistent growth in its use and its potential to contribute to useful scientific or policy related research.

### 5.1.1 Dynamic determinants of maize production in Kenya

Agricultural data are key drivers of much of agricultural analysis and form a crucial basis for scientific conclusions, eventual policy formulation and other important intervention outcomes. The extent of detail in the available data defines the extent researchers can go in their analysis of the theme investigated.

The production of maize is determined by both policy and non-policy variables. In the case of nature-induced factors, their unpredictability makes agricultural production susceptible to output fluctuations from season-to-season. For instance, climate plays a major role as a supply shifter in maize production. Given the vulnerability of production to rainfall conditions and temperature variability, investment has been made in the production of maize seed varieties capable of surviving extreme weather conditions. In order to achieve sustainable maize yields, taking requisite measures at the farm and national levels is necessary. The gradual introduction of intensification research techniques in order to develop appropriate types and quantities of fertilizers is necessary in improving maize yields, given the existing pressure on acreage.

In order to access better yielding maize seed varieties, it is important to carry out appropriate research aimed at identifying the short-term needs of the crops and the long-term needs of the soil. Frequent soil analysis is critical in ensuring that the right fertilizer is applied and leads to the highest returns from the inputs. This strategy can be an important determinant for the level of maize yields, hence overall production. In addition, a combination of manure and inorganic fertilizer would lead to increased yields.

## 5.2 Zambian maize production data

Maize is an important cereal consumed by many rural and urban households in Zambia. Besides its immediate consumption, this staple cereal has a growing cash value for both small-scale and large-scale producers, through domestic trading. Low-income urban dwellers consume a large proportion of the maize sold in the major urban areas than any other cereals. Most of the large scale maize production is marketed in urban areas by marketing agencies that collect maize from the producing areas. The increasing value of maize as a cash crop and a staple crop implies that there is increasing competition from other substitute cereals, such as wheat or rice.

In Zambia, maize production occupies the largest portion of agricultural land set aside for cereal production; hence making it an essential crop for both consumption and providing cash to farmers. Maize's production was furthered by the government's encouragement of it as a way of guaranteeing sufficient food reserves for domestic consumption as well as for export. There are a few other staple food crops in Zambia whose production was subsidized, but the maize cereal received the highest level of support. This enabled maize to remain as the most important staple crop in the country, whose supply serves as a proxy for food security. The free fall of copper prices beginning in 1973 and continuing on to the 1980s led to massive external debt incurred by the government and erased most of the country's import potential (Chizuni, 1994; Young & Loxley, 1990). This economic reversal had wide-ranging implications for the country's ability to continue financing the heavy subsidies that accompanied its production.

The end of Kenneth Kaunda's era and the subsequent appointment of Frederick Chiluba as Zambia's president in 1991 prompted the beginning of a new era for the agricultural sector (Rakner, 2003). In contrast to the old government, the succeeding one embraced liberal economic policies in agricultural production and marketing (Chizuni, 1994). These policies in turn brought about a new discourse on agricultural production. The abolition of subsidies and government support prices on maize and fertilizer was not received well by many farmers and consumers. In turn, the government encouraged farmers to shift back to crops that were more ecologically adapted to their respective regions, a concept known as the ecological comparative advantage. The lack of guaranteed markets, accompanied by rising input costs, discouraged farmers from producing hybrid maize for sale. Rather, farmers switched to maize production for their own consumption rather than for the market, due to fluctuating prices and increasing market uncertainties brought about by liberalization. Other farmers resorted to the production of more reliable crops, steering away from maize production.

The changing discourse in agricultural and food policies in Zambia, particularly pertaining to southern Zambia, led to a growing chorus of non-governmental institutions supporting the

removal of incentives for maize production and the promotion of drought resistant crops that alleviate food insecurity (Sitko, 2008). However, some of these efforts, such as discouraging maize production in southern Zambia, continued to stymie the efforts to have farmers abandon maize production. The transition period, which occurred in the 1990s, was a difficult one for Zambia. The country faced challenging economic times and witnessed an increase in overall food insecurity, particularly among poor urban and rural households. The prices of copper, which the country had continued to depend on as the main sector in the economy, stagnated throughout the 1990s. In the interim, the government had removed price and food subsidies. Private sector investment and general commercial activity in the rural areas was limited due to poor transportation.

During the 1980s and 1990s, household food security was particularly important due to the effects of structural adjustment policies and the droughts that characterized Zambian agriculture (Seshamani, 1998). The droughts were fairly common during the mid-1990s and were a continual menace to agricultural production. Low-income and poor farmers, often vulnerable to production shocks, influenced government support programs for them. The maize sub-sector performed rather poorly between 2000 and 2007, as represented by the maize production trend in the figure that follows. This eight-year period was characterized by unstable agricultural output during the eight-year period, not only for maize, but also for other agricultural commodities. There were mid-season droughts in 2001, 2002, and 2005, which caused bad crop yields for each of these years.

High levels of food insecurity and malnutrition characterize marginal, urban and peri-urban areas. In the rural areas, food insecurity is prevalent due to low agricultural productivity and insufficient access to agricultural services and resources accompanied by poor rural agricultural policies that failed to meet the specific conditions of local agricultural producers, particularly small-scale ones. In the past, the promotion of maize, particularly hybrid maize, in unsuitable areas resulted in low cereal retention levels. In urban areas, inadequate food supply levels are due to deteriorating purchasing power which is caused by a shrinking economy, a scarcity of income-generating activities and high levels of inflation as illustrated in **Figure 3**.

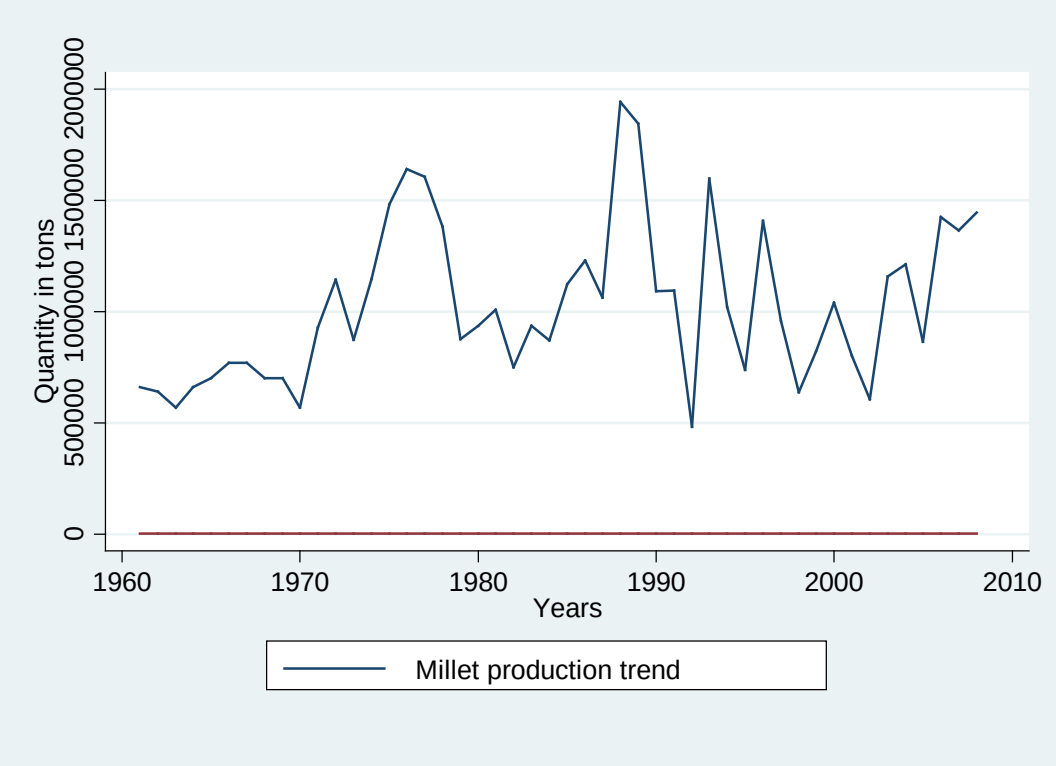


Figure 12. Maize production in Zambia: 1961-2008

It is evident from **Figure 12** that in spite of the withdrawal of government support, maize still commands much higher production levels than most other cereals. Fluctuations are not uncommon from year-to-year due to rainfall and temperature variability. This fluctuating trend appears consistent with that of the period prior to the introduction of policy reforms.

The production of maize is higher in terms of aggregate output as compared to that of other commonly consumed staples. Growing other cereal substitutes cannot be compared to maize-growing in terms of acreage or total seasonal output. Southern province and the north-west region of Luapala are the two main areas that specialize in the production of cassava, and in these areas the production of maize remains unpopular. The notable increase in maize output is not driven by a widespread use of inorganic fertilizer; rather the use of high-yielding maize, even by small-holders, contributes to the rising yields. Aggressive government-sponsored research aimed at creating high-yielding maize seeds gradually paid off, and the use of these new seed varieties was common, even by small-holder farmers with limited cash income. Compared to other regions, the commercial farming sector is relatively well-developed in southern Africa, where fertilizer-responsive maize is an important crop. **Figure 12** captures average maize production, providing national trends, but does not give any information on regional trends. Maize production mainly takes place in a few provinces in Zambia - Lusaka and Eastern Province.

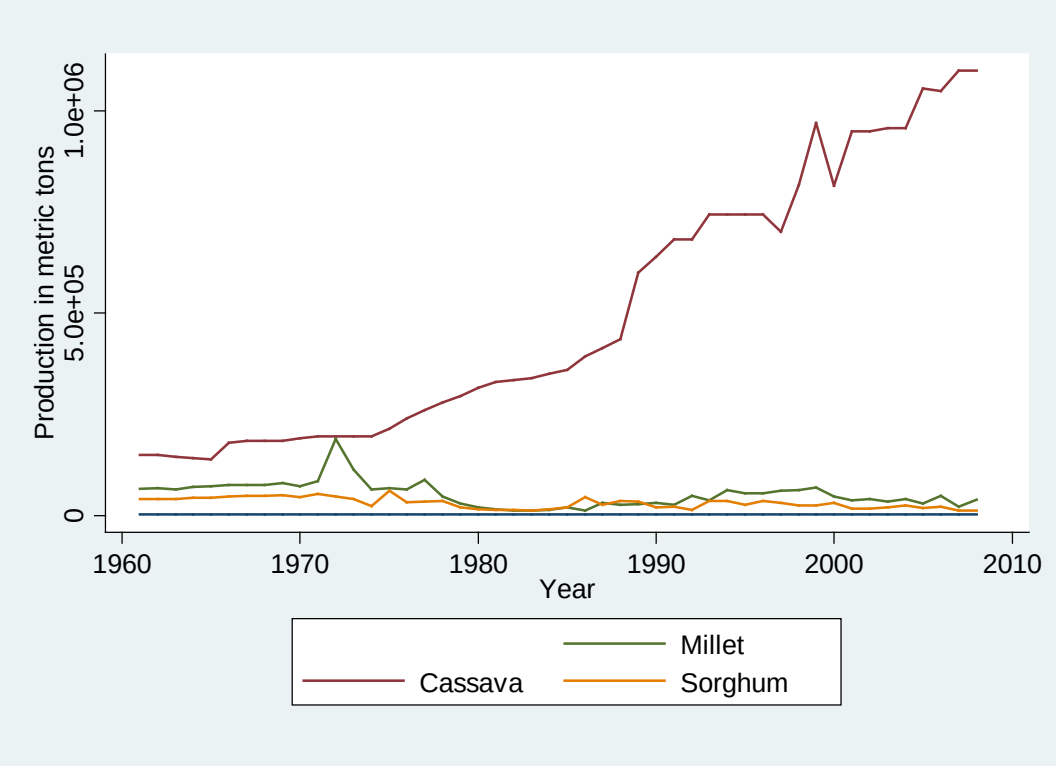


Figure 13. Zambia food production: 1961-2008

A view of the production of the main food crops in Zambia in **Figure 13** shows an increasing trend in the total production of three other commonly consumed staples. Even with the introduction of liberalization in agricultural markets and the withdrawal of government subsidies, regional preferences in the production of the most common cereal remains a defining characteristic of rural areas. Agricultural production remains heterogeneous in Zambia, and the introduction of new policies do not seem to have resulted in any drastic changes in farmer's production practices.

For instance, producers would be less willing to grow maize in southern Zambia than cassava. The consumption of cassava versus maize is also a common indicator of what small-holder households are more likely to grow for domestic consumption. The interplay of these factors is important in facilitating the eventual interpretation and analysis of the results of the model. The interrelation, as well as structural issues, exert a pro-cyclical effect on input and output prices. However, other externally induced factors also affect the domestic response of agricultural production in general.

The main source for the data sets used in the empirical estimations was the Central Statistical Office (CSO), Zambia. Included with the statistical tables are informal discussions on the data. These collections consist of published and unpublished government records and published and unpublished material from donor governments and agencies. Data interpretation was facilitated by discussions with government officials, researchers from the Food Security Research Project (FPRSP) and some insight from the Food and Agriculture Organization (FAO) country desk officials. The FAO country desk provided certification of the production, consumption, and food security statistics. Economic indicators per sector were also obtained from the Ministry of Finance and National Planning. Besides the published and unpublished statistics obtained for this study, the rest of the informal interviews carried out with the relevant officials are only important in the qualitative description of the study.

The annual agricultural data utilized in this research is that which is published in the various official government books. However, the compilation of the monthly statistics into annual statistics is well-documented in the annual statistics published in the Post Harvest Survey (PHS) conducted annually by the Central Statistics Office (CSO). These surveys provide a comprehensive analysis of the performance of the agricultural sector and provide an assessment of its contribution to the national economy. In the case of Zambia, they offer a survey of the data collection exercise and describe the specific regional conditions and difficulties incurred while collecting data.

### 5.2.1 Imperfect domestic markets and cross-border maize smuggling

Agriculture has not been one of the most influential industries in the economic history of Zambia prior to the 1980s. During the 1970s the government relied on simple, relatively inexpensive agricultural research programs as a means of enhancing agricultural productivity. Instead, the government concentrated its efforts on manufacturing and industrial production. In the early stages of the research programs, the research was conducted in order to develop productivity enhancing technologies such as fertilizers, pesticides, and capital-intensive crops. However, the design of these research programs did not meet the collective needs of small-scale producers.

Agricultural production statistics in Zambia suggest an increasing output trend of traditional crops particularly from the end of the 1980s and onwards. This can be attributed to the growing importance of the agricultural sector and its subsequent expansion. The predominance of maize as the main staple crop in Zambia is also indicative of the growing importance of the crop as a food security indicator. Even with the drastic declines between the crop years of 1992/1993 to 1998/1999, maize production has otherwise remained

consistent and steady at above 1 million metric tons per year. The extent to which this production trend is in response to changes in domestic agricultural policies is at the center of this research. For instance, between 2000 and 2008, agricultural expenditure was driven by a policy of an increased government interest and investment in agricultural development. The sector's dependence on donor funding also shifted during the 2003 crop year when government funding was increased in order to finance fertilizer subsidies and other food price subsidies (Govereh et. al., 2009). In other cases, output variations from year-to-year may also be attributed to natural and other man-made factors. The most common output interruptions have been extreme natural disruptions such as floods on the one hand and droughts on the other.

In spite of domestic food demand and the country's food security needs, at least half of domestic maize production is marketed domestically or abroad. Losses in the total national harvest due to smuggling to neighboring countries are an additional factor that imperils the demand and supply gap annually (Good, 1986). The smuggled quantity of maize, particularly that going to neighboring Zaire, has increased due to the attractive prices that producers would fetch when selling in those cross-border markets. The official price of maize in Zaire in 1983 was 18.3 Zambian Kwacha (ZM) per a bag, but a Zambian farmer could easily obtain ZM 35 by selling in Zaire (Good, 1986). The price offered to smugglers is almost twice what producers are offered in domestic markets.

These implicit losses of maize output are a constraint to the attainment of sufficient food supply in Zambia, as measured by the quantity of output procured domestically. Influential government officials have often been blamed for complicity in cross-border smuggling schemes. The government's failure to streamline the marketing institutions has created a constant lack of self-insufficiency in the supply of the most commonly consumed cereal. In the past, government attempts to ease inadequate domestic production have proven to be costly. The government is often forced to import maize, often at a higher price, which actually defeats the purpose of the evident wasteful smuggling out of the country of commodities that could otherwise be consumed domestically.

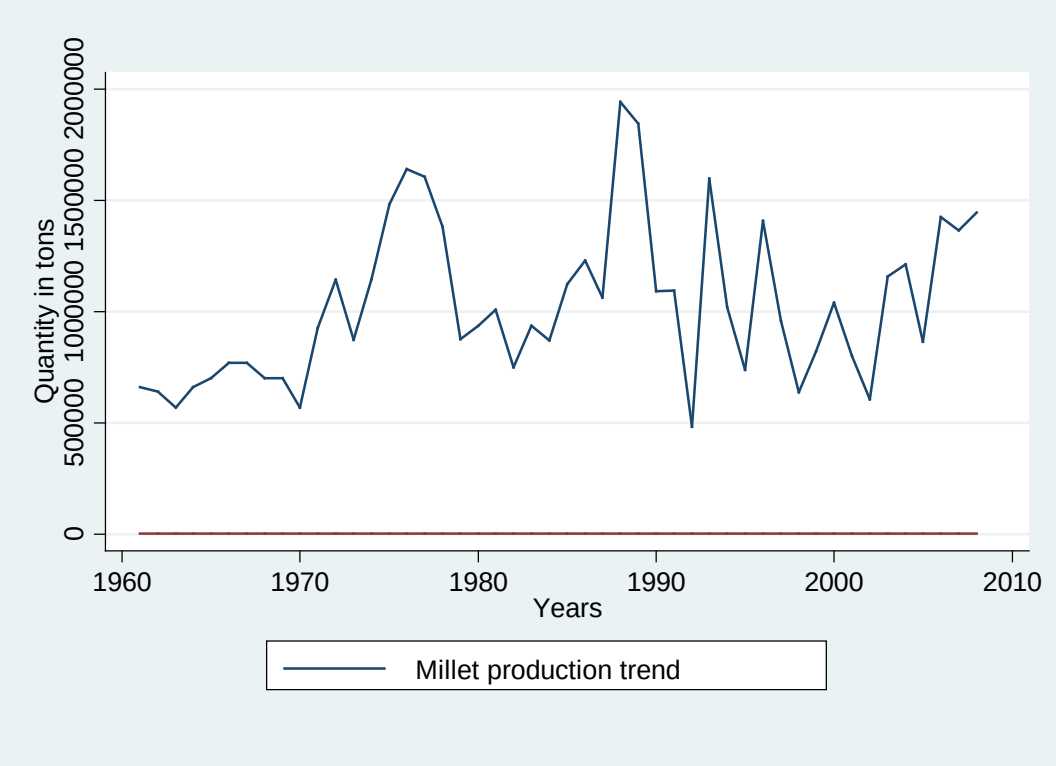


Figure 14. Millet Production in Zambia: 1961-2008

**Figure 14** above captures an annual series of millet production in Zambia. As a traditional crop millet is of relatively little interest to the state as compared to maize. Commercial inputs are not a direct benefactor of millet production, and its production trend is most likely driven by weather and other climatic conditions in the main producing regions.

### 5.2.2 Maize production and price data

Acreage is an important, but not the single most important, variable in determining maize output. This is under the implicit assumption that agricultural productivity is not influenced by agricultural technology. However, available arable land and its expansion is still a critical maize supply shifter. In some other cases, acreage is taken as a proxy for output due to the close relationship between arable land and the level of output. Statistics from Zambia suggest that maize, which is a cereal of national interest and a food security barometer, reflects steady progress in terms of the total production as well as the size of the area of land dedicated to its production. During the 1980s, maize acreage remained rather high, due to the support provided for farmer access by the government as a part of its support of the agricultural sector in general.

Maize production in Zambia is vulnerable to droughts and occasional floods, causing households to require access to stocks and imports if they are to maintain their consumption levels. The prices of maize in Zambia follow domestic production trends based upon the annual supply levels. Price policies in Zambia are tied to those in the southern African region, due to similar policy structures and the existence of a common market. However, this does not imply that cereal prices in the region are exclusively cushioned from international cereal trends. They remain dependent on international market trends which affect the respective products, and prices paid by local consumers vary slightly by country due to the cost of movement within the region.

Relative to the world and regional levels, prices in Zambia have remained exceptionally high and volatile. This volatility reflects two market chain elements:

i. An overall regional deficit in maize requires imports into the region from the world market. This causes prices in the region to realign with world levels, in addition to the transportation cost from the ports of entry.

ii. Shortfalls in the domestic maize market lead to prices rising to Zambian import parity levels. Regional countries are able to import grain in the event of a harvest shortfall. During normal harvests, the domestic market functions, and households are able to purchase their needed cereal at reasonable prices.

As a land-locked country, transport costs in Zambia, relative to other countries in the region, are high. This implies that even during normal harvest periods, prices will be between import and export parity. The cost of accessing the export ports in the southern African region, either for exports or imports, directly influences product prices.

### 5.2.3 Dynamic determinants of maize production in Zambia

There are basic underlying determinants of maize production in Zambia that are similar to those that drive agricultural production in Kenya. Among these, climatic and soil conditions are common natural factors which influence cereal output in both countries. There are other similarities in the institutional and infrastructural arrangements. The marketing of agricultural input and output systems is similar, but the outcomes of these policies have often led to different results. These factors, in combination to other region and policy specific conditions, have facilitated the expansion of maize production in Zambia.

The production of maize has expanded, making it the most important food crop for urban and rural consumers. The constantly increasing demand for maize and closely related cereals has created the need for producers to increase production in response. The rise of maize as a political crop drives the government to encourage its production in order to ensure that consumers, particularly urban residents, have sufficient access to it, at affordable prices. In the case of Zambia, maize became a major staple food consumed in the copper-producing regions. The increase in agricultural production in these regions was facilitated by a better road system, which permitted the distribution of agricultural commodities to the area. The growth in overall maize output was in response to the demand for maize and maize products in order to feed the workforce in the region.

Government support of maize research programs and the diffusion of technological research have contributed to better yielding hybrid seeds. The rapid dissemination of these technologies focused more on the research of maize than that of other crops (Byerlee & Eicher, 1997). Their widespread use, particularly hybrid seeds, has improved smallholder production yields and expanded the crop's marketability. The different varieties of maize seeds were made accessible to small-scale and large-scale producers with the overall effect of accelerating maize yields. However, while the introduction of hybrid seed varieties is crucial for maize production growth, the real cause behind the rise in output has been driven by area expansion. In Zambia, expansion into marginal areas has been fuelled by a high rate of population growth, 3.7 percent annually, during most of the 1970s (Kumar, 1994). Zambia wields strong potential for maize production through the cultivation of its existing large tracts of land. In terms of the proportion of arable land to the population density, Zambia has a greater expansion potential. The increasing urban and rural demand markets can be met by expanding the existing arable land potential for cultivation, especially in the Eastern and Southern provinces.

The expansion of regional integration in Eastern, Central and Southern Africa has given way to the expansion of trade across country frontiers. While ongoing trade is comprised of non-agricultural goods, agricultural commodities are also common, due to the strong agricultural base of the countries within the Common Market for Eastern and Southern Africa (COMESA). The main goals of COMESA include full market integration through increased efficiency. The formation of COMESA, under its free trade zone is an important instrument in the free movement of goods and services which also benefits the movement of agricultural commodities important in anchoring food security through trade. In the East African region, the renegotiation of the East African Community (EAC) provides a new opportunity for trade in the area both for agriculture and other sectors.

In the 1970s, the use of mechanical land preparation technologies, such as ox-plow and tractor cultivation, encouraged the expansion of area under cultivation. An abundant supply

of these mechanical implements facilitated expansion. These 'technologies' encouraged small-holder producers to substitute land for labor by applying sub-optimal crop husbandry practices. Improved land preparation technology facilitates area expansion, only to impose a labor constraint during subsequently important farm operations. Access to existing extension policies and other agricultural programs backed by the government encourages the expansion of agricultural crop area.

## 5.3 Summary description of the data

Maize output is defined as the total annual marketed maize measured in metric tons. The maize prices were collected from the statistical offices, but were compiled at the market value of a 90 kilogram sac. Acreage represents the total planted area of maize. Due to a lack of data, the loss of output arising from wastage or general losses is unaccounted for. Given the differences in fertilizer prices according to type, the most commonly used nitrogen fertilizer prices are selected. This type of chemical fertilizer is assumed to be the most commonly used by maize farmers. The price selected is based on an average annual market price as recorded by the Central Bureau of Statistics in either Kenya or Zambia. Hybrid maize seeds or their prices are not included in the estimations due to lack of pertinent data.

Table 3. Summary Description of Statistics

| **Zambia** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Variables** | **Units** | **Obs** | **Mean** | **Median** | **Max.** | **Min.** | **Std. Dev** |
| Maize acreage | Ha | 40 | 740747 | 736543 | 1116000 | 454500 | 184040.4 |
| Wheat acreage | Ha | 40 | 4721.5 | 2722 | 14880 | 41 | 4985.65 |
| Maize output | Tons | 40 | 1010692 | 936273 | 1943219 | 483492 | 363300.3 |
| Maize price | ZK | 40 | 67.86 | 14.7 | 478.9 | 2.5 | 112.1 |
| Rainfall | MM | 40 | 998.07 | 978.9 | 1274.6 | 770.3 | 131.7 |
| Fert. Price | ZK | 40 | 478107.4 | 632.5 | 3940298 | 147 | 1072418.7 |

| **Kenya** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Variable** | **Units** | **Obs.** | **Mean** | **Median** | **Max.** | **Min** | **Std. Dev.** |
| Maize price | Ksh. | 35 | 3470.1 | 1540 | 14494 | 275 | 4508.5 |
| Maize output | Tons | 35 | 889718.4 | 3060 | 2600000 | 1422 | 969603.7 |
| Tea acreage | Ha | 35 | 78813.3 | 82142 | 120390 | 27340 | 27564.3 |
| Maize Acreage | Ha | 35 | 66.09 | 66 | 87.2 | 50 | 8.76 |
| Fert. Price | Ksh. | 35 | 10307.54 | 10588 | 22668 | 0 | 6243.03 |
| Rainfall | MM | 35 | 658.46 | 644.2 | 962.7 | 472.6 | 122.87 |
| Wheat Acreage | Ha | 35 | 4532.02 | 131.834 | 154240 | 99.9 | 26049.55 |

The foregoing table consists of the summary of the variables used in the estimations presented in Chapter 7.

Table 4. Variable definitions

| | | |
|---|---|---|
| **Kenya** | | |
| **Dependent Variable** | | |
| $X_{1t}$ | Maize Output | Metric tons |
| **Independent Variables** | | |
| $A_{1t}$ | Current maize acreage | Hectares |
| $A_{2t}$ | Current wheat acreage | Hectares |
| $A_{3t}$ | Current tea acreage | Hectares |
| $K_{1t}$ | Fertilizer price | Ksh |
| $K_{t-1}$ | Lagged fertilizer price | Ksh |
| $MP_{1t}$ | Current maize price | Ksh |
| $MP_{1-t}$ | Lagged maize price | Ksh |
| Precip | Average annual rainfall | Millimeters |
| **Zambia** | | |
| **Dependent Variable** | | |
| $X_{1t}$ | Maize output | Metric tons |
| **Independent Variables** | | |
| $A_{1t}$ | Maize acreage | Hectares |
| $A_{2t}$ | Wheat acreage | Hectares |
| $K_{1t}$ | Fertilizer price | ZK |
| $MP_{1t}$ | Maize price | ZK |
| $MP_{1-t}$ | Lagged price of maize | ZK |
| Precip | Average annual rainfall | Millimeters |

# 6. The Econometric Model

## 6.1 Econometric approach

Theory and application are two important ingredients in any economic study. To begin with, theory forms the basis for an abstracted presentation of the data. For this study, the theoretical foundation is discussed in Chapter 4. The research proceeds by transforming the stated theory into a testable model. A time series model is selected as the most convenient economic approach in studying how the selected variables, presumed to be instrumental in shaping maize supply, change over time with respect to their influence on cereal supply. The omission of certain variables or the presence of randomness in multivariate analysis may lead to spurious results. In time series analysis, the use of a lagged explanatory variable is critical in explaining the outcome of a dependent variable.

The use of structural and reduced form equations is fundamental in econometric studies. The former describes the determination of the endogenous variables. Lagged variables, when used along with structural equations, are considered fixed and predetermined. The multivariate regression used in this research aims at estimating how the variables affecting cereal production, hence food supply, evolved in a changing policy environment. The econometric estimates, applied to data from Kenya and Zambia are presumed to serve as a guide in furthering economic, political and socio-environmental response to policy shocks.

Estimation methods often vary depending upon the intended objective of the researcher. The most common method applied is the least squares and maximum likelihood approach. Newer and sophisticated estimation techniques have been developed, but the traditional approaches still remain important. The least squares method is based on the minimization of the sum of squares of the residuals.

Maize output (domestic production) is represented by a dynamic production function in which some explanatory variables are presumed to affect output in current and in lagged time. This is typical in agricultural production where producers are assumed to exercise rationality in deciding their level of output given a range of inputs at their disposal. The incorporation of production response lags is important and common in the agricultural production inter-linkages in price expectations and acreage adjustment decisions. The assumption of producer rationality in production decisions is captured in the selected variables from year to year.

Agricultural production in Kenya and Zambia mostly relies on simple technology, abundant labor, and fairly thin markets. In addition to these characteristics, the use of fertilizer, hybrid

seeds, and some extension services is common as indicated in the generalized production model below:

$$X_{1t} = F(A_{it}, P_{it}, K; u) \quad (8)$$

$X_{1t}$ = maize output, $A_{it}$= acreage, $P_{it}$= price vector, $K_{it}$= input price vector, $u$= error term

In order to operate with a reasonably simple function, it would be necessary to assume zero values of the $u$. The relation of $u$ to the other variables may not be directly measured due to the lack of data, and agricultural production which is dependent on uncontrollable biological factors; the economic interpretation of which, given a set of values of acreage, prices and inputs, producers respond to differently. Variance in production decisions suggests that the factors of production are evaluated differently based upon the production environment and attending constraints or other unmeasured factors.

The data utilized in the estimation of the suggested economic relationship is based on secondary data sets[12]. In a few cases, however, information collected from relevant ministry desk offices enhances the interpretation of the research results based on the methods employed in data collection and survey, including any flaws that may exist in the research methods.

## 6.2 Econometric specification of supply equations

An econometric model of cereal supply requires sufficient analysis of the commodities that are being estimated. In any form of agricultural production, farmers are assumed to have rational expectations and to make some predictions on unknown variables based upon available information set at the time of production. These predictions are represented as mathematical expectations of the exogenous variables. Qualitatively, they are captured by the farmer's production level.

The following model uses simple approximations to model the exogenous variables (prices and policies). Policies in this case range over several or most of the variables used in the econometric representations. These policies would mostly be hidden and difficult to measure

[12] *Data used in estimating the equations in this research are subject to several qualifications. These qualifications pertain to the extent of reliability and policy applications thereof. The same data drawn from these countries are used by other international agencies such as the World Bank or other United Nations agencies and thus may be deemed reliable.*

except for the role of policies over prices (inputs and output) or overall agricultural marketing. On the assumption that policy changes occurred after the end of the 1980s, a dummy variable for policies will be assigned the value of '0', for the period prior to liberalization, and the value of '1' for the period after the introduction of reforms. The approximations are autoregressive that provide adequate representations as opposed to using similar, but more complicated relations. Data sets for non-land costs for the production of cereals and other cash crops are unavailable, so they become part of the error term. The estimation procedure, which considers cross-equation correlation of disturbances in the model, minimizes the effect of the missing information on parameter estimates.

In the econometric analysis, two types of cereals are analyzed: wheat and maize (also referred to as corn in most literature). Agricultural production in developing countries affects the market formation of various commodities and their marketing. Intensive production is presumed to lead to rapid vertical expansion (greater production per unit area) than non-intensive production. This form of production also relies on more intensive research aimed at the further improvement of cultivars for yield potential and the enhancement of cultural technology. Wheat production in Kenya has undergone some intensive research aiming at producing cultivars more tolerant to soil acidity and aphids.

The following AR specification is preferred over other ARIMA processes. The random disturbance term in average annual output of maize is represented by a first-order autoregressive process,

$$e_{1t} = \rho e_{1t-1} + U_t^e, |\rho| < 1 \tag{9}$$

The total acreage planted by all crops (maize and other crops) is represented by a second-order autoregressive process:

$$\bar{A}_t = \gamma_1 \bar{A}_{t-1} + \gamma_2 \bar{A}_{t-2} + U_t^{\alpha}, |\gamma_2| < 1, \gamma_1 + \gamma_2 < 1, \gamma_2 - \gamma_1 < 1 \tag{10}$$

A suggested option is to treat the area of land as fixed for all $t$. Farmers are often confronted with low crop yields (low productivity) due to inefficient production techniques applied to the land. In addition to these productivity constraints, agricultural policies exogenously constrain the level of maize output.

The condensed variables in equation [8] are selected based on their presumed relation to agricultural output, particularly cereal production. The estimation of a maize supply function will rely on the economic relationship of the prescribed variables to total maize output. In effect, the extent to which the explanatory variables influence the dependent variable will be interpreted on the basis of the sign and intensity of the individual variable parameters (co-

efficients). However, it is commonly assumed that due to the limited use of dynamic production technology in developing country agriculture, the application of intensive agricultural production techniques is not considered to be a reliable maize supply shifter. Natural or biological factors, which in most cases remain unmeasured, are aggregated to the error term. A common example is the irregularity of droughts or similar weather-related changes on which agricultural productivity depends.

In rural agricultural production acreage is a critical determinant of output, and hence the source of income which supports rural livelihood in the form of food and non-food benefits. A large portion of the staple food produced in rural areas is consumed as food while the surplus is marketed locally for income. Agricultural production that fetches profits for farmers eases access to production inputs, which is important in improving yields. Higher input prices (costs to the farmer) may at times prohibit farmer access. However, profitable marketable commodities often enable producers to invest some of the profits in the acquisition of inputs in required proportions. The exogenous character of input prices makes agricultural producers dependent on factors beyond their control. In theory, there exists a strong positive correlation between the level of output and the level of inputs until a point where diminishing returns take over.

$$A_{1t} = \alpha_0 + P_{1t-1} + P_{2t-1} + A_{3t} + e \tag{11}$$

Productive arable land is shared between a diverse set of commodities and producers, who continually change the type of commodity used based upon its economic value, its productive capacity or, in some cases, its cultural value. In general, maize production competes for existing land against tea, coffee, and other staple or non-staple crops. Increasing food production can be achieved by both intensive and extensive means. The intensive growth entails increasing the yield of a crop from a given area of land. Extensive agricultural production entails increasing total output by expanding the area of land. It is a practice that is preferred by agricultural producers in Kenya and Zambia, where the return from labor used is much higher than for intensification. Given that these countries are technology deficient and have abundant labor, extensive production is an economically practical resource.

$$P_{1t} = \alpha + \delta P_{1t-1} \ ; \ |\delta| < 1 \tag{12}$$

After the deletion of maize production costs and the other agricultural crop, this equation represents a function of variables that farmers might be aware of at time $t$. It is non-stochastic because it contains only variables in the farmers' information set.

$$A_{1t} = \delta A_{1t-1} + \mathbb{\Pi}_1 \bar{A}_t + \mathbb{\Pi}_2 \bar{A}_{t-1} + \mathbb{\Pi}_3 P_{1t-1} - \mathbb{\Pi}_4 P_{2t-1} + \mathbb{\Pi}_4 e_{1t-1} \tag{13}$$

# 7. Empirical Application to Kenyan and Zambian maize data

The graph below summarizes maize output data for Kenya and Zambia. The graphical summary of output only depicts the direction of output for each country. The estimations that follow will provide an explanation for these output trends and how food security as measured in maize was influenced by the suggested policy changes.

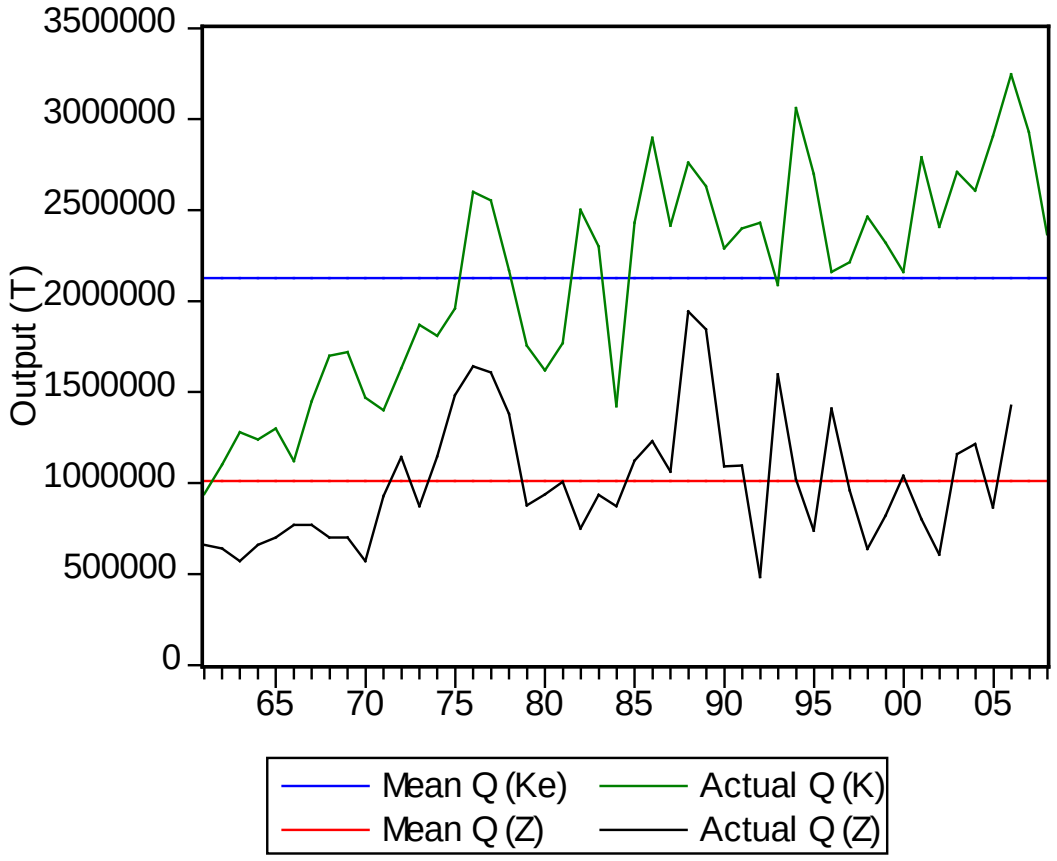


Figure 15. Maize output trend for Kenya and Zambia: 1961-2008

Figure 15 summarizes the broad overview of maize production, but the impact of policies cannot are not evident. The regressions in Chapter 7 are selected so as to identify the role that policies played in maize production during the years when policies were assumed to be in effect. An analysis between policy developments and maize output, hence food security for many households in both Kenya and Zambia, is made. This assessment considers the varied

the suggestion is that the policies affecting the agricultural sector were changed to such an extent that they impacted the delivery of agricultural output. Therefore, the figure only depicts the average aggregated maize production for both periods. It is also evident that the average aggregate maize output for Zambia does not show a remarkable shift in terms of quantity, but that the average output of Kenya experiences a marked quantitative increase. These averages do not take into account year-to-year changes and the possible factors driving such changes.

The estimation results below are founded on the hypothesis stated in Chapter 1 - that agricultural reforms were detrimental to agricultural output. The hypothesis is accordingly tested econometrically by the regression of the maize output against selected explanatory variables, using separate data from Kenya and Zambia in order to determine whether maize output responded to policy variables as such. The first set of results obtained consists of Kenyan data and the second set of results is comprised of Zambian data. The maize supply equations are estimated using Ordinary Least Squares (OLS) and by the Cochrane-Orcutt iterative procedure, with the results being presented in **Tables 5** through **Table 16** below. The properties of the entire maize output time series, which is about 41 crop years (ranging from 1961 to 2006), are therefore analyzed based on policy developments and the perceived response by the maize sub-sector and associated markets. A dynamic maize production considered, in which maize output, the regressand, is regressed against closely related explanatory variables. These regressors comprise of maize prices, maize acreage, input prices and the price of other close substitutes.

The results are evaluated against the performance of actual maize output and the presumed response to structural adjustment policies. The structural and policy changes were introduced in the second half of the 1980s and are representative of the range of policies introduced to the agricultural sector. These policies are subsequently presumed to influence maize production and the related markets. Policy factors affecting agricultural supply are wide-ranging and their imprecision makes it impossible to explicitly capture or accurately measure them. The suggested structural change is assumed to represent a range of the general economic policies that are presumed to affect not only the agricultural sector in general, but more precisely the maize sub-sector. The period prior to the mid-1980s was characterized by massive government intervention in the economy. Agricultural production during this period was not characterized by direct market demand through competitive prices; rather the government announced the prices for both producers and consumers. As a consequence, the implementation of reforms, which was often gradual, is considered integral in agricultural markets and in the formation of agricultural prices or other market indicators. Certain structural parameters in the economy – such as factor intensity, overall employment, production, and consumption – were the key indicators targeted by reforms.

In analyzing maize cereal output, lagged market prices are assumed to induce current supply according to the concept of producer rational expectations. The theoretical exposition in Chapter 4 postulates, through rational expectations, the cause and effect of lagged variables on their current observations. In that discussion, it is stated that producer rational expectations guide production decisions in response to market demand. For the current study, it can be extrapolated that the free flow of market information is an integral component of the decisions of maize producers. In addition, the proliferation of market information facilitates price formation and the subsequent transmission of market outcomes back to producers. Similarly, input prices, and in other cases demand, are influenced by existing policies. The effects of exogenous shocks on market functioning, by changing energy costs in international markets or unfavorable agricultural terms of trade, often negatively influence the agricultural sector in unpredictable ways. Changing energy prices, which are crucial in the production of fertilizer – an important agricultural input, could similarly affect the prices of other inputs unavailable domestically.

Table 6. Cochrane-Orcutt iterative procedure for serial correlation: 1962-2006

| Variable | Co-efficient | t-statistic | p-value |
|---|---|---|---|
| Maize acreage | 714.04 | 3.27 | 0.003* |
| Wheat acreage | 6.9 | 2.46 | 0.02** |
| Lagged maize price | -38.73 | -2.26 | 0.033** |
| Tea acreage | 9.67 | 3.16 | 0.004* |
| Precipitation | 427.4 | 0.77 | 0.45 |
| C | -632672.3 | -1.25 | 0.22 |
| AR (2) | -0.42 | -2.27 | 0.03** |
| R-Squared | 0.63 | | |
| Adj. R-Squared | 0.54 | | |
| **Breusch-Godfrey Serial Correlation LM test** | | | |
| F-statistic | 0.995729 | Prob. F(2,23) | 0.3848 |
| Obs*R-squared | 2.549938 | Prob. Chi-Square(2) | 0.2794 |

*, ** Signify significance at 1% and 5% levels

In the Cochrane-Orcutt iterative procedure, the co-efficient of the lagged price of maize and the acreage variable take the wrong sign. This outcome could be suggestive of the market conditions surrounding the period of state interference in the agricultural economy. It is difficult to identify the effect of policies on maize production, hence overall output. However, the equation yields robust results. Serial correlation is absent from the equation based on the diagnostic measure used; the Breusch-Godfrey serial correlation LM test.

significant. This may be attributed to the redundancy of the fertilizer price variable, which is caused by the inconsistence of input markets.

Table 8. OLS Estimate of the post-liberalization maize output: 1986-2006

| **Variable** | **Co-efficient** | **t-statistic** | **p-value** |
|---|---|---|---|
| Lagged fertilizer price | -31.55 | -1.70 | 0.12*** |
| Maize acreage | 28685.73 | 1.82 | 0.11*** |
| Lagged maize price | 107.62 | 2.41 | 0.04** |
| Tea acreage | -29.95 | -2.14 | 0.06** |
| Precipitation | 1770.23 | 2.29 | 0.05** |
| C | 2236621 | 1.31 | 0.22 |
| R-squared | 0.56 | | |
| Adjusted R-squared | 0.29 | | |
| **Breusch-Godfrey Serial Correlation LM test** | | | |
| F-static | 8240133 | Prob. F (2, 6) | 0.0000 |
| Obs*R-squared | 14.00000 | Prob. Chi-Square (2) | 0.0009* |

*, **, *** Signify significance at the 1%, 5% and 10% levels

In **Table 8** above, Wheat acreage is dropped as an explanatory variable, given its marginal value as a substitute for maize. The presence of serial correlation suggests that the significance of the included variables cannot be trusted. **Table 9** below illustrates, through the Breusch-Godfrey serial correlation LM test, that the equation is serially correlated.

Table 9. Breusch-Godfrey Serial Correlation LM test: 1986-2006

| | | | |
|---|---|---|---|
| F-static | 8240133 | Prob. F (2, 6) | 0.0000 |
| Obs*R-square | 14.00 | Prob. Chi-Square (2) | 0.0009* |

| **Variable** | **Co-efficient** | **t-statistic** | **p-value** |
|---|---|---|---|
| Lagged fertilizer price | 31.5 | 1589.8 | 0.00 |
| Maize acreage | -28637.1 | 2251.3 | 0.00 |
| Lagged maize price | -107.5 | -2986.1 | 0.00 |
| Tea acreage | 29.9 | 2219.6 | 0.00 |
| Precipitation | -1766.2 | -2236.6 | 0.00 |
| C | -2236621 | -1382.5 | 0.00 |
| RESID (-1) | 0.00032 | 2.46 | 0.05** |
| RESID (-2) | 0.000142 | 1.6 | 0.19 |

** is indicative of the serial correlation of the first order in the equation

The Breusch Godfrey serial correlation LM test reveals the presence of first order serial correlation. In order to remove serial correlation, the Cochrane-Orcutt iterative procedure is carried out below.

Table 10. Cochrane-Orcutt Iterative Procedure: 1986-2006

| **Variable** | **Co-efficient** | **t-statistic** | **p-value** |
|---|---|---|---|
| Lagged fertilizer price | -5.4 | -0.39 | 0.79 |
| Maize acreage | 24714.9 | 1.82 | 0.01* |
| Lagged maize price | 42.15 | 2.41 | 0.48 |
| Tea acreage | -33.5 | -2.14 | 0.04** |
| Precipitation | 998.1 | 2.29 | 0.09*** |
| C | 1330348 | 1.31 | 0.35 |
| AR (1) | 0.71 | 5.7 | 0.00* |
| R-squared | 0.85 | | |
| Adjusted R-squared | 0.81 | | |
| F-statistic | 25.05 | | |
| DW statistic | 2.3 | | |
| **Breusch-Godfrey Serial Correlation LM test** | | | |
| F-statistic | 0.432684 | Prob. F(2,6) | 0.6675 |
| Obs*R-squared | 1.764672 | Prob. Chi-Square(2) | 0.4138 |

*, **, *** Signify significance at the 1%, 5% and 10% levels

**Table 10** summarizes the regression equation, calculated based on data from the post-reform period, during which the role of the state in input and output markets had been significantly reduced. In Kenya, this was characterized by the decline in the role of the National Cereals and Produce Board (NCPB), a dominant state marketing agency, allowing for entry into maize marketing by private marketing enterprises. The NCPB lost its monopoly status and the wide-ranging powers, including the food security mandate accorded to it by the state. The vacuum resulting from the NCPB's relinquishment of its cereals market influence was not fully filled by the private sector.

The c-oefficient of maize acreage stands at 0.01, representing the highest significance at the 1% level. This is also indicative of the extensive nature of agricultural production in contributing to maize output in Kenya. The increase in maize output in Kenya, as in other developing countries, is mostly achieved through acreage expansion. The price co-efficient is positive, but insignificant, with a p-value of 0.48. The liberalization of prices and their resulting exposure to free market forces is one type of reform hypothesized to have had an effect on maize output. Of importance is the extent of the effect of price policy liberalization

on agricultural production and a combination of other policy and non-policy factors. There are non-policy variables, such as bio-physical conditions, that may not be captured in the estimated equation.

The price policies were decisive in maize production, mainly through inputs and output. However, in the equation, the lagged price of maize has a positive co-efficient, but it is statistically significant. In this case, it cannot be ruled out that prices were not important in determining output. Rather, it is suggesting that the price evolution in markets was incoherent, mainly due to government intervention in the markets. Prices, previously determined by the NCPB, in practice served as an intermediary between markets and producers. In theory, the price level serves as an incentive for markets by attracting the quantity that producers would be willing to supply. It would also mean that the importation and exportation of commercial maize to and from the interior would only take place in response to sizeable shifts in the price – shifts large enough to exceed the transport costs – thereby reducing the role that external trade would play in stabilizing domestic prices (Hubbard, 2003). However, it cannot be concluded fully whether the positive response of maize output to price policy change resulted in greater access to maize by traders.

First, the summary in **Table 10** suggests that maize output may not have responded well to price policy reform. This affirms the role that markets, if well regulated, would play in spurring production. According to the theory of rational expectations, farmers make their planting decisions and prepare current year acreage based on their expectations as observed in the preceding year (positive or negative). Other non-policy factors, such as local conditions, also play a role. However, the fertilizer variable takes the right sign, but is statistically insignificant. This may not concretely suggest that fertilizer is unimportant in contributing to maize output. The lack of statistical causality may be due to inconsistent access to the fertilizer input.

Structural adjustment programs supported output and input liberalization policies which, if adopted effectively, would generate growth in the agricultural sector. However, they were not immediately implemented, due to political opposition, as well as public resentment of the economic pain they implied. In theory, markets are a clearing house for production, where supply and demand converge to determine the price level. Farmers respond to higher or lower prices in their production; by raising their supply in response to higher prices and reducing output during periods when prices are low. In anticipation of higher prices for the next season, farmers form expectations by allocating the level of inputs and planting area to permit maximum output. In the case of inputs, given the extent of poverty in Kenya, the liberalization of input markets had the immediate effect of increasing the prices of inputs, particularly fertilizers.

Domestic maize output remains the most significant source of supply for the food consumed by rural and urban consumers in Kenya. The alternative source of cereal supply to meet domestic food (cereal) demand is imports from international markets. Through the importation of maize, often viewed as a temporary food security measure, the government may generally help ease the supply deficiency in the country. However, for low-income households in rural regions of Kenya, the reality of income poverty would not permit them to purchase the imported maize. Rural agricultural producers consume most of the maize they produce, making use of markets only in the case of a surplus. In the post-liberalization scenario, these farmers could benefit if they had enough to sell in markets for income. The policy implication of the results of **Table 10** for both rural and urban consumers may be mixed as the prices are likely to be counterproductive for their consumption, depending on market response to the prices. In spurring maize output, the potential of encouraging markets exists. However, it is also possible that the policy would serve as a disincentive for demand.

The inclusion of precipitation in the equation overwhelms other important factors that equally influence maize output. Over the years, maize supply instabilities have been common in Kenya. The country was more than self-sufficient in regards to maize production in good crop years (1982, 1983, 1987, 1989, 1990, and 1994). However, in bad crop years (1981, 1984 and 1993), a large amount of maize was imported. According to research conducted, the amount and timing of rains, poor quality fertilizer and seed maize, and falling prices during supply overrun periods were responsible. Sufficient rains at any given year during the land preparation and maize planting seasons may not be the sole determinant of the level of output; nevertheless, their amount and timing are crucial determinants. In the regression summary of **Figure 10,** a positive and significant interpretation of precipitation is expected. It is also notable that maize acreage is statistically significant in relation to total output, and that the co-efficient takes the correct positive sign. The fertilizer variable is also not statistically significant as observed in the same regression summary. Producers rely on rains in their maize-planting decisions. Rain delays tend to affect the quantity of harvested output, implying low market supply and higher market prices. Even with access to the other factors important for output, sufficient rainfall is a crucial factor; other variables depend on it for the realization of higher output. The introduction of reforms and the subsequent removal of subsidies had the direct effect of weakening fertilizer demand.

When the cash prices of coffee or tea decline, farmers producing those crops suffer losses based on their production and marketing costs. There are also losses associated with the opportunity cost of producing those crops, as opposed to producing maize or a more profitable crop. Unlike legumes or other horticultural products, tea does not permit intercropping. It is clear from **Table 10** that, rather than being complementary, increasing tea acreage does not improve the income position of producers by allowing them to purchase, for instance, the inputs necessary for maize growing. The actual net tea prices are often low and

as such do not earn income sufficient to allow farmers to purchase, for instance, inputs for maize planting. In the case of tea, the entry of other global tea producers, such as Vietnam and China, into the global tea market has led to overruns of tea supply in those markets.

The maize price co-efficient in **Table 8** behaves according to economic theory, which arguably supports the contention that policy has an effect on agricultural production. In the pre-liberalization era, inter-district (regional domestic trade) in Kenya was banned. Maize trade was not subject to open competitive markets. As such, maize trade was mostly conducted under the supervision of a government cereals agency. Corruption and cross-border smuggling of maize and other cereals was common prior to the introduction of reforms.

The stated hypothesis that the introduction of liberal policies negatively impacted food supply can be viewed from the response of the explanatory variables in the estimated equation. It may be concluded that maize output response was generally positive. However, it was not proven that market reforms resulted in a greater access to maize for consumption by the general public. Marketed maize response was most important for maize producers with access to markets.

Table 11. OLS estimates of pre-liberalization maize output results: 1962-1985

| **Variable** | **Co-efficient** | **t-statistic** | **p-value** |
|---|---|---|---|
| Maize acreage | 634.3 | 2.8 | 0.01* |
| Wheat acreage | 20.6 | 3.04 | 0.01* |
| Lagged maize price | -738.8 | -1.04 | 0.3 |
| Tea acreage | 21.9 | 1.93 | 0.07*** |
| Fertilizer price | 35 | 0.38 | 0.7 |
| Precipitation | 85.7 | 0.18 | 0.86 |
| C | -2642635 | -2.48 | 0.03** |
| R-Squared | 0.70 | | |
| Adjusted R-squared | 0.55 | | |
| **Breusch-Godfrey Serial Correlation LM test** | | | |
| F-statistic | 0.184521 | Prob. F(2,6) | 0.8360 |
| Obs*R-squared | 0.869148 | Prob. Chi-Square(2) | 0.6475 |

*, **, *** signify significance at 1%, 5%, and 10% levels

The regression results in **Table 11** illustrate the pre-reform regression equation and suggest that maize output responded strongly to most of the selected explanatory variables. However,

such response is subject to question, given the absence of free market conditions. State control over agricultural market instruments impeded any incentive for the exercise of market-based price formation for inputs and outputs. Pan-territorial pricing particularly discouraged agricultural producers from market-based production, due to the fixed prices dictated by the government. Consumer prices were often lowered, as a form of subsidy, in order to guarantee increased consumption. In the unrestricted model, the p-statistic suggests no viable link between market prices (a policy measure) and maize output. The lagged price co-efficient takes the wrong sign and there is an absence of statistical significance and no indication of an economic interpretation. The relationship between maize acreage and maize output may suggest a causal link, but the absence of free markets discredits such an interpretation. There are likely to be other non-policy factors that spur output as well. In the face of reform, maize output is assumed to have responded to policies. Such a response is indicative of the effects of policies on market instruments. The dependence of agricultural production on natural conditions such as the weather, rainfall, and temperature, is likely to overshadow the effect of observable policy factors.

A small group of private entrepreneurs, often with political ties, colluded to keep prices high, adding an additional cost to market. While this was common in other agricultural commodities, the sensitivity of the maize cereal in Kenya heightened the infiltration of corruption into the maize supply chain, from production to the market. Private investors, except for those with government ties, were mostly stifled out of maize markets. The introduction of reforms has paved the way for efficient export marketing, allowing farmers to keep a larger share of the export price for some products. However, maize producers faced difficulties in obtaining inputs in sufficient proportions due to ineffective fertilizer markets. Most fertilizer traders were unwilling to offer inputs on credit because of the likelihood of buyers reselling the same inputs to competitors and then defaulting on the payment.

Supply response to reforms is greater for export crops than for food crops. Farmers have often responded by reallocating land from one crop to another, or by expanding the overall area under cultivation, as opposed to increasing yields (Kherallah et al., 2002). Most of the cash crops are perennial, unlike maize, which is an annual crop with a shorter storage life. It is unclear from the estimations whether the removal of fertilizer subsidies increased fertilizer use, as was earlier anticipated. The statistical insignificance of the fertilizer co-efficient implies that a conclusive economic link cannot be made.

The foregoing results are based on nationally aggregated data, which naturally represents a loss of important economic information. Normally, economic information tends to be lost when data is aggregated – hence leading to a loss of meaningful tools of analysis. Market-related developments, such as global economic conditions, may not be accurately measured in so far as they influence domestic maize markets**.**

## 7.2 Summary of regression results for Zambia

The following regression results are based on the OLS estimates. The Breusch-Godfrey serial correlation LM test is also applied to check for the presence of serial correlation. In case of serial correlation, the Cochrane-Orcutt iterative procedure is applied. In all subsequent regression, maize output is the dependent variable. Assuming a structural change in the mid-1980s, the regression results from both the period before reforms and after reforms are included, for the purpose of comparison.

The estimations below are based on the following equation:

Estimated equation: $X_t = A_{1t} + A_{2t} + K_{t-1} + MP_{t-1} + precip_t$

Table 12. Zambia maize output OLS estimates: 1962- 2006

| **Variables** | **Co-efficient** | **t-statistic** | **p-value** |
|---|---|---|---|
| Maize acreage | 0.80 | 2.51 | 0.01* |
| Wheat acreage | 39.96 | 2.62 | 0.01* |
| Lagged maize price | 1010 | 0.66 | 0.51 |
| Fertilizer price | -0.16 | -1.33 | 0.19 |
| Precipitation | 630.98 | 1.39 | 0.17 |
| C | -378015 | -0.76 | 0.45 |
| R-Squared | 0.34 | | |
| Adjusted R-squared | 0.24 | | |

**Breusch-Godfrey Serial Correlation LM test**

| | | | |
|---|---|---|---|
| F-statistic | 3.748881 | Prob. F(2,31) | 0.0348 |
| Obs*R-squared | 7.595578 | Prob. Chi-Square(2) | 0.0224 |

*, **, *** signify significance at 1%, 5% and 10% levels

After performing the Breusch-Godfrey serial correlation LM test, the presence of first order serial correlation is detected in the estimates in **Table 12.** The use of lagged variables in the equation invalidates the DW test. To remove serial correlation and render the results more robust, the Cochrane-Orcutt iterative process is performed. The result convergence is illustrated below:

Table 13. Cochrane-Orcutt Iterative Procedure for serial correlation, 1961-2006

| Variables | Co-efficient | t-statistic | p-value |
|---|---|---|---|
| Maize acreage | .86 | 2.07 | 0.05** |
| Wheat acreage | 39.25 | 1.89 | 0.07*** |
| Lagged maize price | 569.12 | 0.35 | 0.73 |
| Fertilizer price | -0.12 | -0.81 | 0.42 |
| Precipitation | 805.03 | 1.9 | 0.06** |
| C | -519023 | -1.15 | 0.25 |
| AR (1) | 0.41 | 2.51 | 0.01* |
| R-Squared | 0.48 | | |
| Adjusted R-Squared | 0.38 | | |
| DW statistic | 2.11 | | |
| Inverted AR roots | .41 | | |

**Breusch-Godfrey Serial Correlation LM test**

| | | | |
|---|---|---|---|
| F-statistic | 0.483 | Prob. F(2,29) | 0.62 |
| Obs*R-squared | 1.227 | Prob. Chi-Square(2) | 0.54 |

*, **, *** signify significance at the 1%, 5% and 10% levels

The Cochrane-Orcutt iterative process for removing serial correlation indicates that only precipitation, maize acreage, and wheat acreage are statistically significant variables at the 5% and 10% levels. The removal of serial correlation by applying the iterative procedure in **Figure 13** results in a slight improvement in the significance of the results. Although the wheat acreage variable is statistically significant, it does not suggest any meaningful interpretation. As a crop competing for land area, the co-efficient is expected to be negative.

Table 14. OLS estimates of maize output: 1986- 2006

| Variable | Co-efficient | t-statistic | p-value |
|---|---|---|---|
| Maize acreage | 1.42 | 1.45 | 0.19 |
| Wheat acreage | -21.92 | -0.65 | 0.52 |
| Fertilizer price | -0.11 | -0.61 | 0.55 |
| Lagged maize price | 135.78 | 0.07 | 0.95 |
| Precipitation | 1375.71 | 1.41 | 0.23 |
| C | -772144.8 | -0.6 | 0.51 |
| R-Squared | 0.47 | | |
| Adjusted R-squared | 0.24 | | |

**Breusch-Godfrey Serial Correlation LM test**

| | | | |
|---|---|---|---|
| F-statistic | 1.34 | Prob. F(2,7) | 0.32 |
| Obs*R-squared | 4.15 | Prob. Chi-Square(2) | 0.12 |

*, **, *** represents significance at the 1%, 5% and 10% levels

The equation in **Table 14** lacks statistical significance. The application of the Breusch-Godfrey serial correlation LM test does not detect any serial correlation in the estimation results. These results can be viewed in two ways. First, the presence of government intervention in agricultural and maize markets implies that markets were not allowed to flourish, hence the disconnection between the policy variables and agricultural output. Secondly, the introduction of the precipitation variable in the equation almost crowds out the significance of the other variables. In order to test this, an estimation of the same equation is repeated without adding precipitation or lagging the price of fertilizer.

Table 15. OLS estimates of maize output: 1986 – 2006

| Variable | Co-efficient | t-statistic | p-value |
|---|---|---|---|
| Maize acreage | 1.94 | 2.06 | 0.06** |
| Wheat acreage | -32.73 | -1.95 | 0.36 |
| Fertilizer price | -0.10 | -0.73 | 0.48 |
| Lagged maize price | 1042.79 | 0.61 | 0.55 |
| C | 1923339 | 2.7 | 0.79 |
| R-Squared | 0.47 | | |
| Adjusted R-Squared | 0.41 | | |
| DW statistic | 2.97 | | |
| AR Inverted roots | -.58 | | |

**Breusch-Godfrey Serial Correlation LM test**

| | | | |
|---|---|---|---|
| F-statistic | 5.6 | Prob. F(2,8) | 0.03 |
| Obs*R-squared | 8.75 | Prob. Chi-Squ.(2) | 0.013 |

*, **, *** signify significance at the 1%, 5% and 10% levels

The detection of serial correlation is followed by its removal by applying the Cochrane-Orcutt iterative procedure for serial correlation.

Table 16. Cochrane-Orcutt iterative procedure for serial correlation: 1986-2006

| Variable | Co-efficient | t-statistic | p-value |
|---|---|---|---|
| Maize acreage | 2.42 | 3.30 | 0.01* |
| Wheat acreage | -44.26 | -2.14 | 0.06** |
| Fertilizer price | -0.06 | -0.55 | 0.59 |
| Lagged maize price | 517.36 | 0.41 | 0.69 |
| C | -1894.7 | -0.004 | 0.99 |
| AR (1) | -0.56 | -1.86 | 0.09*** |
| R-Squared | 0.62 | | |
| Adjusted R-Squared | 0.42 | | |
| AR Inverted roots | -.56 | | |

**Breusch-Godfrey Serial Correlation LM test**

| | | | |
|---|---|---|---|
| F-statistic | 3.384734 | Prob. F(2,7) | 0.0937 |
| Obs*R-squared | 7.374433 | Prob. Chi-Square(2) | 0.250 |

*, **, *** signify significance at the 1%, 5% and 10% levels

In **Table 16** the maize and wheat acreage variables regress well. The wheat acreage particularly reflects the likely competition for land area. This is noted by its negative co-efficient, implying that increasing wheat acreage results in a negative effect on maize output since they are competing for the same area of land. Policy variables such as the price of fertilizer and maize are insignificant, which is suggestive of the lack of functional free markets.

By recalibrating the estimates in **Table 16**, the results based on the Cochrane-Orcutt iterative procedure suggest that both fertilizer and maize price variables are statistically insignificant. The $R^2$ statistic, which measures the equation's goodness of fit, improves in the corrected equation. The response of maize output to changes in acreage is stronger after the removal of serial auto-correlation from the equation. The strong significance suggests that while policies had an influence on maize output, most of the output shift occurred due to acreage expansion. This is particularly the case in Zambia, which has a higher acreage ratio of land relative to producers and where the maize acreage variable co-efficient is plausible.

The results from **Tables 14** through **Table 16** suggest that acreage has a strong influence on maize output. This phenomenon may be due to the removal and reintroduction of fertilizer subsidies in Zambia, due to public pressure. The stop-and-go policy implementation experience was a common feature of economic liberalization. This never allowed fertilizer prices to freely respond to market conditions; rather, the government sanctioned the market. It can be interpreted that the implementation of reform policies was slow overall, particularly insofar as it affected the maize sub-sector. Constant policy reversals by the government may be the main cause, but other causes may be hypothesized, but difficult to measure. The direct state prevention of market development also hindered the other factors suggested to be directly associated with the production and marketing of agricultural products. A lack of price policy coherence for both maize inputs and outputs is certainly evident given the documented government interference in the economy. The simulated equation lacks evidence of the direct effect of prices in boosting maize production. Farmers' exercise of rational expectations is absent in maize production as well as across other sectors.

## 7.2 The implications of maize output estimates

These results present considerable variations in the maize sub-sector's response to agricultural reforms in the two countries. Even with the roughly similar approach applied in the estimations, and the selection of explanatory variables based on the maize economy in each country, the outcome depicts a varied maize output response. Several conclusions may be drawn from these outcomes. First, policies cannot be assumed to be the sole

maize/agricultural output determinant, given the nature of the agricultural sector in these countries. Additional crucial, but often ignored, factors would be at work as well.

The maize output equation (17), which is the core estimated supply equation, has direct implications on food security, due to the presumed contribution of domestic maize production to consumption and incomes. The maize cereal and derivative products is a major staple in the diet of rural and urban households, as compared to other cereals, such as millet or sorghum. Previous research on food security and agriculture has reiterated how agricultural productivity can enhance food security (Pletcher, 1986; Seshamani, 1998; Sitko, 2008; Muyatwa, 2001). These studies also imply that the proportion of aggregate population directly dependent on agriculture continues to increase. The expansion of maize production has been generally on the rise due to maize research and the commercialization of the maize variety technology. This is indicative of the importance of maize as a single staple and cash crop. Further, the decreasing or constant production value of traditional substitute cereals, such as millet and sorghum, suggests that the value of maize in consumer diets on average is higher and increasing. Access to production-based endowments also strengthens access to food and other livelihood means available from markets for average households.

One of the policy conclusions that can be drawn from the results based on Kenya is that maize output faces competition from cash crops, such as tea. At times, there exists the possibility that growing tea alongside maize may benefit its production by the investment of tea earnings into maize growing. However, the estimations suggest that tea is a competitor of maize, mainly for acreage. Rising maize production costs are not assuaged by the constant earnings from tea sales. In practice, the two markets have parallel characteristics. The rising cost in agricultural production, particularly maize production, does not mean that farmers with a tea plantation are better off than those who do not have one, even if the tea market is more vertically integrated and guarantees a constant source of income for farmers. Maize production inputs consist of: fertilizers, hybrid seeds, and other tools.

Elaborate agricultural policies affecting inputs and outputs harness the rate of growth in the food supply, a crucial partial element of food security. While the equation does not explicitly describe these important elements, they can be derived from recorded time series statistics. The food production aspect of food policy can be deducted from the total maize output and its response when controlling for other explanatory variables. On that score, policy instruments are crucial in informing policy makers of appropriate measures necessary in ensuring food self-sufficiency. The reflected long-run elasticity trends for maize output are crucial in aiding policy makers to draw policy conclusions. The data sets used in the main econometric equation are all aggregated nationally, which makes any conclusions drawn an embodiment of national food supply dynamics.

As reiterated earlier, the maize acreage variable, or acreage in general, is essential to maize output. This is consistent with the production of maize, which is an extensive and common crop in many agricultural economies. Maize output elasticity, with respect to acreage, is positive for Zambia. This response is an important indicator of the extensive nature of maize production. Even with the investment in maize research through agricultural research institutions, access to yield-enhancing technology is not yet widespread. The diversity of farming systems and the scale of production in the country cannot be decisively assumed to converge. The maize output response to changes in acreage suggests a strong positive correlation with maize. On the one hand, that confirms the extensive nature of maize production in Zambia. The acreage co-efficient is positive in relation to maize output at an aggregate level, and is in keeping with the general expectation for agricultural production in Zambia. However, this does not assume a similar trend when viewed domestically, due to decreasing per capita land holdings and decreasing marginal output, which is caused by an abundance of labor.

Maize's growing importance for food and income highlights farmers' responsiveness to prices and other market incentives. Improved price signals and efficient institutions serving the agricultural sector remain integral in deepening the role of markets in resource allocation. Access to sufficient inputs tends to affect the production side of agricultural markets by enabling producers to deliver desirable levels of output. Thin input markets lead to a contraction of agricultural output. Due to a lack of reliable data from the reference countries, input price data is not comprehensively elaborated. The maize supply response in the foregoing equation can be interpreted both as a response of output to prices, as well as a response of output to the manipulation of inputs. Input access manipulation can have consequences on the quantities producers apply in a given crop year. However, other important production inputs, such as technology, extension and marketing, are not adequately discussed in the study; rather, their role is qualitatively discussed in the course of the study.

The estimations suggest that wheat is a weak maize substitute in the case of Kenya. Wheat is a more technologically-intensive cereal, utilizing less labor and more machinery from planting to harvesting, as compared to maize, which is mostly labor-intensive. Wheat productivity has not improved and its supply has remained weak in the face of a rising demand. In sub-Saharan Africa, wheat demand has been overtaken by other coarse grains such as maize and rice, which can both be grown on a much smaller scale. The production of cereals, particularly wheat, is also constrained by ecological factors, so that its demand is met by other cereals. It is also noted in the literature that on average the SSA region produces only about 18% of the wheat it consumes, while the rest is imported (Morrison, 1984).

# 8. Conclusion

The objective of the study was to analyze the economic impacts of agricultural reforms on food security in two developing countries, Kenya and Zambia. Food security is defined within a supply perspective. A framework representing a macro-level analysis of the effects of agricultural reforms in general is formulated, on which basis an analysis of the maize sub-sector was developed. To evaluate the impacts of agricultural reforms, empirical data from the agricultural sector of both Kenya and Zambia was used in the estimations. A production model which accounts for rational expectations is empirically tested with time series data from both Kenya and Zambia.

The results from these empirical estimations suggest that the introduction of agricultural policies had varying effects in the countries studied. These results highlight the countervailing measures arising from state intervention, significantly for the case of Zambia. The discussed reforms were made up of wide-ranging structural changes applied generally within the agricultural sector, with a tremendous effect on the maize sub-sector. The policy reform measures considered included the liberalization of input and output prices through the elimination of subsidies, the inclusion of the private sector, and the restructuring of public marketing enterprises.

Based on the econometric results, it is evident that the results would vary even if generally similar structural adjustment policies were followed in the countries of study. The dissimilarity in outcome can be due to existing domestic conditions, or to the reaction of the lagged variable, multiplier effects and long-run differences. As this research focuses on policy implications, it is recognized that the state plays a decisive role in determining certain agricultural or economic outcomes. In effect, the organization of the state is a function of the performance of agricultural output.

Agricultural theory emphasizes the role of prices as a crucial policy instrument that signals producers and provides a benchmark for maize markets. Price changes allow producers to increase or decrease their production based upon existing market conditions. Maize output responded to maize prices in the post-liberalization era in Kenya much more strongly, and were it not for the intermittent setting of prices for inputs and output, the response would have varied. Similarly, the state’s influence over maize markets exerted a more disruptive outcome in Zambia as a result.

In both countries, acreage still remains a critical maize output shifter. The general lack of access to the essential inputs and technologies leaves producers with no choice other than to expand the area of land in order to increase output. While reform policies may have entered the maize supply chain through acreage, it is difficult to make strong policy conclusions as to

how they determined acreage size choice. The decision to expand acreage may have been a result of producers' direct access to subsidies enabling them to afford the basic inputs necessary for production. A specific example can be made from Zambia, which has a long history of providing subsidies for maize farmers to increase production, particularly during bad crop years. During the droughts of 2002, the government encouraged farmers to produce more maize, and even supported large-scale producers to do the same with the aim of averting a crisis in the next crop year.

Wheat and tea acreage are the selected land-competing variables in Zambia and Kenya respectively. It can be concluded that wheat is a maize substitute in Zambia while it is not in Kenya. For this reason, wheat may be deemed a marginal crop in Kenya. Tea acreage is the corresponding variable selected for the case of Kenya. Rather than complementing maize producers, expanding tea acreage serves as a direct competitor to maize output. It is at times assumed that earnings from tea crop sales by farmers growing both maize and tea may be plowed back to maize growing. Such income would enable these farmers to acquire inputs, such as seeds, fertilizers and other marketing costs, or enable them to switch to more intensive production. However, the results obtained in this study, with regard to tea acreage expansion; do not support such a conclusion.

The precipitation variable, whose occurrence is often unpredictable, influences maize output differently in the two countries. While the effect of precipitation is not quite as evident from Zambian results as it is from Kenyan ones, it stands to reason that rainfall is a decisive factor in agricultural output. The results suggest that the maize output in Zambia does not respond to the amount of rainfall and its inclusion in the equation distorts the other variables. Initial equation simulation indicates that its inclusion in the estimated equation made all the other variables statistically insignificant. However, it is statistically significant for the equation that applies to Kenyan data sets. In spite of the variance in outcomes, rainfall and weather in general remain a critical non-policy factor.

It is evident that producer response to policy change is slightly more significant in Kenya than in Zambia based upon the co-efficients of policy variables. Contrary to conventional thinking, producers in these countries do respond to market changes. This also implies that a considerable portion of the significant supply shift in maize output in Kenya would have been a result of the change in policies. However, the producers were confused by the multiple signals coming from markets, such as the implementation and withdrawal of policies.

It is evident from the results in both Kenya and Zambia that precipitation is an important factor in agricultural production. This is particularly evident given the ravaging effects of climate change, such as prolonged droughts. In the case of Kenya and Zambia, it should become government policy to explore other sources of underground water in order to reduce their complete reliance on rainwater. Even with such reliance, water harvesting and storage

should be improved in order to increase usage during the planting and growing season. This would imply the need for sustainable investment in irrigation schemes.

Finally, it is evident from this research that there is a tendency to rely on year-to-year maize harvests in order to ensure sufficient supply. Government policies should encourage and invest in maize cereal storage facilities to reduce avoidable wastage. Producers at the grass-root level may be educated through the ministries of agriculture on how to best improve storage facilities.

**Maatalousmarkkinoiden vapauttamisen vaikutus ruokaturvallisuuteen kehitysmaissa: vertaileva tutkimus, Kenia ja Sambia**

Tutkimus tarkastelee maatalousmarkkinoiden vapauttamisen vaikutuksia ruokaturvallisuuteen kehitysmaissa tarjontapuolen näkökulmasta. Politiikan rooli tutkitaan tarkastelemalla Kenian ja Sambian maissi-sektoria maataloustuotannon keskeisenä osa-alueena. Tutkimus analysoi ja arvioi 1980-luvun alussa valittua politiikkaa sekä tämän politiikan vaikutusta maissin tuotantoon. Tämän perusteella tutkimuksessa muotoillaan maataloustuotannon malli kuvaamaan viljakasvin tuotantoa ja siihen vaikuttavia tekijöitä kehitysmaaympäristössä.

Tutkimus alkaa katsauksella viitekehykseen ja rakennesopeutusohjelmien päämääriin, ja etenee kohti niiden toteuttamista Kenian ja Sambian maissintuotannossa. Ruokaturvallisuuden kysynnän ja tarjonnan synteesin kirjallisuustarkastelussa käsitellään useista kehitysmaista tulevia esimerkkejä. Toisin kuin aiemmat ruokaturvallisuutta koskevat tutkimukset, tämä tutkimus käsittelee komparatiivisesti kahta maata, joiden taloudellinen orientaatio on toisistaan poikkeava. Tutkimuksessa arvioidaan myös maataloussektorin reaktiota talous- ja instituutiopolitiikkaan erilaisissa puitteissa. Kvantitatiivinen empiirinen analyysi tehdään dynaamisella ekonometrisella mallila, jolla-arvioidaan niin politiikan kuin muiden tekijöiden vaikutuksia maissin tuotantoon.

Empiiristen tulosten mukaan politiikalla on vain vähän vaikutusta maissin tuotantoon, mutta sen sijaan sademäärä- ja pinta-alatekijät vaikuttavat erittäin suuresti maissin tuotantoon. Tutkittavien maiden heikkojen maanomistus-oikeuksien ja rakenteiden vuoksi politiikkamuutosten suoria vaikutuksia maamarkkinoihin ja maankäyttöratkaisuihin ei voida täsmällisesti mitata. Hallituksen jatkuvat väliintulot rakennesopeutusten toimeenpanon aikan häiritsivät osto- ja myyntimarkkinoiden tehokasta toimimista etenkin Sambiassa. Maissin ja lannoitteiden osto- ja myyntihinnat_reagoivat Keniassa voimakkaammin kuin Sambiassa, missä hallitus usein antoi periksi yleiselle paineelle kumoamalla suunnitellut politiikkatoimenpiteet. Ekonometrisen analyysin tulosten mukaan maatalousmarkkinat yleensä, ja erityisesti maissi-sektori, reagoivat voimakkammin toimeenpantuun politiikkaan Keniassa kuin Sambiassa, jossa tuettiin sosialistisempaa talousjärjestelmää.

Tutkimustulokset ossoivat, että ollakseen tehokasta politiikan täytyy ottaa huomioon sektori- ja aluekohtaiset erityispiirteet. Nain ei kuintenkaan tehty 1980-luvun rakennesopeutusten muotoilussa ja toteutuksessa. Voidaan sanoa, että maat, joissa oli dynaamiset taloudelliset rakenteet ja instituutiot, pärjäsivät paremmin kuin maat, joissa oli sosiaalisesti painottunut jäykkä järjestelmä.

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Appendix 1: Kenya agricultural statistics (1962-2005)

| Year | Maize output | Maize acreage | Wheat Price | Fertilizer Price | Maize Price | Tea acreage |
|---|---|---|---|---|---|---|
| **1962** | **156.7** | **34** | **47.92** | **17131** | **31.93** | **16.2** |
| **1963** | **211.6** | **35** | **47.9** | **16676** | **32.84** | **17.8** |
| **1964** | **110.1** | **30.2** | **47** | **31665** | **36.19** | **19.9** |
| **1965** | **130.8** | **30.9** | **47** | **47138** | **35.53** | **19.5** |
| **1966** | **132.1** | **57.3** | **49.17** | **30689** | **40.07** | **34** |
| **1967** | **235.1** | **57.6** | **51.17** | **28804** | **35.26** | **22.5** |
| **1968** | **352.6** | **51.6** | **56.26** | **38259** | **30.8** | **29.8** |
| **1969** | **280.3** | **55.8** | **54.51** | **31115** | **27.55** | **36.1** |
| **1970** | **205.7** | **59.3** | **45.1** | **50170** | **27.5** | **41.1** |
| **1971** | **256.6** | **66.29** | **50.61** | **41025** | **33.33** | **36.3** |
| **1972** | **373** | **77.2** | **50.61** | **54668** | **38.89** | **53.3** |
| **1973** | **440.8** | **75.8** | **57.26** | **73247** | **38.89** | **56.6** |
| **1974** | **365.4** | **63.7** | **80.36** | **104051** | **46.43** | **53.4** |
| **1975** | **487.8** | **68.09** | **104.71** | **44354** | **69.79** | **56.7** |
| **1976** | **564.71** | **74.3** | **120.3** | **20104** | **76.59** | **62** |
| **1977** | **424** | **85.4** | **133.33** | **88201** | **88.89** | **86.3** |
| **1978** | **236.3** | **72.8** | **133.33** | **78170** | **77.47** | **93.4** |
| **1979** | **241.7** | **56.7** | **143.64** | **38375** | **88.89** | **99.3** |
| **1980** | **217.9** | **70.7** | **163.86** | **61829** | **95.37** | **89.9** |
| **1981** | **472.9** | **87.2** | **166.67** | **61005** | **100** | **90.9** |
| **1982** | **571.3** | **81** | **187.58** | **70808** | **107.74** | **95.6** |
| **1983** | **637.1** | **55.3** | **222.2** | **72272** | **153.9** | **119.3** |
| **1984** | **560.6** | **57.3** | **269** | **36339** | **175** | **116.2** |
| **1985** | **582.9** | **69** | **271** | **111532** | **187** | **147.1** |
| **1986** | **669.5** | **61.1** | **293** | **120813** | **198** | **143.3** |
| **1987** | **651.9** | **68.8** | **295** | **52681** | **209** | **155.8** |
| **1988** | **485.3** | **64.9** | **340.57** | **66173** | **214.23** | **164** |
| **1989** | **625.9** | **66.9** | **342.8** | **50205.9** | **223.32** | **180.6** |
| **1990** | **509.3** | **66.79** | **450** | **27100** | **264.67** | **197** |
| **1991** | **303.5** | **66.2** | **500** | **51263** | **287.01** | **203.6** |
| **1992** | **515.2** | **66.1** | **385.67** | **49254** | **239.65** | **188.1** |
| **1993** | **241.8** | **66** | **565** | **49787** | **810** | **215** |
| **1994** | **316** | **65** | **1200** | **74593** | **950** | **209.4** |
| **1995** | **401** | **75** | **1300** | **35067** | **800** | **244.5** |
| **1996** | **295.5** | **65** | **1563** | **65155** | **1055** | **257.2** |
| **1997** | **204.6** | **64** | **1770** | **73392** | **1373.2** | **220.7** |
| **1998** | **218** | **50** | **1690.1** | **59965** | **1284.4** | **294.3** |
| **1999** | **223.5** | **62** | **1815** | **81064** | **1385.9** | **244.8** |
| **2000** | **201.2** | **63** | **1651.7** | **96305** | **1449.4** | **236.3** |
| **2001** | **461.5** | **85** | **1840.8** | **99738** | **1359.8** | **294.6** |
| **2002** | **398** | **80** | **1724.3** | **65265** | **1034** | **287.1** |
| **2003** | **280.5** | **65** | **1908.8** | **69122** | **1189.5** | **293.7** |
| **2004** | **448.5** | **83** | **2216.7** | **167986** | **1534.2** | **324.6** |

# Appendix 2: Zambia Agricultural production statistics (metric tons)

| Year | Maize | Guts | S. Flower | Cotton | Wheat | Tobac1 | Tobac 2 | Rice | Sorghum | Millet |
|---|---|---|---|---|---|---|---|---|---|---|
| **1989/90** | 1,119,670 | 29,450 | 29,450 | 36,536 | 53,601 | 1,550 | 3,489 | 9,293 | 19,591 | 31,531 |
| **1990/91** | 1,095,908 | 19,161 | 16,361 | 48,721 | 58,732 | 1,300 | 2,655 | 14,186 | 20,939 | 25,573 |
| **1991/92** | 483,492 | 19,833 | 10,645 | 25,899 | 54,490 | 1,050 | 1,258 | 9,325 | 13,007 | 48,029 |
| **1992/93** | 633,326 | 20,504 | 1,493 | 47,851 | 69,286 | 2,514 | 4,138 | 15,742 | 35,448 | 37,394 |
| **1993/94** | 679,356 | 34,301 | 15,479 | 33,093 | 60,944 | 1,083 | 5,015 | 13,993 | 35,068 | 62,644 |
| **1994/95** | 520,165 | 34,732 | 9,821 | 16,578 | 38,019 | 1,560 | 2,240 | 6,358 | 26,523 | 54,501 |
| **1995/96** | 675,565 | 36,119 | 13,649 | 40,824 | 36,019 | 1,892 | 1,950 | 12,110 | 35,640 | 54,858 |
| **1996/97** | 649,039 | 34,755 | 26,178 | 75,412 | 57,595 | 2,360 | 4,399 | 13,296 | 30,756 | 61,129 |
| **1997/98** | 510,372 | 45,859 | 74,332 | 66,897 | 70,810 | 2,827 | 6,848 | 6,399 | 25,399 | 62,236 |
| **1998/99** | 818,149 | 56,934 | 5,708 | 58,381 | 89,743 | 3,762 | 4,838 | 14,700 | 13,914 | 60,413 |
| **1999/00** | 1,052,806 | 57,246 | 7,064 | 58,276 | 90,000 | 3,350 | 6,183 | 8,835 | 26,898 | 42,863 |
| **2000/01** | 801,877 | 53,251 | 19,176 | 49,282 | 82,264 | 4,196 | 7,420 | 12,387 | 30,245 | 49,606 |
| **2001/02** | 839,783 | 76,194 | 7,588 | 65,979 | 74,527 | 4,930 | 7,941 | 5,303 | 16,801 | 37,615 |
| **2002/03** | 1,207,202 | 82,550 | 4,860 | 64,659 | 84,000 | 12,465 | 8,462 | 10,744 | 20,301 | 35,331 |
| **2003/04** | 1,213,601 | 69,696 | 13,857 | 144,307 | 82,858 | 20,000 | 16,000 | 11,699 | 24,467 | 39,784 |

(1) Burlington Tobacco, (2) Virginia Tobacco

Source: Central Statistical Office, Zambia.

# Quantity of marketed cereal production in Zambia (metric tons)

| Year | Maize | Wheat | Paddy rice | Sorghum | Millet |
|---|---|---|---|---|---|
| **1989/90** | 601,165 | 51,457 | 5,594 | 205 | 135 |
| **1990/91** | 602,884 | 57,635 | 8,905 | 1,007 | 4,417 |
| **1991/92** | 260,125 | 52,701 | 5,686 | 664 | 11,022 |
| **1992/93** | 929,936 | 60,204 | 10,219 | 5,310 | 5,575 |
| **1993/94** | 476,288 | 53,607 | 3,553 | 3,722 | 12,836 |
| **1994/95** | 344,676 | 31,816 | 6,388 | 7,751 | 13,242 |
| **1995/96** | 668,123 | 49,402 | 7,475 | 7,017 | 13,684 |
| **1996/97** | 314,608 | … | 8,216 | 5,129 | 12,164 |
| **1997/98** | 182,384 | … | 1,568 | 3,917 | 12,364 |
| **1998/99** | 250,003 | … | 4,483 | 3,520 | 12,759 |
| **1999/00** | 191,592 | 79,493 | 3,194 | 1,553 | ... |
| **2000/01** | 292,401 | 93,877 | 7,494 | 3,361 | ... |
| **2001/02** | 292,979 | 65,618 | 6,189 | 1,385 | 4,020 |
| **2002/03** | 591,300 | 84,000 | 5,716 | 2,625 | 7,325 |
| **2003/04** | 481,184 | 100,000 | 3,524 | 2,519 | 8,415 |

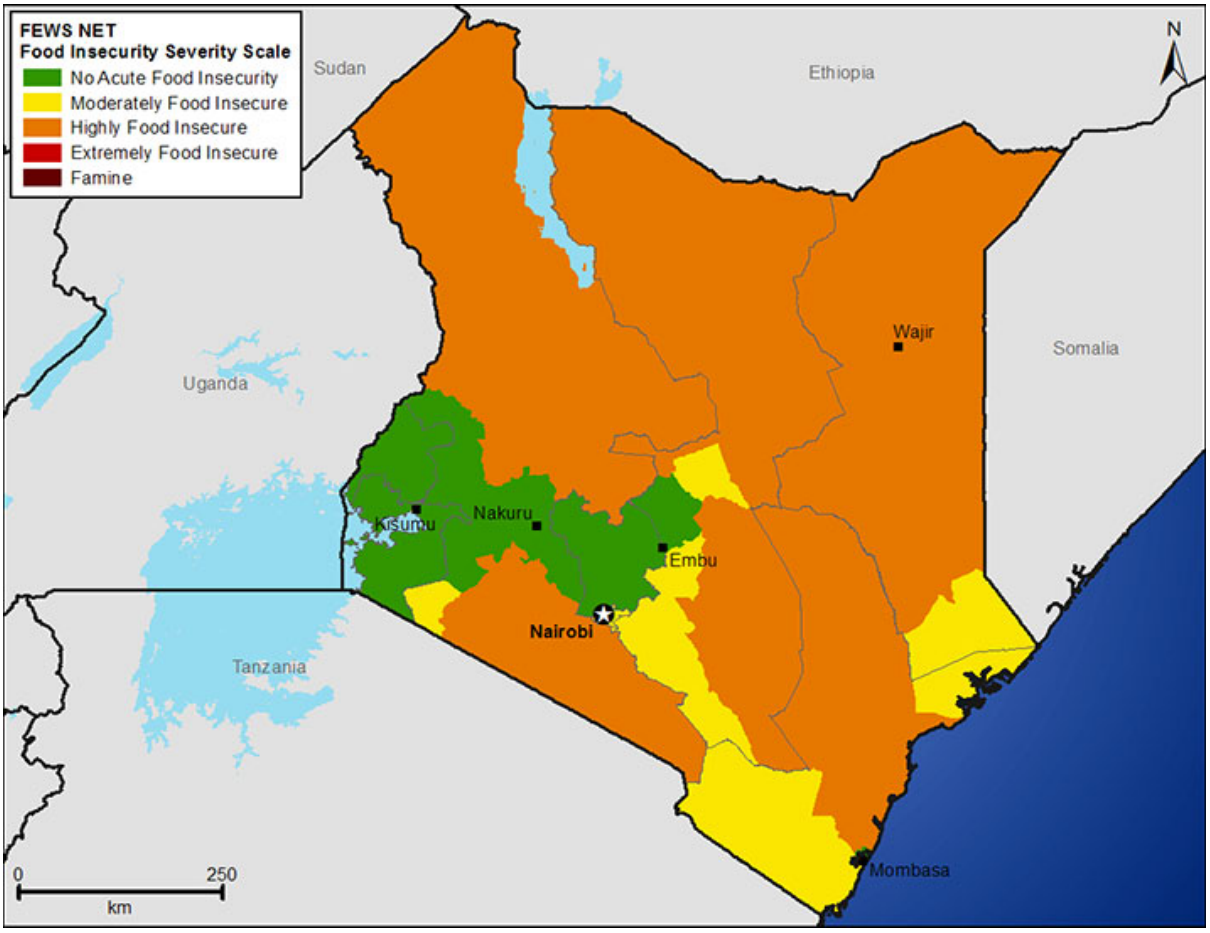
Source: Central Statistical Office, Zambia

## Acreage for the major agricultural commodities in Zambia (ha)

| Year | Maize | Grndnuts | S Flower | Cotton | S.bean | Wheat | P. Rice | Sorghurm | Millet | M. Beans |
|---|---|---|---|---|---|---|---|---|---|---|
| **1989/90** | 763,258 | 80,443 | 44,289 | 64,036 | 29,815 | 11,595 | 9,627 | 48,466 | 58,869 | 26,436 |
| **1990/91** | 639,390 | 80,470 | 36,490 | 74,020 | 29,200 | 11,849 | 13,450 | 31,790 | 45,270 | 28,940 |
| **1991/92** | 661,305 | 68,724 | 32,302 | 59,614 | 22,786 | 10,964 | 14,369 | 40,323 | 66,598 | 38,508 |
| **1992/93** | 623,340 | 71,415 | 39,450 | 76,492 | 19,864 | 13,656 | 13,802 | 46,563 | 52,654 | 38,489 |
| **1993/94** | 679,914 | 105,737 | 31,079 | 50,067 | 25,447 | 11,566 | 7,177 | 55,245 | 82,302 | 48,599 |
| **1994/95** | 520,165 | 100,431 | 32,433 | 35,200 | 21,612 | 7,806 | 9,746 | 40,365 | 73,809 | 41,462 |
| **1995/96** | 675,565 | 89,488 | 47,621 | 66,217 | 25,489 | 10,327 | 9,888 | 47,839 | 76,930 | 43,240 |
| **1996/97** | 649,069 | 126,573 | 20,745 | 89,879 | 17,273 | 10,693 | 12,412 | 40,237 | 78,639 | 41,541 |
| **1997/98** | 510,374 | 154,682 | 15,692 | 80,254 | 11,681 | 11,251 | 9,065 | 35,864 | 90,047 | 35,379 |
| **1998/99** | 598,181 | 119,945 | 14,280 | 70,629 | 11,716 | 12,682 | 13,346 | 36,405 | 77,292 | 30,780 |
| **1999/00** | 605,648 | 69,532 | 12,983 | 36,947 | 11,721 | 14,113 | 10,532 | 37,388 | 61,277 | 39,853 |
| **2000/01** | 583,850 | 137,108 | 37,666 | 56,939 | 16,754 | 14,380 | 14,321 | 43,354 | 69,738 | 51,025 |
| **2001/02** | 696,619 | 139,562 | 22,600 | 87,026 | 17,963 | 22,600 | 13,050 | 33,955 | 61,347 | 40,043 |
| **2002/03** | 699,276 | 150,460 | 22,521 | 86,431 | 17,402 | 26,277 | 10,305 | 37,054 | 56,751 | 44,002 |
| **2003/04** | 631,080 | 116,978 | 30,689 | 121,593 | 33,186 | 13,543 | 12,379 | 45,350 | 59,081 | 45,270 |

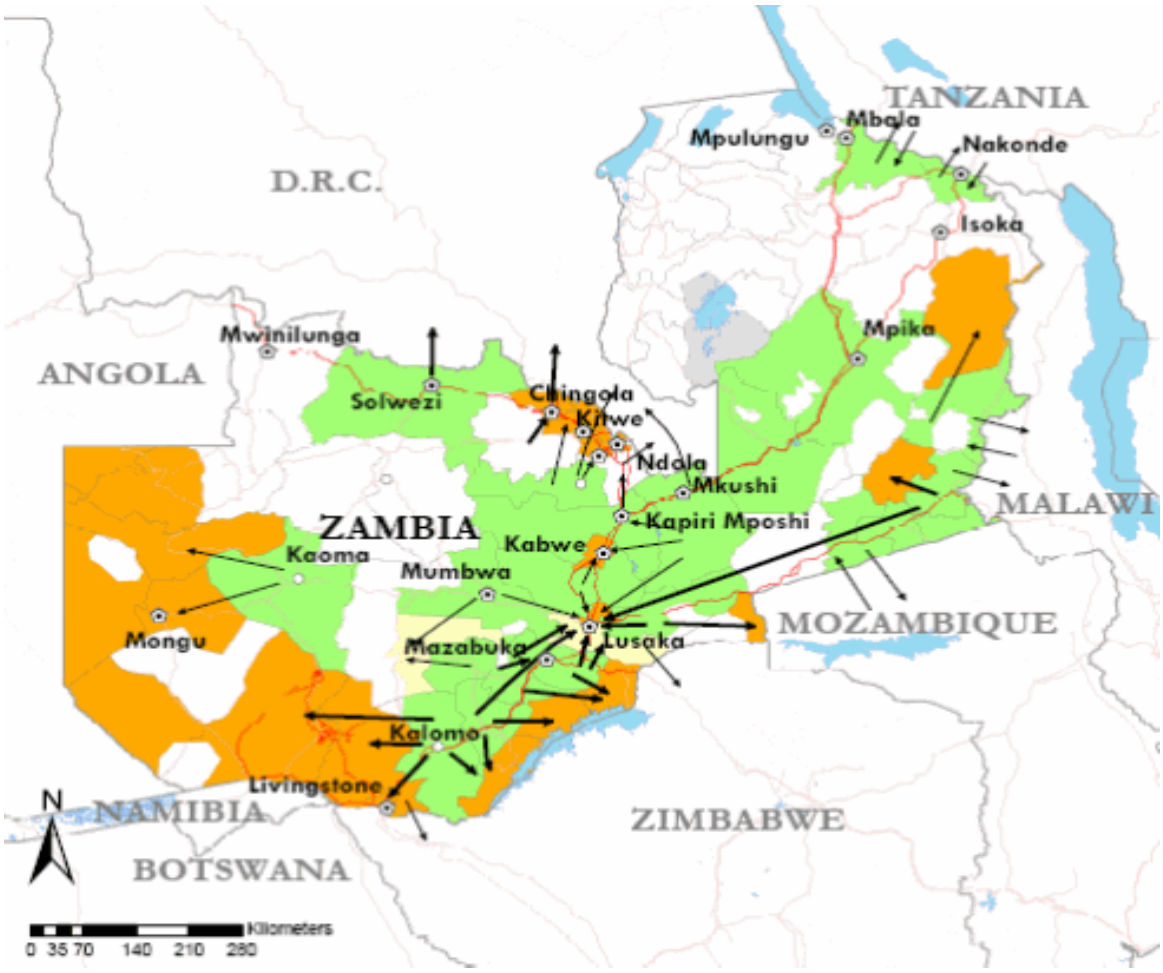
Source: Central Statistical Office (CSO), Zambia

## Map of Kenya

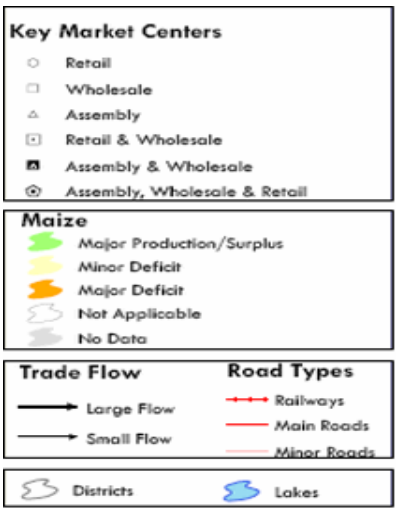



Source: Famine Early Warning System Network (FEWS)

## Map of Zambia




Source: FEWS




Source: Famine Early Warnings System Network (FEWS)